Using OVERSEER® in Regulation

Technical resources and guidance for the appropriate and consistent use of OVERSEER® by regional councils

August 2016

Project developed by an OVERSEER® Guidance Project Board consisting of the following organisations:
Bay of Plenty Regional Council, Environment Canterbury, Hawkes Bay Regional Council, Waikato Regional Council, Horizons Regional Council, Ministry for Primary Industries, Ministry for the Environment, Overseer Limited, Dairy Industries Council, Horticulture NZ, Foundation for Arable Research, Beef + Lamb NZ, and Landconnect Limited

Project funded by the following organisations:
Ministry for the Environment, Ministry for Primary Industries, DairyNZ, Horticulture NZ, Environment Southland, Greater Wellington Regional Council, Bay of Plenty Regional Council, Environment Canterbury, Hawkes Bay Regional Council, Horizons Regional Council, Nelson City Council, Marlborough District Council, Otago Regional Council, and Waikato Regional Council.

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The document may be cited as:

Freeman, M, Robson, M, Lilburne L, McCallum-Clark, M, Cooke, A, & McNae, D. (2016) Using OVERSEER in regulation - technical resources and guidance for the appropriate and consistent use of OVERSEER by regional councils, August 2016. Report prepared by Freeman Environmental Ltd for the OVERSEER Guidance Project Board.

Published on 8 August 2016 by
Freeman Environmental
Christchurch,
New Zealand

ISBN: 978-0-473-36530-1

This document is available for downloading from www.overseer.org.nz

Cover photo - Lake Heron Station, Colin Monteath/Hedgehoghouse.com

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Executive Summary

Background

Much of New Zealand's freshwater resources are being adversely affected by diffuse discharges of nitrogen and phosphorus from urban and rural land. Under the National Policy Statement for Freshwater Management 2014 (NPS-FM) regional councils are required to establish freshwater objectives and set freshwater limits for water quality. The NPS-FM also requires regional councils to develop a freshwater quality accounting system to monitor nutrient concentrations/loads, the sources/amounts of nutrients, and where limits have been set, the proportion of that limit that is being used.

Where it is not practicable to measure diffuse discharges directly, the requirements of the NPS-FM will generally require some form of catchment and source nutrient load modelling to provide a basis for identifying and implementing appropriate management measures to achieve water quality objectives. The modelling used can range from simple conceptual models to complex software that models interactions between land use, topography, soils and climate.

OVERSEER® Nutrient Budgets (OVERSEER) is a computer software model that is being used to provide estimates of annual losses of nitrogen and phosphorus from a broad range of farm systems. OVERSEER models nutrient use and movement within a farm system. OVERSEER estimates the nutrient flows in a farming system and specifically includes estimates of nitrogen and phosphorus loss through leaching and/or run-off. The core of OVERSEER is a nutrient budget, which includes the nutrient inputs and outputs of a farm system.

How should OVERSEER be used under the Resource Management Act

OVERSEER is being used in regional plans and resource consents in many different ways throughout New Zealand and while there is some guidance on technical aspects of its use, there has been little guidance on its use in plan-making or in the resource consent process. The decision to use OVERSEER in these situations needs to be made in the knowledge of the model's assumptions and limitations and the issues that may arise with its use. Finding appropriate ways to address issues that arise is critical to ensuring the use of OVERSEER is fit for purpose under the Resource Management Act.

The purpose of this report is to provide information and advice to those who are using or are considering using OVERSEER to assist in informing the establishment of freshwater objectives, in setting and managing to freshwater quality limits under the NPS-FM, and in resource consent processes. Specifically, the report has been prepared to meet two key objectives:

1 To provide guidance for regional councils on the principles governing the use of OVERSEER in plan-making and resource consents.

2 To provide specific guidance for regional councils on how to manage the key modelling limitations that impact how OVERSEER can be used in plan-making and resource consents.

There is no single correct approach to managing the impacts of land use on water quality, and OVERSEER may be used in different ways within these different approaches. This report identifies key principles and practical guidance for using OVERSEER in the context of the overarching imperative to manage the impacts of land use on water quality.

This report is primarily intended for regional council staff (and consultants) who are involved in preparing and implementing regional plans, consultants involved in regional plan-making and resource consent processes, and Resource Management Act (RMA) decision-makers.

This document does not specifically address the question of whether a regional council should or shouldn't use OVERSEER in a regional plan and/or resource consent process, although the information contained should assist with such decisions.

Key Messages

1 Providing the assumptions, limitations (Appendix 3) and principles (Table 1) are taken into account, OVERSEER is suitable to provide estimates of nutrient loss for use in the implementation of the National Policy Statement for Freshwater Management 2014.

2 The decision by a regional council on whether or not to use OVERSEER will be influenced by a range of factors such as:

- the nature and extent of the water quality issue;
- the specific characteristics of the catchments;
- the state of knowledge about the water quality and catchment characteristics and the data available;
- the likely sources of nutrient(s) contributing to the water quality issue and the ability to measure at or near source;
- whether input-based or output-based methods of managing diffuse nutrient discharges are preferred;
- consideration of the relevant assumptions, limitations and principles, particularly those relating to uncertainty and version change management;
- the resources available to the regional council and the community; and
- the overall planning approach and philosophy.

3 The most appropriate approach to using OVERSEER in the development of plan provisions will depend on the specific catchment characteristics, the extent of nutrient water quality issues, the level of information available, the resources available to develop and implement a regional plan, the objectives sought by the regional plan and the consideration of these in the context of the principles outlined in Table 1.

4 Plan objectives and policies specific to nutrient water quality need to be clear and directive to ensure the environmental results sought by the plan are clear and to provide clear guidance for resource consent decisions that involve OVERSEER nutrient loss estimates.

5 The specification of a source nutrient load in plan provisions (e.g., objectives and/or policies) provides a high level of transparency and certainty. However, this is contingent on a robust mechanism to deal with improving information and model version change where the specified load is largely reliant on OVERSEER estimates.

6 In addition to the existing guidance on resource consent conditions, there are important specific matters that need to be considered and incorporated in resource consent conditions that require an OVERSEER nutrient loss estimate, to ensure that the intent of limiting nutrient losses is achieved and ultimately that freshwater quality objectives are achieved.

7 OVERSEER can be a critical part of the process of estimating catchment nutrient source loads. However, it is important to understand the implications of the different estimation methods and the factors that need to be taken into account e.g., uncertainties related to OVERSEER estimates, catchment attenuation factors and OVERSEER version changes.

8 OVERSEER version changes are an essential consequence of improvements to the accuracy of OVERSEER estimates, broadening of its applicability and improving its usability and/or user interface. However, OVERSEER version changes (excluding usability and user interface changes) can result in significant changes to estimates of N and/or P loss. The consequential changes in nutrient loss estimates can vary significantly from property to property, depending on the level of similarity of soils, climate, climate patterns, topography, farm systems, etc.

9 OVERSEER version changes can potentially affect the understanding of source nutrient losses that was relied on in the plan-making process, and can potentially affect the status of activities under regional rules and/or resource consents. A range of methods can be used in regional plan provisions and resource consent conditions to avoid or minimise the consequences of version changes (see Sections 3 & 4).

10 Uncertainty in OVERSEER nutrient loss estimates is inevitable and regional plan and resource consent decisions need to acknowledge and endeavour to reduce uncertainty. Uncertainty is not a reason to take no action. Rather, the higher the uncertainty, the greater the need for robust monitoring and review processes for plan provisions and resource consents.

11 Some uncertainty in OVERSEER nutrient loss estimates will be reduced by undertaking and incorporating further science e.g., collecting more evaluation data under different soils and climates. Other forms of uncertainty are essentially irreducible e.g., biological variability. There are options and methods for using OVERSEER and OVERSEER outputs in a way that recognises and manages uncertainty in planning and resource consent processes.

12 Provided that the relevant assumptions, limitations (Appendix 3) and principles (Table 1) are taken into account, OVERSEER is suitable to model P as well as N source loss at a property and catchment level.

13 The receipt and long-term management of individual OVERSEER property files need well-designed data management and security systems to ensure that all legal, technical, and long-term information needs are met. Significant resources are required to develop and implement the necessary data provision and security measures.

14 OVERSEER modelling requires a detailed knowledge of the New Zealand farming system being modelled and a detailed understanding of OVERSEER. This is particularly significant for scenario modelling. Therefore, only people with the requisite knowledge should undertake OVERSEER modelling to meet regional plan and or resource consent requirements.

15 A high level of assurance about the fitness for purpose of an OVERSEER estimate of nutrient loss needs independent auditing by a person with significant knowledge of the modelled farming system and OVERSEER.

16 The use of OVERSEER requires an understanding of the functions and relationships of component parts of the model. This requires regular publication of the details of those functions and relationships.

Recommendations

Recommendations – Plan-making (Section 3)

1 There is no one best way to apply OVERSEER within a regional planning framework. How and where OVERSEER is used in the plan-making process needs to be considered in the wider context of specific catchment characteristics, the extent of nutrient water quality issues, the level of information available, the resources available to develop and implement a regional plan, the freshwater objectives, and consideration of the principles outlined in Table 1.

2 Regional plan provisions should have clear and directive objectives and policies specific to nutrient water quality (e.g., receiving water nutrient concentrations and algal biomass) and catchment nutrient limits to ensure the environmental results sought by the plan are clear. This would provide clear guidance for any resource consent application process that involves OVERSEER nutrient losses estimates.

3 Where farm environment plans are identified as an implementation mechanism within a regional plan, the provisions should be clear about their specific role i.e., are they intended to be a primary enforceable element of a rule and/or resource consent condition (see Section 3.4) or are they intended to primarily provide information to complement other conditions?

4 Take account of the potential implications of OVERSEER version changes by:

   (a) incorporating a process in an implementation plan (see sections 3.2, 3.3 & 3.4) to assess the implications of OVERSEER version changes on estimates of catchment source nutrient loads and any other relevant improved catchment information (e.g., hydrological information) for plan provisions,

   (b) avoiding the used of fixed numerical thresholds with no OVERSEER version management method in permitted activity and prohibited activity rules that require OVERSEER estimates to determine compliance with those thresholds,

   (c) ensuring that there is a robust method of managing the effects of an OVERSEER version change if thresholds are used in any rules classifying activity categories that require OVERSEER estimates to determine compliance with those thresholds (see Section 6),

   (d) to the extent the methods referred to in (c) above are not fully effective in managing the effects of OVERSEER version change, minimising the reliance on activity status definition thresholds that depend on OVERSEER estimates e.g., by minimising the number of classes of activities defined by such thresholds to minimise the risk of a land use or discharge changing activity status as a consequence of an OVERSEER version change,

   (e) considering the use of a mechanism to minimise the impact of OVERSEER version changes on regional rule (and resource consent) thresholds, including, but not limited to, a link to an external calculator or reference files, but recognising that (as at July 2016) there is no case law on this type of linked external mechanism (see Section 6), and

   (f) recognising that methods of using OVERSEER in regional plans and resource consents are still developing and that approaches adopted by some plans have not been fully tested.

5 Where regional rules are set that rely on OVERSEER estimates to determine compliance, they should include the following requirements:

   (a) a requirement to undertake OVERSEER modelling in accordance with appropriate standards and guidelines e.g., the relevant Best Practice Data Input Standards (BPDIS), and in particularly sensitive situations, a requirement for independent auditing as outlined in Table 12.

(b) a defined period(s) of time over which the OVERSEER modelling must be undertaken – generally a minimum of a rolling average of three to five years (see Section 8),

(c) a minimum qualification requirement for the person undertaking OVERSEER modelling of a Massey University Certificate in Advanced Sustainable Nutrient Management, an equivalent qualification, or extensive experience in a specific farming system and detailed understanding of OVERSEER. For OVERSEER modelling of particular significance, independent auditing of modelling should be undertaken by a person with the minimum qualification specified above, against the factors and process outlined in Table 12 (see Sections 10 & 11).

(d) A requirement to provide the relevant OVERSEER XML file and supporting information by a specific date, on request, or if a specific event occurs, to ensure that the consent authority is able to audit the information provided (see Section 10).

6 The following technical matters should be taken into account in the use of OVERSEER in the regional plan-making and implementation processes, along with other considerations such as cost and resourcing implications:

(a) Uncertainty – particularly the uncertainties associated with estimating both source and receiving water nutrient loads, and how this uncertainty should be managed and transparently taken into account in developing plan provisions e.g., using methods for generating source loads with low or moderate uncertainty, using OVERSEER outputs in a way that minimises uncertainty such as in a relative sense, prioritising the sourcing of good quality data for critical OVERSEER variables, incorporating adaptive management policies, having an implementation plan that specifies frequent receiving water quality monitoring and annual reassessment of catchment nutrient loss estimates, etc. (see Sections 5 & 7).

(b) Averaging – the potential for high inter-annual variation in estimated nutrient losses and less accurate nutrient loss estimates where the use of one year's actual farm system data may not be consistent with OVERSEER's long-term climate data means that the development and implementation of plan provisions should generally not rely on one year's actual farm system data (see Section 8).

7 An implementation plan should be developed that among other matters includes a plan for managing data provided to the council (e.g., OVERSEER XML files) (see Section 10).

Recommendations – Resource consent conditions (Section 4)

1 Resource consent conditions that specify thresholds that require an OVERSEER estimate to determine compliance should contain the following components:

(a) A well-defined threshold (see Appendix 4). There can be advantages in also including a pre-threshold 'trigger response' condition that requires a specific action to be taken prior to a critical threshold being reached.

(b) A requirement to undertake OVERSEER modelling in accordance with appropriate standards and guidelines e.g., the BPDIS, and in particularly sensitive situations, a requirement for independent auditing as outlined in Table 12.

(c) A defined period of time over which the OVERSEER modelling must be undertaken – generally a minimum of a rolling average of three to five years (see Section 8).

(d) An OVERSEER version management mechanism e.g., using a threshold defined with a GMP calculator or reference files, by not relying solely on one threshold condition, by providing an updating mechanism (e.g., providing for previously compliant model inputs to remain compliant in a new version, or using an external calculator/reference files system), by

providing complementary conditions that would make it relatively easy to apply to change and/or to initiate a review of conditions as a consequence of an OVERSEER version change, a fixed version (if available), etc. (see Appendices 4 & 6 & Section 6).

(e) A minimum qualification requirement for the person undertaking OVERSEER modelling of a Massey University Certificate in Advanced Sustainable Nutrient Management, an equivalent qualification, or extensive experience in a specific farming system and detailed understanding of OVERSEER. For OVERSEER modelling of particular significance, independent auditing of modelling should be undertaken by a person with the minimum qualification specified above, against the factors and process outlined in Table 12 (see Sections 10 & 11).

(f) A requirement to provide the relevant OVERSEER XML file and supporting information by a specific date, on request, or if a specific event occurs to ensure that the consent authority is able to audit the information provided (see Section 10).

(g) A requirement for an FEP – to provide a tangible practical guide on how farm management will be undertaken. However, there needs to be absolute certainty about whether the FEP is a primary enforceable condition or is primarily to complement other conditions, and care is needed to avoid any conflicts between conditions (see Section 3.4).

2 The following technical matters should be taken into account in the use of OVERSEER in resource consent conditions, along with other considerations such as cost and resourcing implications:

(a) Uncertainty –conditions that take uncertainty into account are likely to be needed e.g., adaptive management conditions such as monitoring and consequential 'trigger response' requirements, short duration term combined with appropriate monitoring/ investigations and reporting to provide more information, a review condition that specifies an event that would trigger a review, etc. (see Section 7 and the QP website).

(b) Averaging – there is potential for high inter-annual variation in estimated nutrient losses and less accurate nutrient loss estimates where the use of one year's actual farm system data may not be consistent with OVERSEER's long-term climate data (see Section 8).

Recommendations - Estimating catchment nutrient loads (Section 5)

1 Where source loads calculations are used to inform source and receiving environment nutrient load limits, use information and methods with low or moderate uncertainty, as outlined in Table 4.

2 There needs to be targeted long-term nutrient water quality monitoring to progressively test the modelling assumptions used in the catchment modelling, including attenuation factors, and a process for assessing and, where appropriate, updating those factors as new information becomes available. This would then enable that new information to be considered in a plan review process.

3 The implications of OVERSEER version changes on source nutrient load estimates and calculations used as a basis for setting catchment nutrient load limits should be assessed as soon as practicable after each version change.

Recommendations – Overseer version change issues (Section 6)

1 The implications of OVERSEER version changes for regional plan provisions where OVERSEER was used to inform the development of those provisions should be assessed as soon as practicable after each version change e.g., by checking the effects of the version change on any source nutrient loss estimates and calculations used in developing plan provisions, and checking the effects of the version change on regional rule thresholds that require OVERSEER estimates.

2 OVERSEER version change issues should be taken into account in the development and implementation of regional plans and resource consent conditions (see Sections 3 & 4).

3 The specification of nutrient loss model alternatives to OVERSEER in regional plan provisions or resource consent conditions should be complemented with technical criteria and/or specifications to enable an appropriately qualified person acting on behalf of the regional council (e.g., a senior officer, consultant/commissioner) to certify or not that an alternative model complies with those criteria and/or specifications.

4 OVERSEER Limited should consult with OVERSEER stakeholders and users to review the frequency and content of OVERSEER version changes e.g., to consider the option of having only one version change per year that involves an OVERSEER 'engine' change that could affect N and/or P loss to water estimates.

5 Regional councils, the Ministry for the Environment, and the Ministry for Primary Industries should review the options for developing robust processes for the incorporation of changes to models such as OVERSEER that are regularly updated with new versions and are specified directly or indirectly in regional plan rules or resource consent conditions.

Recommendations – Uncertainty (Section 7)

1 Uncertainty in OVERSEER nutrient loss estimates is inevitable and the development and implementation of regional plans and resource consent conditions should acknowledge uncertainty and endeavour to reduce uncertainty by:

(a) acknowledging in the plan-making process that catchment modelling and OVERSEER modelling involves significant uncertainties and communicating which options and methods are being used to manage uncertainty (see Table 8)

(b) using good quality data inputs, in particular for the more influential inputs (which will vary from situation to situation e.g., by spending more time in sourcing these data, using expert verification and/or independent modelling sources

(c) using qualified and experienced OVERSEER model users, using appropriate standards and guidelines e.g., the appropriate BPDIS, and taking account of other quality factors (see Table 12)

(d) endeavouring to use independent parallel sources of information where OVERSEER is being used significantly beyond its calibration range (system/soil/climate) e.g., through other models and/or relevant robust information

(e) using OVERSEER outputs in a way that minimises the impact of uncertainty e.g., using model outputs in a relative sense or using adaptive management methods (see Sections 3 & 4)

(f) communicating the potential consequences of uncertainties in OVERSEER outputs e.g., undertaking significance analyses and considering the impact of ranges of possible nutrient losses

(g) considering the use of policy, rule and resource consent condition frameworks that support adaptive management (see Sections 3 & 4) and are driven by appropriate indicators, such as the status of the receiving environment, and as more information comes available including from future modelling.

(h) ensuring ongoing targeted monitoring and data collection within a catchment where OVERSEER has been used to generate nutrient source load estimates, and if necessary, testing and revising the modelling and assumptions that underpin the catchment load calculations.

2 Additional investment should be made in research and investigations in priority OVERSEER science to reduce uncertainties, particularly for those situations that are significantly different from original calibration studies used in the development of OVERSEER e.g., locations with different soils, more or less annual precipitation, different farm systems, etc.

Recommendations – Averaging (Section 8)

1 The development of regional rules and resource consent conditions should recognise that one year's actual annual farm system data, as input into OVERSEER, may not be consistent with long-term climate data. Where they are inconsistent, nutrient loss estimates are likely to be highly uncertain and unlikely to represent the actual nutrient loss in that year.

2 Typical representative farm systems or averaging OVERSEER outputs can be used to endeavour to address the potential inconsistency that is otherwise likely to occur using one year's actual annual farm system data with OVERSEER's long-term climate data. If the climate over that averaged period is significantly different from the long-term climate, the result may overestimate or underestimate actual nutrient losses.

3 Any typical representative farm systems used for predictive purposes (e.g., when developing plan provisions) should be well defined e.g., as in the Matrix of Good Management (Robson et al., 2015).

4 Generally, OVERSEER outputs rather than inputs should be averaged. OVERSEER inputs should only be averaged if there is a clear understanding of the limitations and risks involved.

5 For the purpose of assessing compliance with a threshold in a regional rule or resource consent condition, a rolling average of a minimum of the previous 3–5 years of OVERSEER outputs should generally be used to provide a less variable and more meaningful indication of long-term nutrient loss from that farm system.

6 OVERSEER estimates of nutrient losses for farm systems undergoing a significant farm transition period e.g., dryland to irrigation, will have a relatively high uncertainty compared to stable farm systems. Therefore, reporting of nutrient losses should generally not be done for a farm system during a significant farm transition or, if this cannot be avoided (e.g., where reporting is required and a significant farm transition has occurred), appropriate assumptions should be incorporated to reduce that uncertainty (e.g., if the transition is to a more intensive land use with higher nutrient loss, to model that more intensive land use for the transition year).

7 The new capability (in OVERSEER version 6.2.2) to enter monthly climate data should not be used for the development or implementation of regional rules or resource consent condition until the BPDIS indicate that the capability is appropriate for non-research purposes.

8 Where short-term estimates of nutrient losses are required, e.g. seasonal estimates or for target water bodies that respond very quickly to changes in nutrient loading, an alternative to the currently available OVERSEER version should be considered, such as a more process-based model e.g., APSIM (2016).

9 Further investigation of appropriate averaging periods should be undertaken e.g., by reviewing the available pasture farmlet experiments that have measured N leaching and especially by reviewing the data available for non-dairy farm systems.

Recommendations - Nitrogen and Phosphorus modelling (Section 9)

1 The use of OVERSEER should take into account the different processes involved in N and P loss, the different modelling approaches taken in OVERSEER for N and P, and the assumptions and limitations that apply specifically to N and/or P (see Table 11 and Appendix 3) e.g., it is critical to appreciate the specific nutrient loss sources that OVERSEER models in a catchment and the need to use other methods to estimate other nutrient loss sources.

2 The current evidence strongly indicates that OVERSEER modelling of P loss is not inherently more uncertain than OVERSEER modelling of N, and provided that the relevant assumptions, limitations (Appendix 3) and principles (Table 1) are taken into account, OVERSEER modelling of P is suitable to be used in the modelling of property and catchment P loads.

3 Investigations should be undertaken to assess the feasibility of developing guidance for 'blocking' a farm on the basis of P critical source areas. This may also assist with linkage to complementary models with the resolution needed to identify, and target mitigation to, critical source areas.

Recommendations – Data management, security and quality assurance (Section 10)

1 Regional councils should:

(a) Store OVERSEER XML files using a method that enables file data to be extracted using an automated process, and that provides for access controls and logging e.g., in a controlled system (document management system or database) or in a dedicated database table or store machine-readable references to the document, which may be stored in a document management system.

(b) Include additional database information to track:

(i) the provenance (original source) and date of the farm model,

(ii) the OVERSEER version used to develop the farm model/outputs,

(iii) for audit reviewed OVERSEER XML files, the reviewer, date of review, OVERSEER version used, audit rating, and any review notes, and

(iv) for any modification to OVERSEER XML files (e.g., after an audit review or to ensure the farm model complies with required practices), the date, originator and purpose of the modification, as well as the OVERSEER version used.

(c) Consider automated extraction of key farm model data or calculated outputs (such as farm areas, stocking rates, N and P nutrient budgets) to a separate table or area to enable rapid reporting without needing to extract individual results from XML or recalculate (OVERSEER version and date of calculation would also need to be stored with the extracted data).

(d) Consider developing methods to export anonymised OVERSEER file data from the database via a secured process to support use for purposes such as auditing, catchment studies or sensitivity analyses.

(e) Ensure that an information security policy for the organisation defines appropriate policies and controls for the type of data held and allows the organisation to audit or check that those policies and controls are implemented, including mechanisms to determine the authentication or identity of people accessing farm model data along with their authorisation to access such data, and to record such data access.

(f) Once the above information security policy and controls are implemented, consider seeking accreditation under the Farm Data Code of Practice, which would provide further assurance to farmers and advisors regarding the rights and controls surrounding identifiable farm data.

(g) Implement processes to ensure that all parties who provide OVERSEER XML files as part of a regulatory requirement are advised of the processes and protocols used to manage that information.

(h) Consider collectively or individually creating datasets that contain information such as typical range of stocking rates or pasture grown (or consumed) for different soil types of land classes to be used as a quick check for OVERSEER file information.

(i) Develop criteria for apportioning nutrient loss allocations specified in resource consents, if needed as a consequence of property subdivision.

(j) Ensure that OVERSEER modelling undertaken to meet a regional plan or resource consent requirement in a location of particular significance, e.g., for estimating nutrient losses in a catchment with significant nutrient water quality issues with regional plan objectives and policies that require reductions in nutrient source loads, is audited against a comprehensive suite of factors, such as those detailed in Table 12. Only those model outputs that have a modelling audit rating of High or Medium should be accepted for a regulatory requirement. (Also see Section 11).

(k) Consider development of processes to provide detailed guidance for the OVERSEER file audit process outlined in Table 12 e.g., to ensure consistency between auditors.

2 OVERSEER Limited and users such as regional councils and advisors should consider development and implementation of a mechanism that allows the creator of an OVERSEER XML file to identify the purposes for which it was created and released, supported by 'digital signing' so that later modifications could be identified and repudiated.

3 OVERSEER Limited and regional councils should consider developing a simple linking or reference mechanism to assist traceability of data from multiple sources. This could be implemented within the nodes or sections in an OVERSEER XML file.

4 OVERSEER Limited should endeavour to maintain backwards compatibility for at least 4 years i.e., to ensure that OVERSEER XML files generated 4 years previously can still be successfully run on the current OVERSEER model. If the need for significant model improvement/enhancement means that this cannot be achieved, there should be prior consultation between OVERSEER LIMITED and regional councils to enable the development of a methodology to achieve backwards compatibility.

5 Regional councils and OVERSEER Limited should support initiatives to enhance the interoperability of models used in Resource Management Act processes that involve OVERSEER inputs or outputs.

Recommendations - Qualifications and auditing (Section 11)

1 The minimum qualification requirement for undertaking OVERSEER modelling should be a Massey University Certificate in Advanced Sustainable Nutrient Management, an equivalent qualification, or extensive experience in a specific farming system and detailed understanding of OVERSEER.

2 For OVERSEER modelling of particular significance, e.g., for estimating property nutrient losses in a catchment with significant nutrient water quality issues with regional plan objectives and policies that require reductions in nutrient source loads, independent auditing of modelling should be undertaken by a person with the minimum qualification specified above, against the factors and process outlined in Table 12.

3 The functions and relationships of component parts of the OVERSEER model need to be published and those publications updated regularly by OVERSEER Limited to ensure that they are understood by those involved in the use of OVERSEER.

1 Introduction

The cumulative effect of diffuse nutrient discharges from farming on water quality is recognised as a significant resource management issue (LAWF, 2010). Managing the effects of land use on water quality is a national as well as a regional challenge. Under the National Policy Statement for Freshwater Management 2014 (NPS-FM) (MfE, 2014), regional councils are required to establish freshwater objectives and set freshwater quality limits for water quality. This requirement has increased interest in, and use of, a range of tools and models including OVERSEER® Nutrient Budgets (OVERSEER).

As OVERSEER is developed and changes to the Resource Management Act occur, this guidance document may need to be updated.

1.1 Purpose

The focus of this report is to provide information and advice to those who are using or are considering using OVERSEER to assist in informing the establishment of freshwater objectives related to nitrogen (N) and/or phosphorus (P), in setting and managing to freshwater quality limits under the NPS-FM, and in resource consent processes[3]

This report builds on a suite of existing information (see Appendix 1) and has been prepared in accordance with a specific brief (see Appendix 2).

There is no single correct approach to managing the effects of diffuse nutrient loss from land use on water quality, and OVERSEER may be used in different ways within these different approaches. This report identifies key principles and practical guidance[4] for using OVERSEER in the context of the overarching imperative to manage the effects of land use on water quality.

This report is primarily intended for regional council staff (and consultants) who are involved in preparing and implementing regional plans, consultants involved in regional plan-making and resource consent processes, and Resource Management Act (RMA) decision-makers. This guidance is expected to also enhance the level of consistency across New Zealand where, despite the significant differences between catchments, there will be greater scope for regional plans and resource consents to have common frameworks.

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[3] Achieving freshwater quality objectives and limits is likely to involve a broad range of activities as well as regulation including education, training, monitoring, non-regulatory mechanisms, farming and industry programmes, and leadership.

[4] The scope of this guidance does not extend to:
- software development
- field trials and scientific investigations
- development of user training or certification material
- general guidance on the development or implementation of catchment nutrient management plans
- general guidance on the development or implementation of regional plans
- nutrient allocation methods.

To understand what OVERSEER may provide for plan-making and resource consents a general level of knowledge of OVERSEER is essential. While this guidance document provides a significant amount of information which draws from a wealth of experienced practitioners, published and unpublished literature, it is recommended that readers first familiarise themselves with the basics of OVERSEER e.g., by reading the background material available on the OVERSEER website.

This document does not specifically address the question of whether a regional council should or shouldn't use OVERSEER in a regional plan and/or resource consent process, although the information contained should assist with such decisions.

1.2 What is OVERSEER?

OVERSEER is a computer software model that models nutrient use and movement within a farm system. OVERSEER estimates the nutrient flows in a farming system and specifically includes estimates of N and P loss to water through leaching and/or run-off. The core of OVERSEER is a nutrient budget, which includes the nutrient inputs and outputs of a farm system. A more detailed description is in Watkins and Selbie (2015).

1.3 Key RMA considerations

The use of OVERSEER, particularly in plan-making processes, needs to be considered in the wider context of regional plan development under the RMA and the implementation of regional plans. As expanded on in Section 3, regional planning is undertaken in the context of regional councils' functions under s30 of the RMA. Regional plans must give effect to the NPS-FM and relevant regional policy statements and proposed plan provisions must be evaluated in accordance with s32 of the RMA before plan notification.

This report is focussed on the use of OVERSEER to estimate the existing or potential diffuse loss of nutrients from land uses into water, which can then be used as a basis for policy and/or regulation through regional plans and resource consents. It is acknowledged that this can result in policy and regulation for land use and discharge activities not being guided by measured effects. However, in many situations, it is not practicable or possible to routinely measure diffuse nutrient losses (Figure 1). The use of OVERSEER enables a focus on estimated effects rather than relying on activities or inputs into a farm system. Providing the challenges of using a model are adequately managed, OVERSEER is considered to be an appropriate tool to use to inform the establishment of regional plan provisions that meet the requirements of the NPS-FM. In this context, this report focusses on how the challenges associated with the use of a model need to be considered in, and managed through, planning frameworks under the RMA.

Figure 1 illustrates in simple terms why models may be needed to manage the effects of diffuse nutrient discharges, depending on which methods of management (input or output) are used (see Section 2.2 for more detail.).

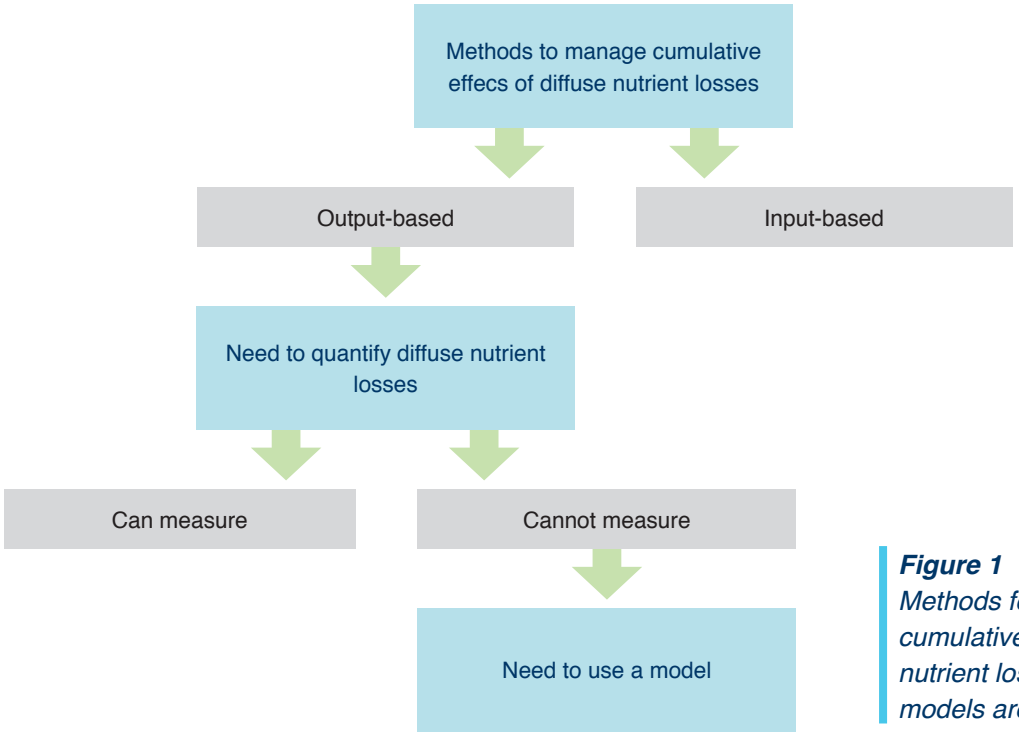

Figure 1
Methods for managing the cumulative effects of diffuse nutrient losses and where models are needed

1.4 Water quality management and using OVERSEER

To manage water quality, the sources of the key contaminants in a catchment need to be established. These contaminants may come from either point sources, discharged at discrete, identifiable locations and usually measurable (Novotny, 2003), or diffuse sources arising from land-use activities (urban and rural) that are dispersed across a catchment (D'Arcy et al., 2000) and usually difficult to measure. Farming is often a significant contributor of diffuse nutrients in a catchment. This report focusses on the nutrients N and P.

To help manage the effects of land use a conceptual model[5] of a catchment can be developed to understand the relationship between nutrient sources and water quality for a specific catchment (Figure 2). Depending on the nature and severity of the water quality problem and the management approach preferred, numeric models that build on these conceptualisations may be useful or necessary tools.

Modelling nutrient losses from land uses into the catchment may not be needed for management of water quality if the relationship between land use and water quality is quite simple, if there is little pressure on the resource, if the nature of the water quality issue is measurable, or if directed management interventions (such as fencing or tree planting) are likely to be successful. However, modelling nutrient losses from land uses into the catchment is likely to be important if the relationship between land use and receiving water quality is complex, if there is high pressure or risk to the resource/wider environment, if the diffuse losses are not directly measurable, or if there are possible future policy options that need to be tested for the development of a regional plan. OVERSEER is the principal available model to estimate the farming land-use portion of the source nutrient load (point 'A' in Figure 2).

[5] These conceptual models are created either implicitly by individuals, where knowledge and experience lead to an understanding of how the catchment works, or they can be created explicitly with detailed technical descriptions of catchment processes.

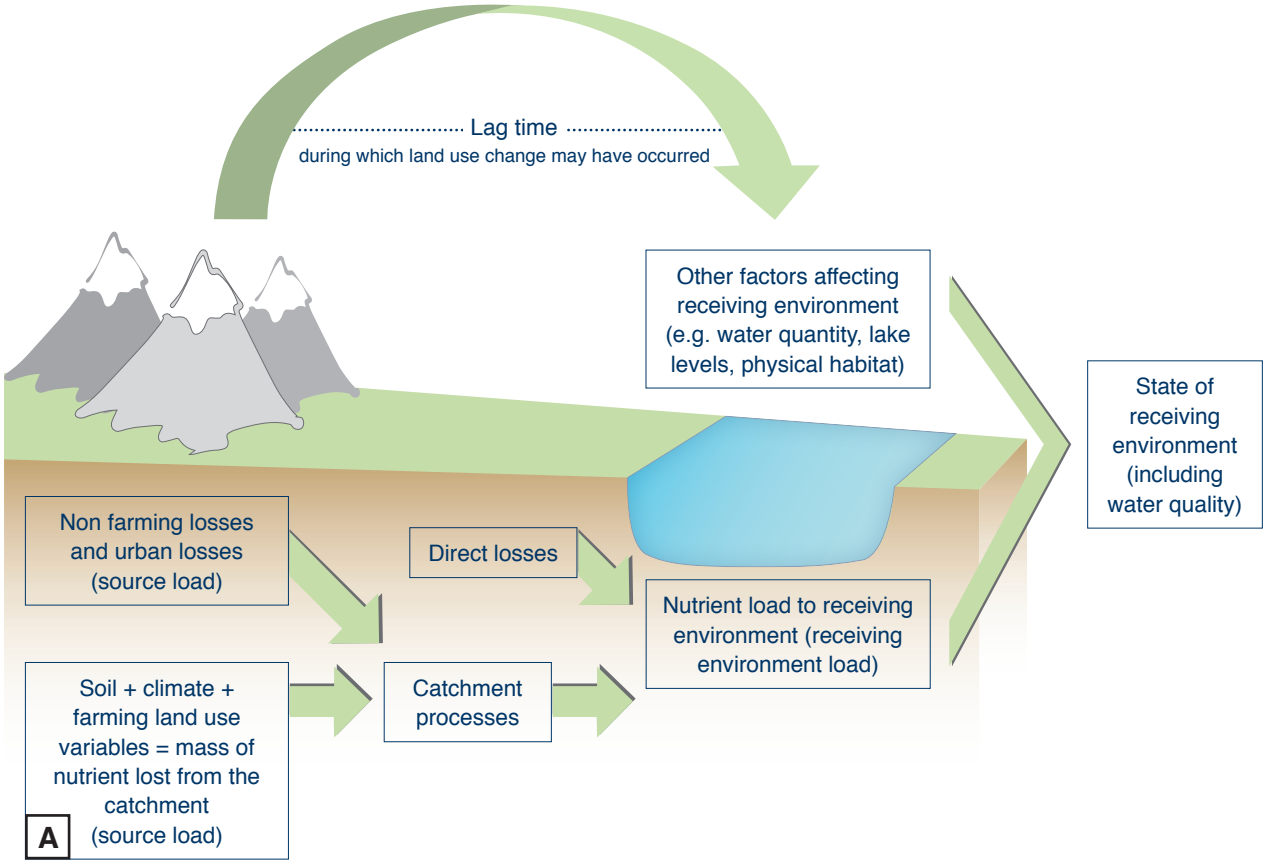

Figure 2
Simplified conceptual relationship between losses of nutrients from the catchment and the state of receiving environment water quality (groundwater, rivers and lakes), 'A' indicates where a model such as OVERSEER can be used to estimate the farming land-use portion of the source nutrient load

There is no single correct approach to managing the effects of land use on water quality, and there will be circumstances where it is not necessary to use a complex numeric model or modelling software, such as OVERSEER, to successfully manage water quality. There will also be circumstances where OVERSEER is not an appropriate model to be used to estimate nutrient losses from farming systems e.g., where the farming system is currently not modelled by OVERSEER.

The decision by a regional council on whether or not to use OVERSEER will be influenced by a range of factors such as:

- the nature and extent of the water quality issue;
- the specific characteristics of the catchments;
- the state of knowledge about the water quality and catchment characteristics and the data available;
- the likely sources of nutrient(s) contributing to the water quality issue and the ability to measure at or near source;
- whether input-based or output-based methods of managing diffuse nutrient discharges are preferred;
- consideration of the relevant assumptions, limitations and principles, particularly those relating to uncertainty and version change management;

- the resources available to the regional council and the community; and
- the overall planning approach and philosophy.

The important questions involved in making that decision are:

1 What is the nature of the issue that needs addressing?

2 What package of data, tools, models and approaches is currently available to address this issue?

3 If there aren't data or other, more effective tools and approaches or models with less uncertainty, can the uncertainties and limitations in OVERSEER be adequately managed for this particular issue?

Whether or not it is preferable or appropriate to use OVERSEER in a particular situation will depend on answers to questions 1, 2 and 3.

1.5 Structure of report and guidance

The report covers the principles and guidance on key topics for the use of OVERSEER in establishing freshwater objectives and setting and managing to freshwater quality limits in regional plans and resource consents. After laying out the key plan-making considerations, the report describes the different approaches to using OVERSEER for managing diffuse nutrient discharges; the supporting principles for the use of OVERSEER; and planning and technical information that provides guidance on the approaches and that underpin the principles (Figure 3).

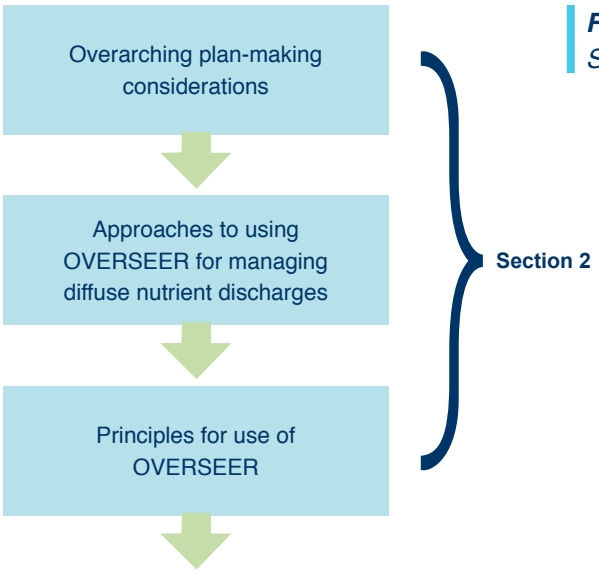

Figure 3
Structure of this report

Supporting guidance:	
Section 3	Plan-making
Section 4	Resource consent conditions
Section 5	Estimating catchment nutrient loads
Section 6	OVERSEER version change issues
Section 7	Uncertainty
Section 8	Averaging
Section 9	Nitrogen and phosphorus modelling
Section 10	Data provision and security
Section 11	Qualifications and auditing

1.6 Terminology

The following definitions have been used in this report. Definitions used in the RMA are followed here, some NPS-FM definitions have been included, and other commonly used technical definitions have been used. Refer to Watkins and Selbie (2015) for further clarification of some technical terms directly related to OVERSEER.

Accuracy	The accuracy of a measurement system is defined as the degree of closeness of measurements of a quantity to that quantity's actual (true) or accepted value (where actual measurement is impractical). There are significant practical difficulties in comparing whole-farm nutrient loss estimates with actual losses because of the great technical difficulty of measuring these losses, such as N leaching.
Adaptive management	Flexible management that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process.
Allocation	An amount of a resource assigned or distributed to a recipient or group of recipients (such as within a catchment or an irrigation scheme) i.e., the assignment of an estimated total source limit to an individual or group of users.
Allowance	See 'threshold'.
Auditing	The systematic and independent examination of the inputs and assumptions made in OVERSEER modelling to determine their accuracy and/or appropriateness for the use of the modelling outputs.
Benchmark nutrient loss	A reference annual nutrient loss for a property.
Baseline nutrient loss	A type of reference annual nutrient loss for a property usually estimated for a specific previous period.
Block	An area of land within a property/farming enterprise that has common physical and management attributes. OVERSEER categorises blocks into types e.g. pastoral, fodder crop, trees and scrub, house. There may be multiple blocks of the same type within a property/ farming enterprise reflecting the different physical or management characteristics of each of the blocks.
Calculate	See 'estimate and calculate'.
Calibration	The process of adjusting numerical or physical modelling parameters in a model for the purpose of improving agreement with experimental data.
Catchment attenuation processes	Processes, such as sedimentation, plant uptake, or denitrification, that can remove nutrients before they enter, or from within a freshwater receiving environment
Catchment attenuation factor	The proportion of the nutrient source load that is removed from the receiving water by catchment attenuation processes.

Catchment load	Generic term for source and/or receiving environment nutrient loads in a defined hydrological catchment.
Critical source areas	Areas of enriched nutrient or sediment sources and hydrological activity that occur in small parts of a catchment or farm, but contribute a disproportionately large amount of nutrient or sediment to the environment (e.g., steep hills, gullies or swales)
Discharge	Refer to Section 15 of the RMA.
Diffuse nutrient sources/ discharges	Nutrients arising from land-use activities (urban and rural) that are dispersed across a catchment.
Engine	The calculation model within OVERSEER. This uses inputs from a user interface or file and produces the outputs.
Error	In a modelling context, error generally refers to the difference between the modelled representation of a system, and the reality of the system. The primary types of error include input, model, and output error, and models could contain combinations of these (see Shepherd et al., 2013).
Estimate and calculate	Nutrient losses from a farm are estimated by OVERSEER; these estimates (along with other sources of information) may be used to calculate a source nutrient load. The use of the word 'calculate' for the catchment load does not denote a greater degree of confidence, only that a calculation has been made.
Evaluation (validation)	All quantitative and qualitative methods for evaluating (or validating) the degree to which a model corresponds to reality.
Farm environment plan (FEP) or nutrient management plan (NMP)	Different regional plans often use different terminology and apply such plans in different ways. However, common features are usually a detailed description of the property including all aspects that can influence nutrient loss, a requirement to undertake and provide an OVERSEER nutrient budget and a detailed plan that identifies how specific nutrient loss objectives/ requirements will be achieved.
Freshwater management unit.	"Is the water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes." (NPS-FM)
Freshwater objective	"Describes an intended environmental outcome in a freshwater management unit." (NPS-FM)
Freshwater quality accounting system	"Means a system that, for each freshwater management unit, records, aggregates and keeps regularly updated, information on the measured, modelled or estimated: a) loads and/or concentrations of relevant contaminants; b) sources of relevant contaminants; c) amount of each contaminant attributable to each source; and d) where limits have been set, proportion of the limit that is being used." (NPS-FM)

Good management practices	This term is often defined in regional plans and no one specific definition is used in this report. However, it is important to distinguish between those definitions and the "good management practices" assumed in OVERSEER. These are more appropriately termed "assumed management practices" to avoid confusion. Examples of these assumed management practices include the even application of fertiliser and sealed effluent storage ponds. Referring to such practices as "good management practice" may not match up with definitions used in regional plans. For example, OVERSEER could model the impacts of excessive amounts of fertiliser applied (which is not good management practice), but would assume that the fertiliser is being applied evenly and in a way where additional losses are not incurred.
User interface	The visual website screens that provide the ability for a user to enter data into OVERSEER to enable the OVERSEER engine to run to produce outputs.
Limit	The "maximum amount of resource use available, which allows a freshwater objective to be met". (NPS-FM)
Nutrient load	An amount of nutrient, usually expressed as an annual amount e.g., kg/yr.
Nutrient budget	Report of net nutrient inputs and outputs to a given scale (block, farm), in a defined system over a fixed period of time.
Nutrient discharge allowance	See 'threshold'.
Nutrient management plan (NMP)	See 'Farm Environment Plan'.
Nutrient losses	Nutrient lost from a farm boundary/root zone (may be described as a mass or concentration).
Over-allocation	Is the situation where the resource: a) has been allocated to users beyond a limit; or b) is being used to a point where a freshwater objective is no longer being met.
OVERSEER	OVERSEER® Nutrient Budgets (OVERSEER) is a computer software model that estimates nutrient use and movement within a farm system. OVERSEER estimates the nutrient flows in a farming system and specifically includes estimates of nitrogen and phosphorus loss to water through leaching and/or run-off.
Point source discharges	Discharges that occur at discrete, identifiable locations and can usually be measured.
Precautionary principle	"Where there are threats of serious or irreversible damage, lack of full scientific evidence shall not be used as reason for postponing cost-effective measures to prevent environmental degradation" (Rio Declaration on Environment and Development, 1992).

Profile available water (PAW)	The amount of water potentially available to plant growth that can be stored in the soil to 100 cm depth. PAW takes into account variations in soil horizons and is expressed in units of millimetres of water i.e., in the same way as rainfall. A PAW value (to a depth of 1 m) of 100 mm implies that 10% of the soil volume is water available to plants. Low PAW is <60 mm, moderate is between 60 and150 mm, and high is ≥150 mm (definition from Landcare Research).
Quality assurance (QA)	Part of quality management focussed on providing confidence that quality requirements will be fulfilled.
Sensitivity analysis	The systematic computation of the effect of changes in all model input values or assumptions (including boundaries and model functional form) on model outputs, to determine their relative influence on model outputs.
Significance analysis	A simple analysis to identify which model inputs are likely to have the most impact on the model output of interest. This is neither a full sensitivity nor a full uncertainty analysis.
Source nutrient load	The total annual amount of nutrients (from diffuse and point sources) lost from a catchment prior to any catchment attenuation processes.
Sub-model	A distinct part of the OVERSEER engine.
Receiving environment	A water body (e.g., groundwater, streams, rivers, lakes) that receives diffuse and/or point source discharges that a freshwater objective is applied to.
Receiving environment nutrient load	The total annual amount of nutrients entering a receiving environment i.e., source nutrient load after attenuation.
Target	A limit which must be met at a defined time in the future. This meaning only applies in the context of over-allocation.
Threshold	A maximum allowed amount or rate of resource use specified in a regional rule (that distinguishes between e.g., classes of activities) or resource consent condition. This is usually expressed as kg /ha/yr or kg /property/yr. A threshold in the context of this report is generally numerical, but can be narrative if the narrative threshold incorporates a numerical calculation e.g., a requirement to meet a well-defined 'good management practice' that is used with OVERSEER to calculate the equivalent nutrient loss. This term is used generically in this report to incorporate the term 'allowance' or 'nutrient discharge allowance' and in some situations the term 'limit' e.g., if a resource consent has a condition that specifies a source or receiving water limit.
Uncertainty	The potential limitation in some part of a modelling process that is a result of incomplete knowledge, mathematical formulations and associated parameters, or data coverage and data quality.
Uncertainty analysis	Investigates the effects of lack of knowledge or potential errors of the model (e.g., the uncertainty associated with parameter values or model design and output).
XML file	The file format used by OVERSEER to store specific input and output data.

2 Informing the establishment of freshwater objectives and setting and managing to limits

2.1 Overarching plan development considerations

National Policy Statement for Freshwater Management 2014

It is a requirement under the RMA that a regional plan gives effect to any national policy statement (s67(3)(a)). The NPS-FM sets out a number of objectives for freshwater management, and through its policies directs regional councils as to how these objectives are to be achieved. Of particular relevance, the NPS-FM directs that freshwater objectives are established in regional plans and freshwater quality limits set for all freshwater management units, to give effect to the NPS-FM objectives (Policy A1) (Figure 4). The process for establishing freshwater objectives is detailed in policies CA1 – CA4. The NPS-FM also directs that targets are specified and methods are implemented to improve water quality where a freshwater management unit does not meet the objectives that are established (this is referred to as 'over-allocation'). The NPS-FM also includes requirements for the monitoring of progress towards and achievement of freshwater objectives (Objective CB1 and Policy CB1), and for establishing and operating a freshwater quality accounting system (Objective CC1 and Policy CC1).

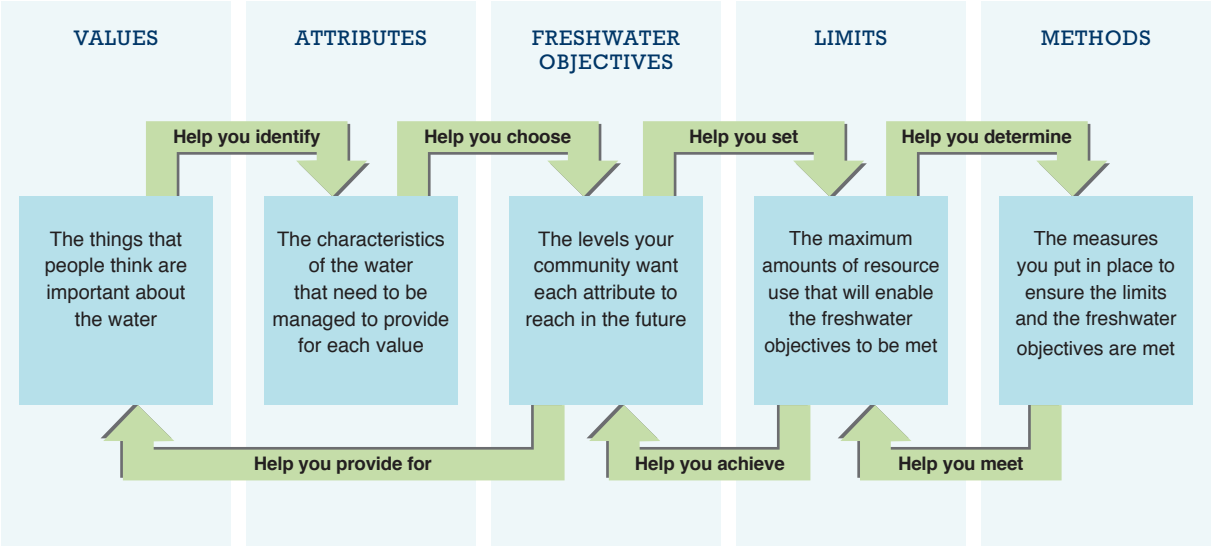

Figure 4
The relationship between freshwater objectives, limits and methods (MfE, 2015) adapted from ECan (2012).

Where it is not feasible or possible to measure diffuse nutrient discharges from land, modelled effects may be required to inform the establishment of freshwater objectives and setting and managing to freshwater quality limits (Figure 4). Similarly, there will be elements of freshwater quality accounting that will be reliant on modelling where measurement is not feasible.

Regional Policy Statement (RPS)

It is also a requirement under the RMA that a regional plan gives effect to any regional policy statement (s67(3)(c)). Therefore, any plan provisions that are developed through the use of OVERSEER must be sufficient to give effect to the relevant RPS. In particular, an RPS may contain objectives and/or policies that include nutrient limits, which if not directly measurable may also necessitate reliance on modelled effects to inform the establishment of limits in the regional planning process.

Section 32 Analysis

Section 32 of the RMA sets out the evaluation that a council must undertake when a proposed regional plan or plan change is prepared (a 'proposal'). In particular, this must assess the provisions (i.e., objectives, policies and rules) in a proposal.

It is important to consider this evaluation early on in the plan development process and it should also be borne in mind as part of any technical analysis undertaken to support plan provisions. This means considering how effective different approaches may be at achieving the plan's objectives. For example, a section 32 analysis requires that the limitations and assumptions resulting from modelling, including the use of OVERSEER, are taken into account as part of the cost-benefit analysis. A section 32 analysis should also explicitly consider the implications of uncertainties in OVERSEER estimates.

Plan Drafting and Activity Status in Rules

There are planning principles and relevant case law that help inform the way a plan is drafted.[6] Any plan provisions that rely on the use of OVERSEER (either explicitly or implicitly) should recognise this best practice. For example, objectives should be a statement of what is to be achieved in relation to a particular issue and policies should set out the course of action to be taken to achieve or implement the objective(s).[7] In relation to rules, there are several commonly accepted principles that apply, namely that they must:

1 be comprehensible to a reasonably informed, but not necessarily expert, person;[8]

2 not reserve to a council the discretion to decide by subjective formulation whether a proposed activity is permitted or not;[9] and

3 be sufficiently certain to be capable of objective ascertainment.[10]

There is also some specific guidance[6] and case law on the very high level of certainty needed for defining permitted and prohibited activities. Some implications of this are expanded on later in this report (see Sections 3, 4 & 6).

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[6] Guidance can be found on the Quality Planning (QP) website: http://www.qualityplanning.org.nz/index.php/plan-steps/writing-plans.

[7] http://www.qualityplanning.org.nz/index.php/plan-steps/writing-plans/writing-issues-objectives-and-policies.

[8] Re Application by Lower Hutt City Council EnvC Wellington W046/2007.

[9] Twisted World Limited v Wellington City Council EnvC Wellington W024/2002.

[10] Ibid.

2.2 General approaches to managing diffuse discharges that use OVERSEER

There are two different types of approach to actively managing N and P loss to water.

- An output-based approach where the quantitative relationship between source nutrient load and receiving environment state is explicitly estimated and nutrient losses are explicitly managed (e.g., N leaching rate thresholds), or
- An input-based or practice-based approach where a series of land-use practices are prescribed (e.g., stocking rate thresholds, nutrient application thresholds).

Within these broad approaches, OVERSEER can be used in different ways (Figure 5) and these are expanded on in Section 3 of this report.

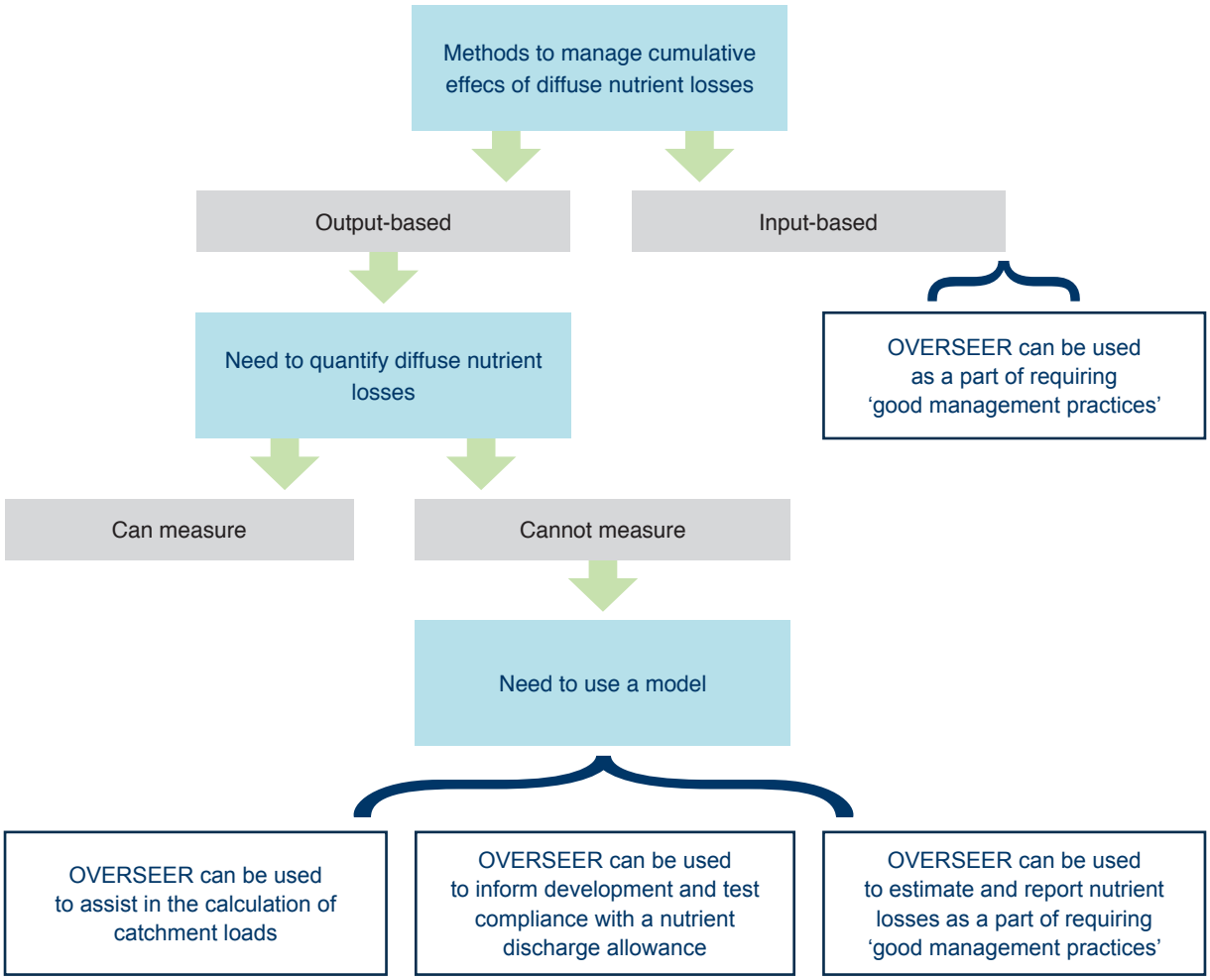

Figure 5
Methods for managing the cumulative effects of diffuse nutrient losses and where OVERSEER can be used

2.3 Principles to assist in establishing freshwater objectives and setting and managing to freshwater quality limits

These principles are specifically intended to guide the use of OVERSEER in assisting the establishment of freshwater objectives and setting and managing to freshwater quality limits (Table 1).

Table 1
Principles for the use of OVERSEER in assisting the establishment of freshwater objectives and setting and managing to freshwater limits

Planning principles	Explanation	Relevant report section
1 If OVERSEER is used to provide estimates of annual nitrogen and/or phosphorus loss from farm systems its assumptions and limitations need to be fully acknowledged and taken into account.	These key assumptions and limitations are addressed in the supporting technical principles detailed below.	Estimating nutrient loads (Section 5), Uncertainty (Section 7), Averaging (Section 8), Modelling N and P (Section 9) Data provision and security (Section 10), Qualifications (Section 11)
2 (i) The use of OVERSEER must recognise that new versions of OVERSEER are released regularly and plan provisions that specify OVERSEER should include a mechanism(s) to manage version change if required. **2 (ii)** Where OVERSEER has been used in calculating source or receiving environment catchment loads there must be a mechanism to periodically re-evaluate and update the assumptions in the supporting catchment science.	OVERSEER is updated regularly (and modelled losses may change) and improved information is expected to result from more water quality monitoring information. A mechanism to accommodate the regular improvements in OVERSEER (through version changes) and the improvements in other data (e.g., through monitoring) is important. This is to ensure that planning provisions can take advantage of improvements in models and other data where those improvements enhance the accuracy and effectiveness of interventions.	Version change (Section 6), Estimating nutrient loads (Section 5)
3 Where OVERSEER is used at multiple stages in a planning process (e.g., in the process of setting nutrient allowances and for assessing compliance), OVERSEER versions and data input standards should be consistent.	OVERSEER is updated regularly (and modelled losses may change) and assumptions used in building an OVERSEER file can affect estimated losses. Therefore, if losses from multiple versions are being compared or using different input standards, any differences may be in part due to changes in the model, not necessarily 'real' differences in nutrient loss. The uncertainty of outcome (for a consent holder or for the environment) is greater if data inputting standards and versions are not consistent.	Version change (Section 6)

4 The use of OVERSEER must recognise that there are uncertainties in estimates of nutrient loss and this uncertainty must be identified, communicated and, as far as practicable, managed.	OVERSEER outputs, like all model outputs, have a degree of uncertainty, and the biological system that OVERSEER is modelling is also variable. Setting and managing to freshwater limits involves dealing with all types of uncertainty (MfE, 2016). The uncertainty in the model outputs can be amplified or managed by the way the model outputs are used. Therefore, where OVERSEER information is used, the uncertainty should be assessed and reduced where practicable, communicated, and reflected/accommodated in plan-making and implementation.	Policy approaches and rule frameworks (Section 3), Uncertainty (Section 7)

Supporting technical principles	Explanation
1 The use of OVERSEER must recognise that OVERSEER only models some sources of nutrients.	OVERSEER currently models seven nutrients including N and P. For these nutrients OVERSEER models losses from agricultural systems; it doesn't model nutrient losses from all activities that may occur in a catchment (e.g., losses from many point sources, land slips, some river bed/bank erosion, and non-agricultural land are not captured). Importantly for P, OVERSEER doesn't explicitly model Critical Source Areas (CSA). If only 'OVERSEER' nutrient sources in a catchment are modelled, this would normally underestimate the actual losses. Therefore, when using OVERSEER in any catchment assessment, consider what sources of nutrients are not modelled by OVERSEER, and whether those sources need to be estimated to account for all sources of nutrients.
2 The use of OVERSEER must recognise that OVERSEER does not model all farm management or mitigation practices and that there are some assumed management practices within the OVERSEER model	There are some farm management practices that are used on farm, and are understood to impact on some nutrient losses, but that are not captured in OVERSEER e.g., contour ploughing or management of break feeding. For P, as CSAs are not explicitly modelled, available mitigations cannot be directly applied to CSAs in the model. There are also some management practices that are assumed within OVERSEER[11]. If practices occurring on farm are not modelled by OVERSEER, or the assumed levels of practice are not happening; the modelled losses may over or under-estimate the actual losses from a farm. Therefore, if OVERSEER information is being used and there is a significant gap between the level of practice actually occurring and those assumed within OVERSEER, or between the practices that occur on farm and what can be modelled, this gap, or its consequences, need to be managed at an information-gathering, plan-making/resource consent or implementation stage.

[11] OVERSEER incorporates "assumed management practice". Refer to definition of "good management practices".

3 The use of OVERSEER must recognise that OVERSEER only estimates nutrient loss from the farm boundary and root zone.	OVERSEER estimates nutrient loss from a farm (through leaching, run-off, direct to streams) as losses from the farm boundary or root zone. A variety of catchment processes can impact on the amounts of N and P that ultimately arrive in a target receiving environment. Therefore, other models need to be used (that include relevant catchment processes) for relating OVERSEER estimated losses to nutrients that arrive at a target receiving environment.
4 The use of OVERSEER must recognise that OVERSEER is a steady-state model and does not model the effects of transition e.g., transition from dryland to irrigated or farm system change such as forestry to pastoral farming.	When a system is in transition e.g., conversion from dryland to irrigation or conversion of pasture to cropping, there are likely to be soil processes occurring that significantly impact on the actual nutrient losses during the transition period. However, OVERSEER assumes near equilibrium farm systems and so these losses that occur as the system changes are not captured. Therefore, OVERSEER may underestimate or overestimate losses during a transition period. Therefore, other information is needed to understand the effects of transition on nutrient losses.
5 The use of OVERSEER must recognise that data inputs to OVERSEER (actual or estimated) need to reflect a long-term, biologically feasible farm system.	In general, OVERSEER doesn't 'sense check' the production data that is inputted to the model. OVERSEER assumes that the system being modelled is biologically feasible. This means that implausible farm systems can be modelled. Also, a farm practice may be viable for a short time e.g., mining soil nutrients. However, if this is not feasible in the long term, the estimated losses of these 'short-term' practices may underestimate the actual requirements and effects of that farm system over the longer term. Therefore, OVERSEER data inputs can be from actual farm data or estimated data. Where actual farm data is used it should be consistent with technical principle 7. Where estimated, data inputs should be supported by either other modelling (e.g., Farmax or crop calculators) or farm system expertise.
6 OVERSEER requires significant expertise to enable farm systems to be modelled accurately and the use must recognise that the quality of the data inputs impacts on the uncertainty associated with the estimated nutrient losses.	As with other models, if the input data and modelling methodologies used to construct an OVERSEER nutrient budget are poor, this will impact on the quality of the modelled result and in turn the uncertainty associated with the estimated nutrient loss. Where OVERSEER is being used and the quality of the data is poor, this should be recognised as a factor likely to increase uncertainty (see planning principle 4). Improved data records will assist with improving the quality of future data. However, this will not improve the quality of historic or absent records. OVERSEER modelling requires significant expertise. See Section 11 regarding the recommended minimum qualifications.
7 The use of OVERSEER must recognise the long-term climate input assumptions built into OVERSEER and choose data inputs consistent with those assumptions.	OVERSEER incorporates a number of significant assumptions based on a stable long-term farm system with similarly stable average climate conditions. Any modelling application that does not match these assumptions must be undertaken with care, and is likely to increase the uncertainty of the estimates. Therefore, OVERSEER data inputs should be consistent with the climate assumptions. Guidance on the choosing appropriate climate data inputs is given in Section 8.

8 The use of OVERSEER must recognise the differences in N and P loss processes and how these are modelled in OVERSEER.	There are significant differences in N and P loss processes and the way OVERSEER models these losses. These differences are important for modelling nutrient losses, and understanding and implementing mitigations. Therefore, catchment modelling and mitigation strategies will need to account for these differences (Section 9)

These principles sit within a context of overarching plan development considerations (Section 3), land use and water quality management assumptions, the general use of models in environmental decision-making, and important information about OVERSEER (Appendix 3).

The principles are supported by the guidance in the remainder of the report. If the limitations, assumptions and uncertainties associated with the OVERSEER model change, the relevant principles may need to be revisited.

3 Plan-making

3.1 Introduction

This section is written primarily for RMA planners involved in the plan making process.

The purpose of this section is to focus specifically on the major ways OVERSEER can be used as part of developing and implementing a regional plan to manage the effects of nutrient discharges to water and to assess the key strengths and challenges of those approaches.[12]

The broad RMA planning framework including the planning principles is outlined in Section 2 of this report.

There are three major broad applications of OVERSEER in regional plan-making and implementation:

1 To assist in the estimation of current and/or future potential source and receiving environment nutrient loads (Section 3.2). For example, OVERSEER estimates can be used in assessing the effects of different land-use scenarios compared to specific water quality objectives (nutrient concentrations/algal biomass). Estimated nutrient source loads may then be explicitly or implicitly used in plan provisions.

2 As the primary[13] method for determining compliance with nutrient loss thresholds in the plan e.g., a threshold within a rule for the average annual amount of N or P that can be discharged for a property (typically specified in kg/ha/yr) (Section 3.3). These thresholds may have been set with some reliance on catchment and/or individual property OVERSEER modelling.

3 As a tool specified to be used by landholders to estimate and report nutrient losses from a farm. This may be required as part of a 'farm environment plan' or 'nutrient management plan' (Section 3.4), as a standalone reporting obligation, or as one of a number of options.

[12] This section assumes a significant level of knowledge about RMA provisions and their general application in regional plans. This section also assumes that the information here would be an input to a wider RMA section 32 analysis that would be undertaken as part of a regional plan development. For example, this section does not address matters relating to costs and benefits of different policy approaches. This section also does not address matters relating to nutrient allocation methodologies i.e., advantages and disadvantages of different methods such as 'grandparenting', Land Use Capability, peak versus average historical losses.

[13] Alternative comparable models are usually provided for, to enable those land uses or farm systems that cannot be modelled by OVERSEER to be modelled.

Box 1 Key messages – plan-making

1 The most appropriate approach to the use of OVERSEER in the development of plan provisions will depend on the specific catchment characteristics, the extent of nutrient water quality issues, the level of information available, the resources available to develop and implement a regional plan, the objectives sought by the regional plan and the consideration of these in the context of the principles outlined in Table 1.

2 Plan objectives and policies specific to nutrient water quality need to be clear and directive to ensure the environmental results sought by the plan are clear and to provide clear guidance for resource consent decisions that involve OVERSEER nutrient loss estimates.

3 The specification of a source nutrient load in plan provisions (e.g., objectives and/or policies) provides a high level of transparency and certainty. However, this is contingent on a robust mechanism to deal with improving information and model version change where the specified load is largely reliant on OVERSEER estimates.

4 Farm environment plans are important components in the implementation of a regional plan with nutrient water quality objectives. However, plan provisions need to be clear about the specific role that is intended e.g., are they to be complementary to specific thresholds, the primary implementation method, or is the role dependent on specific catchment approaches?

5 OVERSEER version changes mean that a range of innovative approaches (see Sections 3.1–3.5) are needed both to maximise certainty for those who may be affected by plan provisions and to ensure that the objectives of the plan are achieved.

6 There are significant technical matters that need to be considered in the use of OVERSEER in the regional plan-making and implementation processes, specifically: implications of uncertainties in OVERSEER estimates, averaging implications, differences between N and P processes and modelling, OVERSEER data management needs, qualifications needed for OVERSEER modelling, and auditing methodology.

This section should be read in conjunction with the other sections of this report that provide further detail on particular aspects of the use of OVERSEER that need to be recognised in the process of developing and implementing a regional plan. In particular, the need to:

- Understand the uncertainties associated with estimating both source and receiving water nutrient loads and how this uncertainty should be managed and transparently taken into account in developing plan provisions e.g., by using methods for generating source loads with low or moderate uncertainty, using OVERSEER outputs in a way that minimises uncertainty such as in a relative sense, prioritising the sourcing of good quality data for critical OVERSEER variables, incorporating adaptive management policies, having an implementation plan that specifies frequent receiving water quality monitoring and annual reassessment of catchment nutrient loss estimates, etc. (see Section 5 - Estimating catchment nutrient loads, and Section 7 - Uncertainty).
- Appreciate the advantages (and disadvantages) of specifying clear and directive objectives and policies specific to nutrient water quality (e.g., nutrient concentrations and algal biomass), and catchment nutrient limits in plan provisions, to provide direction for plan implementation, particularly for any resource consent application process that features OVERSEER nutrient losses estimates (see Section 4 - Resource consents and Section 5 - Estimating catchment nutrient loads).

- Appreciate the implications of OVERSEER version changes for defining and implementing regional rules, and specifically recognise the significant advantages of (see Section 6 - OVERSEER version change issues[14]):
  - not relying on thresholds that depend on OVERSEER estimates to define permitted activities or prohibited activities, unless a robust version management mechanism is used,
  - minimising the reliance on activity status definition thresholds that depend on OVERSEER estimates e.g., by minimising the number of classes of activities defined by such thresholds, to minimise the risk of a land use or discharge changing activity status as a consequence of an OVERSEER version change,
  - using clear and directive policies and assessment criteria, particularly to support a limited number of activity classes, to provide clear guidance for the resource consent process, and
  - considering the use of a mechanism outside of, but linked to, the plan to minimise the impact of OVERSEER version changes on regional rule thresholds, but recognising that (as at July 2016) there is no case law on this type of linked external mechanism.
- Appreciate the advantages that FEPs can provide to develop a tangible farm plan that is consistent with the regional plan's provisions, including the achievement of the freshwater quality objectives (see Section 3.4).
- Where a regional rule specifies a threshold that depends on OVERSEER estimates, consider:
  - the need for a rolling average over a minimum of three to five years rather than reliance on one year's data (see Section 8 - Averaging),
  - where a rule effectively requires the provision of data to the council (e.g. OVERSEER property files), the management and security of this information (see Section 10 - Data provision and security), and
  - requirements for the qualifications and experience of those preparing or auditing OVERSEER file information (see Section 11 - Qualifications).
- Understand the similarities and the differences between OVERSEER N & P loss modelling, particularly for developing catchment source nutrient loss scenarios (see Section 9 – Nitrogen and phosphorus modelling).

Examples of good practice regional rules

Boxes 2 to 8 provide different good practice examples of how the issues summarised in this section can be addressed and incorporated into different regional rules. These examples do not define how such rules should be developed, rather they illustrate how issues can be addressed in different circumstances to develop rules that not only meet general good practice, but also are consistent in whole or part with the guidance outlined in this report. There is no one right way to formulate such rules.

3.2 Estimating source and/or receiving environment nutrient loads

OVERSEER nutrient loss estimates can be used to help calculate the source nutrient load that is predicted to achieve specific freshwater quality objectives. With additional information, this source nutrient load can be used to predict the nutrients arriving in the receiving environment (Section 5).

[14] Legal advice and analysis on OVERSEER version issues are summarised in Section 6 and has been taken into account in developing this section.

OVERSEER can also be used to estimate future source nutrient loads from different future land use or policy options as part of the plan development framework and setting of freshwater objectives. This allows for the implications of various freshwater objectives and associated limits to be explored, as required under the NPS-FM Policy CA2(f), before freshwater objectives are established within any regional plan.

Within a planning framework, the source nutrient load and/or receiving water nutrient load may be:

- not explicitly stated in the plan provisions, but used as a basis for the policy and rule framework (Approach A).
- used as a limit (Figure 4) and expressed at a policy level or as part of an overarching objective e.g., setting a numerical limit (Approach B).

The key strengths of this general approach (whether using Approach A or Approach B):

- It attempts to make explicit and transparent the relationship between losses from a catchment (and individual farms) and what arrives in the eventual receiving environment, thus enabling the estimation of a source load that would meet the freshwater objectives (e.g., concentration of a nutrient or algal biomass).
- It can assist with clearly giving effect to the NPS-FM.
- Catchment relationship provides a link between a geographic area and an amount of nutrients – potentially facilitating a nutrient allocation framework.
- It can be useful in complex catchments with a mix of rural and non-rural land uses.
- Under Approach A, the plan (depending on its detailed provisions) may be less obviously affected by OVERSEER version change issues.
- Under Approach B, the overall receiving environment and/or source load limits are clear and transparent to all plan users. This load also provides a robust reference point for resource consent applications and enables clear reporting on progress.

The key challenges relating to OVERSEER with this general approach (whether using Approach A or Approach B):

- A high level of information is required about land-use activities in a catchment and their associated nutrient losses, and high-quality receiving environment monitoring data is required, along with at least a conceptual understanding of catchment processes, such as hydrology/hydrogeology, denitrification, sedimentation, and plant nutrient uptake.
- It is comparatively expensive to develop good quality catchment load estimates in terms of both initial and ongoing monitoring, data acquisition and modelling costs. Challenges and strengths of different methods for generating source nutrient loads including their likely uncertainty and resource implications are shown in Table 4.
- There will be uncertainty in the relationship between source and receiving environment nutrient loads e.g., time lags and historical land use, and as new information becomes available this relationship may change (see Section 5.2).
- Version changes in OVERSEER (Section 6) may change estimated nutrient source losses, which may have implications for the plan, particularly under Approach B, and plan implementation. A version change may also result in increased or decreased costs of mitigation to meet threshold requirements and therefore affect economic analyses that may have been relied on as part of plan development.

- A mechanism is needed to incorporate updated and improved information e.g. from additional monitoring (see Section 5.2) or new OVERSEER versions (See Section 6). An example of a proposed mechanism for accommodating OVERSEER version change is where a specified catchment land use configuration (represented as a GIS map or soil/climate/land use table) is used to represent and generate an agreed source nutrient load limit using agreed reference OVERSEER files. When a new version of OVERSEER is released, the files are updated and are used to re-generate the expected source nutrient load, based on the reference land use configuration. This mechanism has been proposed in Plan Change 3, Canterbury Land and Water Regional Plan.
- Under Approach A, there may be less specific direction for resource consent decisions and therefore a risk that decisions might not be as aligned to the achievement of objectives as they could be.

Considerations to address the challenges:

- Clear and unambiguous objectives and policies are needed to ensure that resource consent decisions will be consistent with the plan's intentions i.e., the more direction given by objectives and policies, the greater certainty that resource consent decisions will be consistent with the freshwater quality objectives sought by the plan.
- Ongoing and targeted monitoring is needed to collect data to test expected water quality outcomes and catchment modelling assumptions such as catchment attenuation factors (See Section 5.2).
- A mechanism is needed to incorporate updated and improved information e.g., from additional monitoring (see Section 5.2) or new OVERSEER versions (See Section 6). There will be ongoing costs associated with this.
- Approach B requires careful consideration of how a nutrient load limit is defined in a provision. For example, if it has been largely reliant on OVERSEER estimates, version change issues need managing. However, if such a limit specification has not been reliant on OVERSEER estimates i.e., other robust sources of information were used to estimate source loads, version changes need only be considered as part of any wider review process.
- Under Approach A, any load estimates used in developing plan provisions can still be made transparent although not necessarily specified in a formal provision. However, this would not change the potential implications of version changes for the original assumptions about the linkage between source load estimates and water quality objectives i.e., if a version change results in a change in the estimated source load then, depending on the relationship between source loads and receiving water loads, this may or may not change the estimated water quality outcome.
- Under either approach, there is a need for clear direction in the plan provisions for resource consent decisions, particularly for any non-complying activities, to provide a high level of confidence that such decisions will contribute to the achievement of specific freshwater quality objectives.

3.3 Nutrient discharge thresholds

This section considers the use of nutrient discharge thresholds that are specified in a plan and against which compliance is measured and reported using OVERSEER estimates. The use of these OVERSEER thresholds does not preclude the use of other input-based thresholds.

Per Property Threshold

This approach is based on an allowance of nutrients per unit area or per property that can leach or run-off to water (e.g., the amount (in kilograms) of N or P that can be discharged per hectare per annum). OVERSEER can be used to estimate the nutrient losses that underpin the property allowances.

There are many ways that an individual property threshold can be derived (allocation options): this can be based on land use, on a physical aspect of the land e.g., its natural capital (sometimes referred to as Land Use Capability), grand-parenting, or by mathematically dividing the estimated source load by a mechanism, such as an equal allocation for every hectare of land in a catchment. As noted earlier, the advantages and disadvantages of allocation options are not assessed in this report.

The key strengths of this approach:

- It is conceptually simple – each property has a nutrient threshold or allocation.
- It makes explicit the expectations for the farming activity in terms of losses.
- The relationship between property losses and nutrients in the receiving environment can serve as a basis for assessing required mitigation or allowing increases in nutrient losses in order to meet the freshwater quality limits and freshwater objectives.
- It can assist with clearly giving effect to the NPS-FM.

The key challenges of this approach related to OVERSEER:

- There will be uncertainty in the estimated relationship between losses from individual farms and what arrives in the target receiving environment. For example, there may be management practices that are not currently modelled or, for monitoring against a threshold, the climate assumptions that are used in OVERSEER may not reflect the climate that occurred during the modelled period. These factors impact on the likely uncertainty of the nutrient loss estimates (see Sections 7 & 8).
- Version changes in OVERSEER are likely to change estimated nutrient losses from a farm. This may have implications, particularly where an absolute number derived in a previous version has been specified in a rule, as generally non-current versions of OVERSEER are not available (see Section 6). This may also result in a threshold being easier or harder to achieve than was originally thought at the time a plan was developed.
- On-farm management in plan implementation may be driven by what is 'recognised' and modelled in OVERSEER.
- It may be difficult to provide equivalent alternative models for those land uses or farm systems that are not currently modelled by OVERSEER.
- Depending on how a policy and rule framework is implemented (such as the number of properties, the frequency of compliance monitoring, and whether this is administered under a resource consent framework), there will likely be large resourcing implications.
- It can result in a focus solely on the achievement of an OVERSEER threshold and ignoring other methods of reducing nutrient loss that are not currently recognised by OVERSEER.
- The RMA may not be well designed for linking plan provisions to complex computer models and this has potential implications when considering if OVERSEER can be 'incorporated by reference' in a plan (Schedule 1 Part 3) because OVERSEER may not meet the required definition of 'written material'.

Considerations to address some of the challenges:

- Methods to address OVERSEER version changes (see Section 6) are needed e.g., minimising reliance on activity status thresholds that rely on OVERSEER estimates, ensuring that there is a robust method of managing the effects of an OVERSEER version change if thresholds are used in rules that require OVERSEER estimates to determine compliance with those thresholds, regular assessments of the implications of version changes for assumptions about nutrient source losses used in developing a plan, etc[15].
- Methods or options are needed to reduce or manage the uncertainty in OVERSEER outputs e.g., using the model outputs in a relative sense (see Section 7). However, there is very limited case law on the development and application of rules that may rely in part on future OVERSEER versions.
- When rules are set that rely on OVERSEER estimates to determine compliance, an averaging technique e.g., defining a typical farm system, averaging inputs or calculating a rolling average of outputs, can be used to manage some of the uncertainty due to climatic variability (see Section 8). Generally, a minimum of a rolling average of three to five years is considered adequate.
- A mechanism outside of, but linked to, the plan is needed to minimise the impact of OVERSEER version changes on regional rule thresholds, but recognising that (as at July 2016) there is no case law on this type of linked external mechanism. An example of a mechanism for accommodating version change in a nutrient threshold has been proposed in Plan Change 3, Canterbury Land and Water Regional Plan. Numeric thresholds in kg N/ha/year are used to denote, for example, maximum loss rates. When a new version of OVERSEER is released a suite of reference OVERSEER files (>90 files) that are considered to be representative are re-run and the average percentage difference between version is applied to the nutrient threshold.
- Staged implementation is needed to allow industry, council and farmer capacity and capability to be built up e.g., highest risk or largest emitters first.
- There is a need to provide mechanisms that recognise nutrient loss reduction initiatives that are not currently recognised by OVERSEER.
- Robust individual or industry self-monitoring and auditing systems can reduce the resources needed for council compliance monitoring.
- Be aware of the potential limitations of formally incorporating OVERSEER by reference (see Section 6).

Examples of good practice regional rules for per property thresholds are shown in Boxes 2, 3 and 4.

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[15] When there is a version change in OVERSEER the process to determine next steps could include the following steps:

- The new modelling information should be reviewed to understand the nature of the version change (e.g. small change, large change, uniform change, non-uniform change)
- The catchment load modelling should be rerun and the current estimated catchment load should be recalculated with the new OVERSEER information. The differences will be tested to establish if the new information still fits within the conceptual model of the catchment. The possible outcomes of this analysis are:

  → The new information fits plausibly with the current conceptual model and catchment loads or catchment coefficients are updated as appropriate, or

  → The new version of OVERSEER causes a change to the absolute numbers that leads to a re-assessment of the technical understanding about how the catchment works (i.e. an update to the conceptual model of the catchment). This may need to be supported by additional data collection or monitoring. Once an updated conceptual model (and any subsequent numeric models), then catchment loads or catchment coefficients are updated as appropriate.

Box 2 Example model rule for a per property threshold from the Environment Canterbury Proposed Plan Change 5 to the Canterbury Land and Water Regional Plan (notified February 2016):

5.58A Within the Green or Light Blue Nutrient Allocation Zone the use of land for a farming activity on a property greater than 10 hectares in area that does not comply with condition 2 or 3 of Rule 5.57C is a restricted discretionary activity provided the following conditions are met:

1 *A Farm Environment Plan has been prepared for the property in accordance with Part A of Schedule 7 and is submitted with the application for resource consent; and*

2 *Until 30 June 2020, the nitrogen loss calculation for the part of the property within the Green or Light Blue Nutrient Allocation Zone does not exceed a total of 5kg/ha/yr above the nitrogen baseline, and from 1 July 2020 a total of 5kg/ha/yr above the Baseline GMP Loss Rate; unless the nitrogen baseline was lawfully exceeded prior to 13 February 2016, and the application for resource consent demonstrates that the exceedance was lawful.*

The exercise of discretion is restricted to the following matters:

1 *The content of, compliance with, and auditing of the Farm Environment Plan; and*

2 *The content quality and accuracy of the OVERSEER® budgets provided with the application for resource consent; and*

3 *The actual or potential adverse effects of the proposal on surface and groundwater quality and sources of drinking water; and*

4 *The timing of any actions or good management practices proposed to achieve the objectives and targets described in Schedule 7; and*

5 *Methods that limit the nitrogen loss calculation for the farming activity to a rate not exceeding a total of 5kg/ha/yr above the Baseline GMP Loss Rate; and*

6 *Methods that require the farming activity to operate at or below the Good Management Practice Loss Rate, in any circumstance where that Good Management Practice Loss Rate is less than a loss rate equivalent to a total of 5kg/ha/yr above the Baseline GMP Loss Rate; and*

7 *Methods to address any non-compliances that are identified as a result of a Farm Environment Plan audit, including the timing of any subsequent audits; and*

8 *Reporting of nutrient losses and audit results of the Farm Environment Plan to the Canterbury Regional Council; and*

9 *The consistency of the proposal with Policy 4.38A; and*

10 *Methods to prevent an exceedance of any relevant nutrient load limit set out in Sections 6 to 15 of the Plan.*

Box 3 Example model rule for per property threshold from the Waikato Regional Plan (operative as at July 2016):

3.10.5.3 Controlled Activity Rule – Nitrogen Leaching Farming Activities

The use of land in the Lake Taupo catchment for any farming activity existing as at the date of notification of this Rule (9 July 2005) that does not meet the conditions for permitted activities under Rule 3.10.5.1 and which may result in nitrogen leaching from the land and entering water is a permitted activity until 1 July 2007, after which it will be a controlled activity, subject to the following conditions, standards and terms:

Standards, terms and conditions to be met by applicants to enable them to seek consent under this Rule:

Benchmarking in order to determine Nitrogen Discharge Allowance

(a) Benchmark data for a minimum of 12 consecutive months during the period July 2001 to June 2005 shall be submitted to Waikato Regional Council as part of any application for consent under this Rule. The benchmark data shall comprise the parameters and information contained in Table 3.10.5.3. The amount of nitrogen leached from farming activities shall be calculated by Waikato Regional Council's Benchmarking Contractors using the OVERSEERTM Model Version 5.4.3 and the benchmark data. The nitrogen leached shall include any nitrogen arising from the application of farm animal effluent, pig farm effluent, feed pad effluent, stand-off pad effluent, and fertiliser onto land (those activities require authorisation under rules 3.5.5.1 to 3.5.5.5 and rule 3.9.4.11 outside of the Taupo catchment). The amount of nitrogen leached in the single best year (being the 12 consecutive months with the highest leaching value) over the July 2001 to June 2005 period shall be the Nitrogen Discharge Allowance for the land to which the controlled activity consent applies.

Waikato Regional Council reserves control over the following matters:

i. The specification of the Nitrogen Discharge Allowance in kgN/ha/year and total kgN/year for the land to which the controlled activity consent applies as determined under standard and term a);

ii. The requirement for a Nitrogen Management Plan (NMP) for the land to which the controlled activity consent applies if the farm management practices represented by the benchmarking data referred to in standard and term a) are altered. The OVERSEERTM Model Version 5.4.3 shall be used to calculate the nitrogen leached from the land to which the controlled activity consent applies inclusive of the altered farm management practices and this shall form the basis of the NMP. The NMP shall demonstrate that the nitrogen leached from the proposed farming activities complies with the benchmarked Nitrogen Discharge Allowance. The NMP shall be provided to the Waikato Regional Council within 10 working days of the farm management practices being altered;

iii. The self monitoring, record keeping, information provision and site access requirements for the holders of resource consents required to demonstrate ongoing compliance with the Nitrogen Management Plan;

iv. The circumstances and timeframes under which the resource consent conditions may be reviewed, provided that any review of a consent condition specifying the Nitrogen Discharge Allowance shall only occur when regional plan provisions have been made operative which specify a new target for the amount of nitrogen entering Lake Taupo and which requires that target to be achieved by the reduction of the Nitrogen Discharge Allowance specified in any resource consent;

v. The duration of the resource consent;

vi. The circumstances under which resource consents granted under this Rule can be surrendered either in whole or part pursuant to s138 of the RMA.

Box 4 Example model rule for per property threshold from the Environment Canterbury Proposed Plan Change 3 to the Canterbury Land and Water Regional Plan (notified April 2015):

15.5.3 The use of land for a farming activity, except any land that is part of a Nutrient User Group or Farming Enterprise, or land that is within the command area of an Irrigation Scheme where the nutrient loss from the farming activity is being managed by the scheme, that does not meet any of the conditions of Rule 15.4.2 excluding conditions 1(a),1(c) or 4 of Rule 15.5.2, is a restricted discretionary activity provided the following condition is met:

1 A Farm Environment Plan has been prepared in accordance with Schedule 7 Part A, and is submitted with the application for resource consent.

The exercise of discretion is restricted to the following matters:

1 Whether the nitrogen loss from the farming activity will result in the total catchment load limits as per Table 15(p) or the flexibility caps in Table 15(m) being exceeded; and

2 The quality of, compliance with and auditing of the Farm Environment Plan; and

3 The proposed management practices to avoid or minimise the discharge of nitrogen, phosphorous, sediment and microbiological contaminants to water from the use of land; and

4 The potential effects of the land use on surface and groundwater quality and sources of drinking-water; and

5 The appropriateness of the actions and time frames described in the Farm Environment Plan in achieving the maximum cap loss rates in Table 15(n); and

6 The quality and appropriateness of any soil mapping carried out for the property; and

7 The potential adverse effects of the activity on Ngāi Tahu cultural values.

Per Group Threshold

A policy and rule approach may instead (or as well) focus on a threshold per group e.g., irrigation schemes or catchment groups. This allowance can be based on a land use, water permit or a discharge permit. OVERSEER can be used to estimate the nutrient losses that underpin the collective allocation.

An example of this approach would be where the collective scheme or group has been granted a resource consent with an overall discharge allowance (usually a number of tonnes of N per annum) and properties within the scheme/group are then able to be managed flexibly within the overall limit. The land use of individual properties within the scheme would usually be a permitted activity, subject to conditions. Some form of management plan (e.g., an FEP) for each individual farm in the collective may be part of the conditions of the granted resource consent.

In addition to the per property threshold above, the key strengths of this approach are:

- there is increased flexibility for individual landowners in the scheme/group as 'unders and overs' may be accommodated within the overall limits.
- a single allowance covers multiple properties and may reduce the administrative burden on the farmer and council (but this would fall to the scheme or group administration).
- monitoring and compliance within the group can be based on contractual arrangements between the members, rather than through RMA mechanisms.

In addition to the per property threshold above, the key challenge of this approach is:

- the council needs assurance that there are robust and transparent processes for managing performance to ensure compliance.

An example of a good practice regional plan policy and a regional rule for a group threshold is shown in Box 5.

Box 5

(a) Example model policy for nutrient groups from Environment Canterbury Hurunui-Waiau River Regional Plan (operative as at July 2016):

Policy 5.1 To take a tributary and community based approach to managing water quality and improving nutrient management practices.

…the land is subject to:

(i) an Industry Certification System; or

(ii) a Catchment Agreement; or

(iii) an Irrigation Scheme Management Plan; or

(iv) a Lifestyle Block Management Plan

Catchment Agreement [means] … an agreement approved by Canterbury Regional Council that identifies actions to be undertaken to actively manage the use of natural resources in order to achieve high standards of environmental management and optimise production from all properties within a catchment or sub-catchment of the Hurunui, Waiau or Jed Rivers or their tributaries.

…

Any Catchment Agreement must at a minimum, to the extent considered appropriate and corresponding to the scale and significance of the activities within the catchment or sub-catchment contain the elements identified in Schedule 2.

(b) Example model rule for a group threshold from the Environment Canterbury Proposed Plan Change 5 to the Canterbury Land and Water Regional Plan (notified February 2016):

5.41A Despite Rules 5.43A to 5.59A, the use of land for a farming activity where either:

(a) the nitrogen loss from the farming activity is being managed under a resource consent that is held by an irrigation scheme or principal water supplier and the permit contains conditions which limit:

(i) the maximum rate at which nitrogen may be leached from the subject land (as measured in kg/ha/yr); or

(ii) the concentration of nitrogen in the drainage water leached from the subject land (as measured in ppm or g/m3); or

(b) the land is subject to a water permit that authorises the use of water for irrigation and:

(i) the permit was granted prior to 18 January 2014; and

(ii) the permit is subject to conditions that specify the maximum rate of nitrogen that may be leached from the land; and

(iii) the water permit is subject to conditions which requires the preparation and implementation of a plan to mitigate the effects of the loss of nutrients to water is a permitted activity.

3.4 The use of Farm Environment Plans and using OVERSEER to report nutrient discharges

OVERSEER can also be referenced in the policy and rule framework within a regional plan as a tool that is required to be used to report nutrient discharges. This often required as part of a management plan, often known as a 'Farm Environment Plan' (FEP), within which is normally a requirement for the calculation of nutrient losses using OVERSEER. Farm environment plans[16] are farm-specific plans that detail the environmental objectives for the farm and identify the on-farm actions that are implemented to achieve a suite of specified targets or objectives, which can include a threshold or nitrogen discharge allowance (NDA), and can provide important additional context to the data in an OVERSEER budget. A requirement to provide an OVERSEER estimate of nutrient loss can also be made without the need for an FEP or nutrient management plan. However, a disadvantage of this is that it would not demonstrate how an OVERSEER budget fits into a wider integrated farm environmental plan that addresses wider environmental requirements and goals.

The key strengths of this approach:

- Industry group leadership in the development and auditing for FEPs means there are likely to be cost efficiencies for developing FEPs specified in plan provisions. Similarly, there is likely to be less opposition from industry groups about regulatory requirements for FEPs.
- The implementation can be focussed on farm-specific practices that achieve a numeric nutrient loss limit or target that is documented in the FEP.
- Monitoring or auditing of an FEP where OVERSEER reporting is a requirement provides an opportunity for assessing both practices and numeric losses, and therefore can be used to assist in managing uncertainty as a consequence of version change, as underlying practices as well as OVERSEER budgets can be examined. The use of a supporting FEP can also assist in managing the quality of the data inputs.
- Assessment of compliance with good farm management practices required in an FEP has the potential to have higher certainty than compliance assessment focussed solely on OVERSEER estimates. Considering both practices and loss estimates provides a higher level of confidence in the achievement of good farm management practices and achievement of water quality objectives.

The key challenges of this approach:

- Farm environment plans may not be appropriate for a permitted activity rule condition, unless they include very clear and certain requirements that can be enforced, or are clearly only serving to provide supporting information for other primary enforceable conditions. In addition, there are monitoring and compliance resourcing implications for councils as costs cannot be recovered from persons operating under a permitted activity rule.
- There are resourcing implications in terms of the monitoring and auditing required, the number and training of council staff needed and the availability of sufficiently qualified and experienced practitioners.
- Care is needed to ensure that the content and actions to be included in an FEP and auditing pass/fail criteria are clearly set out to ensure the certainty and enforceability of regional rules and resource consents.
- Depending on the wording of a rule, implementation inconsistencies are possible if the farm exceeds a numeric threshold, but the required practices are all in place and being implemented.

[16] Other terms may be used, such as 'nutrient management plan', to which the discussion on FEPs is still applicable.

An example of a good practice regional rule that includes an FEP is shown in Box 6.

Box 6 Example model rule that incorporates a nutrient management plan from Bay of Plenty Regional Council Proposed Plan Change 10 Lake Rotorua Nutrient Management (notified February 2016):

Controlled – The use of land for farming activities on properties/farming enterprises less than 40 hectares in effective area or that were not previously managed by Rule 11 to 11F that do not meet permitted activity conditions

The use of land for farming activities on properties/farming enterprises in the Lake Rotorua groundwater catchment where:

- *The property/farming enterprise is less than 40 hectares in effective area or was not previously managed by Rule 11 to 11F; and*
- *The activity does not comply with permitted activity conditions in Part LR,*

is a controlled activity from 1 July 2022 subject to the following conditions:

(a) A 2032 Nitrogen Discharge Allowance and relevant Managed Reduction Targets have been determined for the land in accordance with Schedule LR One and Policy LR P8; and

(b) A Nitrogen Management Plan has been prepared for the property/farming enterprise by a suitably qualified and experienced person and that person has certified that the Nitrogen Management Plan has been prepared in accordance with Schedule LR Six.

3.5 Activity status thresholds

As part of the rule framework within a plan, it is important to consider activity status thresholds. There are several commonly accepted common law principles and conventions that apply to rule drafting for activity status thresholds (see the Quality Planning (QP) website www.qualityplanning.org.nz for background information and guidance).

Permitted activities are generally those where the resultant effects are not considered significant enough to justify management through a resource consent process. Nutrient loss estimates derived from OVERSEER can be helpful to justify the level at which a permitted activity status is appropriate. For example, OVERSEER estimates for properties under a certain size threshold, or for certain types of land use, can be used to justify a permitted activity status for activities below that threshold or within that land-use type, respectively.

Prohibited activities are at the other end of the spectrum – activities that cannot be granted a resource consent, such as a further allowance in an over-allocated catchment. A significant level of analysis and justification is required to define an activity as a prohibited activity and nutrient loss estimates from OVERSEER can be helpful to assist in such justification.

There is case law and obiter[17] Environment Court statements on the appropriate use of both permitted and prohibited activity rules. In summary, and as noted in Sections 2.1 and 3.1, a very high level of certainty is required for permitted activity and prohibited activity rules, and such rules should

[17] An observation by a judge on a matter not specifically before the court or not necessary in determining the issue before the court.

generally not provide for a subjective mechanism with inherent uncertainty to determine whether an activity is a permitted activity or a prohibited activity. Therefore, the use of permitted or prohibited activity rules with numerical thresholds that are defined in terms of an OVERSEER estimate should be avoided unless a robust OVERSEER version management mechanism is incorporated (see Section 6). This would be particularly relevant in situations where there is a high level of uncertainty associated with OVERSEER estimates. A potential consequence would be a property's status switching with different model versions between being a permitted activity and one requiring a resource consent, or between being a prohibited activity and one requiring a resource consent.

Sitting between the permitted and prohibited activity status thresholds, are those activities that require resource consent to be obtained. Where it is determined that a resource consent process is appropriate, consideration needs to be given to the appropriate activity status to be used (i.e., controlled, restricted discretionary, discretionary or non-complying) and the supporting policy framework. Care is needed to avoid any potential uncertainty about the activity status of an existing or proposed activity.

There are different ways to define the status of an activity, some of which do not use OVERSEER, or use OVERSEER only as a source of information to assist in determining an appropriate threshold. (These are not considered in detail in this report). Examples of different ways to define activity status that do not require an OVERSEER estimate to determine compliance include:

- land-use activity definitions e.g., 20 ha of irrigation, and
- simple property area definitions.

Examples of good practice regional rules for activity status thresholds are shown in Boxes 7 and 8.

Box 7 Example model rule for a threshold based on activities from Environment Canterbury Proposed Plan Change 5 to the LWRP (notified February 2016):

the use of land for a farming activity on a property greater than 10 hectares in area is a permitted activity provided the following conditions are met:

1 *…; and*

2 *The area of the property authorised to be irrigated with water is less than 50 hectares; and*

3 *For any property where, as at 13 February 2016, the area of land authorised to be irrigated with water is less than 50 hectares, any increase in the area of irrigated land is limited to 10 hectares above that which was irrigated at 13 February 2016; and*

4 *The area of the property used for winter grazing within the period 1 May to 1 September does not exceed a total area of 20 hectares; and*

5 *A Management Plan in accordance with Schedule 7A has been prepared and is implemented within 12 months of the rule being made operative, and is supplied to the Canterbury Regional Council on request.*

Box 8 Example model rule for a threshold based on activities from Bay of Plenty Regional Council Proposed Plan Change 10 Lake Rotorua Nutrient Management (notified February 2016):

Permitted – From 1 July 2017, the use of land for farming activities on properties/farming enterprises greater than 5 hectares in area and up to and including 10 hectares in effective area

The use of land for farming activities on properties/farming enterprises in the Lake Rotorua groundwater catchment:

- *Greater than five hectares in area and up to and including 10 ha in effective area; or*
- *From five hectares in effective area and up to and including 10 hectares in effective area, is a permitted activity from 1 July 2017 subject to the following conditions:*

(a) *The stocking rate that occurs on the effective area does not exceed the stocking rates specified in Schedule LR Two at any point in time; and*

(b) *No commercial cropping or commercial horticulture occurs on the land; and*

(c) *There is no increase in effective area or nitrogen inputs from [date of notification] that may contribute to an increase in nitrogen loss onto, into or from land; and*

(d) *There is no transfer of nitrogen loss entitlement either to or from the property/farming enterprise.*

Recommendations – plan-making

1 There is no one best way to apply OVERSEER within a regional planning framework. How and where OVERSEER is used in the plan-making process needs to be considered in the wider context of specific catchment characteristics, the extent of nutrient water quality issues, the level of information available, the resources available to develop and implement a regional plan, the freshwater objectives, and consideration of the principles outlined in Table 1.

2 Regional plan provisions should have clear and directive objectives and policies specific to nutrient water quality (e.g., receiving water nutrient concentrations and algal biomass) and catchment nutrient limits to ensure the environmental results sought by the plan are clear. This would provide clear guidance for any resource consent application process that involves OVERSEER nutrient losses estimates.

3 Where farm environment plans are identified as an implementation mechanism within a regional plan, the provisions should be clear about their specific role i.e., are they intended to be a primary enforceable element of a rule and/or resource consent condition (see Section 3.4) or are they intended to primarily provide information to complement other conditions?

4 Take account of the potential implications of OVERSEER version changes by:

(a) incorporating a process in an implementation plan (see sections 3.2, 3.3 & 3.4) to assess the implications of OVERSEER version changes on estimates of catchment source nutrient loads and any other relevant improved catchment information (e.g., hydrological information) for plan provisions,

(b) avoiding the used of fixed numerical thresholds with no OVERSEER version management method in permitted activity and prohibited activity rules that require OVERSEER estimates to determine compliance with those thresholds,

(c) ensuring that there is a robust method of managing the effects of an OVERSEER version change if thresholds are used in any rules classifying activity categories that require OVERSEER estimates to determine compliance with those thresholds, unless a robust OVERSEER version management mechanism is used (see Section 6),

(d) to the extent the methods referred to in (c) above are not fully effective in managing the effects of OVERSEER version change, minimising the reliance on activity status definition thresholds that depend on OVERSEER estimates e.g., by minimising the number of classes of activities defined by such thresholds to minimise the risk of a land use or discharge changing activity status as a consequence of an OVERSEER version change,

(e) considering the use of a mechanism to minimise the impact of OVERSEER version changes on regional rule (and resource consent) thresholds, including, but not limited to, a link to an external calculator or reference files, but recognising that (as at July 2016) there is no case law on this type of linked external mechanism (see Section 6), and

(f) recognising that methods of using OVERSEER in regional plans and resource consents are still developing and that approaches adopted by some plans have not been fully tested.

5 Where regional rules are set that rely on OVERSEER estimates to determine compliance, they should include the following requirements:

(a) a requirement to undertake OVERSEER modelling in accordance with appropriate standards and guidelines e.g., the relevant Best Practice Data Input Standards (BPDIS), and in particularly sensitive situations, a requirement for independent auditing as outlined in Table 12.

(b) a defined period(s) of time over which the OVERSEER modelling must be undertaken – generally a minimum of a rolling average of three to five years.

(c) a minimum qualification requirement for the person undertaking OVERSEER modelling of a Massey University Certificate in Advanced Sustainable Nutrient Management, an equivalent qualification, or extensive experience in a specific farming system and detailed understanding of OVERSEER. For OVERSEER modelling of particular significance, independent auditing of modelling should be undertaken by a person with the minimum qualification specified above, against the factors and process outlined in Table 12 (see Sections 10 & 11).

(d) A requirement to provide the relevant OVERSEER XML file and supporting information by a specific date, on request, or if a specific event occurs, to ensure that the consent authority is able to audit the information provided (see Section 10).

6 The following technical matters should be taken into account in the use of OVERSEER in the regional plan-making and implementation processes, along with other considerations such as cost and resourcing implications:

(a) Uncertainty – particularly the uncertainties associated with estimating both source and receiving water nutrient loads, and how this uncertainty should be managed and transparently taken into account in developing plan provisions e.g., using methods for generating source loads with low or moderate uncertainty, using OVERSEER outputs in a way that minimises uncertainty such as in a relative sense, prioritising the sourcing of good quality data for critical OVERSEER variables, incorporating adaptive management policies, having an implementation plan that specifies frequent receiving water quality monitoring and annual reassessment of catchment nutrient loss estimates, etc. (see Sections 5 & 7).

(b) Averaging – the potential for high inter-annual variation in estimated nutrient losses and less accurate nutrient loss estimates where the use of one year's actual farm system data may not be consistent with OVERSEER's long-term climate data means that the development and implementation of plan provisions should generally not rely on one year's actual farm system data (see Section 8).

7 An implementation plan should be developed that among other matters includes a plan for managing data provided to the council (e.g., OVERSEER XML files) (see Section 10).

4 Resource consent conditions

4.1 Introduction

This section is written primarily for RMA practitioners involved in the resource consent process.

Resource consents, and specifically resource consent conditions, are generally a critical component of implementing planning provisions designed to achieve specific freshwater quality objectives. In addition to the existing guidance on resource consent conditions[18], there are important specific matters that need to be considered for resource consent conditions that require an OVERSEER nutrient loss estimate, to ensure that those freshwater quality objectives are achieved.

The purpose of this section is to provide specific guidance for developing and implementing resource consent conditions that include a requirement for an OVERSEER nutrient loss estimate.

This section should be read in conjunction with the other sections of this report that provide further detail on particular aspects of the use of OVERSEER that need to be understood and considered in the formulation and implementation of resource consent conditions. In particular, the need to:

- understand the relevance of any catchment nutrient limits and whether these are explicitly or implicitly referred to in plan provisions (see Section 5 - Estimating catchment nutrient loads). For example, it may be appropriate to have an adaptive management condition triggered by the breach of a nutrient limit and/or a breach of a water quality standard.
- acknowledge the uncertainty associated with OVERSEER estimates and take this into account in resource consent conditions, including consideration of e.g., adaptive management conditions such as monitoring and consequential 'trigger response' requirements, short duration consents combined with appropriate monitoring and reporting conditions, and consent review conditions (see Section 7 - Uncertainty).
- understand the impact OVERSEER version changes can have on a consent condition that specifies a threshold that requires an OVERSEER estimate to determine compliance, and the options to minimise the potential for a version change to change the compliance status (see Table 3 and Section 6 - OVERSEER version change issues). Legal advice and analysis on OVERSEER version issues are summarised in Section 6 and has been taken into account in developing this section.
- appreciate the advantages of specifying a clear FEP requirement in a resource consent condition as a tangible farm plan consistent with all relevant regional plan provisions. However, care is needed to ensure there is certainty about whether the FEP is a primary enforceable condition or primarily to complement other conditions (see Section 3.4) and care is needed to avoid any conflicts between conditions.

[18] http://www.qualityplanning.org.nz/index.php/consents/conditions

- where resource consent conditions specify the use of OVERSEER, consider:
  - the need for a rolling average over a minimum of three to five years rather than relying on one year's data (see Section 8 - Averaging),
  - the need to specify the OVERSEER information to be provided and the management and security of this information (see Section 10 - Data provision and security), and
  - the need to specify the qualifications and experience of those preparing or auditing OVERSEER file information (see Section 11 - Qualifications).
- understand the differences between OVERSEER N & P loss modelling and how this may be relevant for resource consent conditions e.g., a resource consent condition specific to P loss would usually need to focus on run-off from an individual property and its potential to enter surface water (see Section 9 – Nitrogen and phosphorus modelling).

Box 9 Key messages – resource consent conditions

1 Resource consents, and specifically resource consent conditions that require the use of OVERSEER modelling, are increasingly a critical component of implementing planning provisions designed to achieve specific freshwater nutrient quality objectives.

2 In addition to the existing guidance on resource consent conditions, there are important specific matters that need to be considered and incorporated in resource consent conditions that require an OVERSEER nutrient loss estimate, to ensure that the intent of limiting nutrient losses is achieved and ultimately that freshwater quality objectives are achieved.

4.2 The use of OVERSEER in resource consent conditions

The process of managing to freshwater quality limits and ultimately achieving a plan's objectives is usually critically dependent on implementation through the resource consent process. OVERSEER is increasingly an important tool included in resource consent conditions dealing with nutrient losses and limits, regardless of whether the relevant plan prescribes the use of OVERSEER. For example, conditions may include a nutrient loss threshold for individual properties or groups of properties, or may require the reporting of nutrient losses to be estimated by using OVERSEER. Consent conditions that require the use of OVERSEER need, like any consent conditions, to meet minimum legal requirements (see the QP website[19]) such as being certain, lawful and enforceable.

Resource consent conditions that specify OVERSEER can be broadly categorised into three types (Table 2).

[19] http://www.qualityplanning.org.nz/index.php/consents/conditions

Table 2
Types of resource consent conditions needed to robustly specify the use of OVERSEER

Type of condition package	Usual application
1. **Information provision** i.e., a requirement to provide information where an OVERSEER estimate is specified as one of a number of acceptable alternatives.	In situations where there are no significant current or looming future nutrient water quality issues but an interest in obtaining information to provide a reassurance that water quality issues are unlikely to develop.
2. **Mandatory OVERSEER estimates** to be undertaken and provided as required/ requested	In situations where there is concern about nutrient water quality but no significant current water quality issues related to N or P. Can be utilised for information gathering in advance of catchment limit setting processes.
3. **Mandatory thresholds with compliance defined in terms of OVERSEER estimates**	In situations where there is a significant current nutrient water quality issue.

Where a resource consent condition specifies a nutrient loss threshold that requires OVERSEER modelling to determine compliance, the following components need to be defined and linked in resource consent conditions (Table 3) to ensure that the overall intention is achieved. More information, including resource consent examples and pitfalls, are outlined in Appendix 4.

Table 3
Resource consent conditions needed to enable robust specification of a threshold with compliance defined in terms of OVERSEER estimates.

Required resource consent condition component	Brief explanation
1. A defined threshold.	It is essential to have absolute certainty on what the mandatory threshold(s) is (are). This will require a numerical or narrative quantitative specification (see definition of threshold) with direct or indirect linkages to definitions contained within the resource consent. It may also be appropriate to have an 'early warning' trigger threshold to ensure that appropriate action is taken to reduce the risk of breaching the threshold e.g., where there is high uncertainty in the OVERSEER estimates e.g., where it is clear that the modelled situation is significantly beyond the original OVERSEER calibration range.

2. A requirement to undertake OVERSEER modelling in accordance with appropriate standards and guidelines e.g., BPDIS (see Section 10), and in particularly sensitive situations, a requirement for independent auditing to be undertaken as outlined in Table 12.	It needs to be explicit that the consent holder has to ensure that OVERSEER modelling is undertaken in accordance with the BPDIS and other appropriate standards, guidelines and considerations to ensure that the results accurately reflect the farm system (see Section 10 & Table 12). Some situations e.g., scale, significance and/or location, may not warrant independent auditing. The need for auditing may be prescribed in the relevant regional plan. If there are relatively few resource consents required in a catchment and they are for relatively significant amounts of nutrient loss, auditing may be needed for all OVERSEER files; conversely, if there are a large number of resource consents with some individually insignificant amounts of nutrient loss, auditing for all resource consents may not be justified.
3. A defined period(s) of time over which the OVERSEER modelling must be undertaken.	This must be made clear and line up with any specific catchment limit timeframe specifications (see Sections 5 & 8). Specifically, see the limitations of using one year's actual farm data.
4. An OVERSEER version management mechanism.	This is essential to clarify how OVERSEER version changes will be managed e.g., by not relying solely on one threshold condition, by providing an updating mechanism (e.g., providing for previously compliant model inputs to remain compliant in a new version, or using an external calculator/reference system), by providing complementary conditions that would provide for a resource consent holder to change and/or review conditions as a consequence of an OVERSEER version change, etc. (see Section 6).
5. The minimum qualification requirement for the person undertaking the OVERSEER modelling and, if auditing is required, the minimum qualification for the person undertaking the auditing.	OVERSEER is a complex model that requires detailed knowledge of both how the model works and NZ farming systems. A minimum qualification is essential (see Sections 10 & 11).
6. A requirement to provide the OVERSEER XML file and supporting information by a specific date, on request, or if a specific event occurs.	It needs to be clear exactly what and when information must be provided to the regional council. The OVERSEER XML file is essential to be able to audit the information provided.
7. Any circumstances that would trigger a requirement for a complementary FEP	An FEP is usually needed to provide a comprehensive integrated plan of how nutrient loss thresholds will be achieved, and to provide information to support the OVERSEER nutrient loss estimates.

Recommendations – resource consent conditions

1 Resource consent conditions that specify thresholds that require an OVERSEER estimate to determine compliance should contain the following components:

   (a) A well-defined threshold (see Appendix 4). There can be advantages in also including a pre-threshold 'trigger response' condition that requires a specific action to be taken prior to a critical threshold being reached.

   (b) A requirement to undertake OVERSEER modelling in accordance with appropriate standards and guidelines e.g., the BPDIS, and in particularly sensitive situations, a requirement for independent auditing as outlined in Table 12.

   (c) A defined period of time over which the OVERSEER modelling must be undertaken – generally a minimum of a rolling average of three to five years (see Section 8).

   (d) An OVERSEER version management mechanism e.g., using a threshold defined with a GMP calculator or reference files, by not relying solely on one threshold condition, by providing an updating mechanism (e.g., providing for previously compliant model inputs to remain compliant in a new version, or using an external calculator/reference files system), by providing complementary conditions that would make it relatively easy to apply to change and/or to initiate a review of conditions as a consequence of an OVERSEER version change, a fixed version (if available), etc. (see Appendices 4 & 6 & Section 6).

   (e) A minimum qualification requirement for the person undertaking OVERSEER modelling of a Massey University Certificate in Advanced Sustainable Nutrient Management, an equivalent qualification, or extensive experience in a specific farming system and detailed understanding of OVERSEER. For OVERSEER modelling of particular significance, independent auditing of modelling should be undertaken by a person with the minimum qualification specified above, against the factors and process outlined in Table 12 (see Sections 10 & 11).

   (f) A requirement to provide the relevant OVERSEER XML file and supporting information by a specific date, on request, or if a specific event occurs to ensure that the consent authority is able to audit the information provided (see Section 10).

   (g) A requirement for an FEP – to provide a tangible practical guide on how farm management will be undertaken. However, there needs to be absolute certainty about whether the FEP is a primary enforceable condition or is primarily to complement other conditions, and care is needed to avoid any conflicts between conditions (see Section 3.4).

2 The following technical matters should be taken into account in the use of OVERSEER in resource consent conditions, along with other considerations such as cost and resourcing implications:

   (a) Uncertainty –conditions that take uncertainty into account are likely to be needed e.g., adaptive management conditions such as monitoring and consequential 'trigger response' requirements, short duration term combined with appropriate monitoring/ investigations and reporting to provide more information, a review condition that specifies an event that would trigger a review, etc. (see Section 7 and the QP website).

   (b) Averaging – there is potential for high inter-annual variation in estimated nutrient losses and less accurate nutrient loss estimates where the use of one year's actual farm system data may not be consistent with OVERSEER's long-term climate data (see Section 8).

5 Estimating catchment nutrient loads

5.1 Introduction

This section is written primarily for scientists and RMA practitioners providing advice for those involved in the plan-making and/or resource consent processes.

The purpose of this section is to assess the strengths and challenges of the general methods for estimating source nutrient loads that use OVERSEER. There is also a short explanation of how OVERSEER information is used in estimating receiving environment loads. This section assumes that other appropriate methods are used to estimate source nutrient loads from activities that cannot be modelled by OVERSEER e.g., from non-agricultural, residential, commercial or industrial activities.

Box 10 Key messages – estimating catchment nutrient loads

1 There are several methods for estimating source nutrient loads that differ in their strengths, challenges, resource implications and uncertainty.

2 A better quality source nutrient load estimation generally has a higher resource requirement.

3 There are many complex processes involved in the attenuation of nutrients as they move from the source to the receiving water. There is often limited information available to assist with developing a catchment attenuation factor, and the understanding of all factors that influence the attenuation of nutrients generally and in specific catchments is still developing.

4 OVERSEER can be used to help derive a catchment attenuation factor. However, this factor will change over time as improved information becomes available.

5 Long-term targeted water quality monitoring is essential to obtain information needed to enhance knowledge about the relationship between source nutrient loads and receiving water loads.

Estimating source nutrient loads

OVERSEER is one model that can be used to estimate source nutrient loads from farming land uses (point A in Figure 2) in a catchment. The individual property losses can be summed to give a farming source nutrient load, and these source nutrient loads can be estimated using OVERSEER in several ways. Examples of different methods, their information needs, strengths, and challenges are tabulated in Table 4. Table 4 is not exhaustive and combinations of these methods may exist. If OVERSEER is used, it is important that other sources of nutrients not captured in OVERSEER are also assessed.

Table 4
Examples of different approaches to estimating source nutrient loads using OVERSEER

Example 1. Use generic or literature nutrient loss values

Description	Industry average or typical nutrient losses are extrapolated to a catchment scale
Main strengths	▪ Easy access to information ▪ Can generate source load estimates quickly
Main challenges	▪ Generic estimates are not specific to the systems, soils and climates in the catchment and therefore may not reflect actual systems, soils or climates ▪ Can be unclear what level of practice has been modelled and what assumptions have been used in modelling ▪ Mitigations can be problematic to apply to these generic estimates if underlying assumptions are unknown
Resourcing implications	Few resources needed
Likely uncertainty of data inputs and ability to manage uncertainty (Appendix 5)	High uncertainty of data inputs. Low ability to manage uncertainty

Example 2. Use anecdotal case studies

Description	Some existing individual OVERSEER budget nutrient losses are extrapolated to a catchment scale
Main strengths	▪ Relatively easy access to information ▪ Can generate source load estimates quickly ▪ If anecdotal (individual) files are available, these can be updated with model version change ▪ Can be used to estimate current source loads
Main challenges	▪ Characteristics and assumptions of the anecdotal systems may not be valid for the whole catchment and subsequent impact on loss rates is compounded with extrapolation to catchment losses ▪ Confidentiality issues can hinder close scrutiny of input data ▪ Anecdotal files are often based on a single year i.e., a snapshot. This can be problematic if the year was atypical (see Section 8 - Averaging) ▪ Anecdotal systems may not cover all of the soils, climates, and systems in the catchment ▪ Current farm management practice encompasses everything from very poor to best management practice. The level of practice would need to be normalised for use in testing policy options and future scenarios ▪ If files were built by multiple modellers, may be difficult to get a consistent level of practice and data input standards ▪ Can be unclear what assumptions have been used in modelling ▪ Mitigations can be problematic to apply to these anecdotal files if underlying assumptions are unknown ▪ Risk of variable quality of information

Resourcing implications	Few resources needed
Likely uncertainty of data inputs and ability to manage uncertainty (Appendix 5)	High uncertainty of data inputs Low ability to manage uncertainty

Example 3. Use representative farms (few)

Description	Some virtual farm nutrient budgets are created to represent the mix of catchment characteristics and are extrapolated to a catchment scale
Main strengths	▪ Can engage farmers/ industry representatives in deriving information for models ▪ As farms are virtual, they can be consistent with OVERSEER assumptions e.g., long-term climate (see Section 8 - Averaging) ▪ Can produce reference files that can be updated with model version change ▪ Can apply consistent level of practice and data input standards
Main challenges	▪ Characteristics and assumptions of few representative farm systems may not be valid for the whole catchment and subsequent impact on loss rates is compounded with extrapolation to catchment losses ▪ The virtual farms are catchment specific ▪ Additional modelling may be needed for the representative farms to be plausibly extrapolated across soils and climates in the catchment ▪ The full range of current land uses in the catchment may not be captured
Resourcing implications	Moderate resources needed
Likely uncertainty of data inputs and ability to manage uncertainty (Appendix 5)	Moderate uncertainty of data inputs Moderate ability to manage uncertainty

Example 4. Use representative farms (many)

Description	Many virtual nutrient budgets are created to cover a range of farm systems, soils, and climates
Main strengths	▪ Can engage farmers/industry representatives in deriving information for models ▪ As farms are virtual, they can be consistent with OVERSEER assumptions e.g., long-term climate (see Section 8 - Averaging) ▪ Can produce reference files that can be updated with model version change ▪ Can apply consistent level of practice and data input standards ▪ Farm systems not confined to a particular catchment
Main challenges	▪ The full range of current land uses in the catchment may not be captured ▪ Farms may need to be aggregated for use in testing policy options and future scenarios

Resourcing implications	Significant resources needed
Likely uncertainty of data inputs and ability to manage uncertainty (Appendix 5)	Low uncertainty of data inputs Moderate ability to manage uncertainty
Additional information	Software has been developed that allows many (hundreds) of OVERSEER files to be generated, run and summarised in very short times (minutes). These tools considerably reduce the resource implications of this approach, but require expert input for initial set up and checking of information produced

Example 5. Use actual farm budgets

Description	All farm nutrient budgets are collected for a catchment
Main strengths	▪ Can be used to assess current source load ▪ Files can be updated with model version change ▪ More closely represents what is occurring in the catchment than representative farms
Main challenges	▪ Current practice encompasses everything from very poor to best management practice – this approach can accommodate this in estimating source loads. The level of practice would need to be normalised for use in testing policy options and future scenarios ▪ If there are many farms, they may need to be aggregated for use in testing policy options and future scenarios ▪ Risk of variable quality of information ▪ If only a single year is collected, this can be problematic if the year was atypical or for systems in transition (see Section 8 - Averaging) ▪ Confidentiality issues can hinder close scrutiny of input data
Resourcing implications	Significant resources needed
Likely uncertainty of data inputs and ability to manage uncertainty (Appendix 5)	Low/Moderate uncertainty of data inputs (Low if model users are experienced, a consistent input standard is used (e.g., BPDIS, 2016) and high-quality data sources are used). Moderate-high ability to manage uncertainty.
Additional information	Software has been developed that allows a consistent set of modelling proxies (intended to represent industry agreed Good Management Practice) to be applied to existing OVERSEER files. This could overcome the challenge of unknown levels of practice with this approach[20].

[20] ECan Farm Portal: https://farmportal.ecan.govt.nz/. GMP tool: https://farmportal.ecan.govt.nz/GMPTool/Auth/Login?ReturnUrl=%2fGMPTool

5.2 Estimating receiving environment nutrient loads

Between N and/or P being lost from a farm and arriving at a specific point in a receiving environment, a wide range of processes, such as sedimentation, plant uptake and denitrification, can occur that can remove those nutrients from the water body or make them effectively unavailable. These processes can be grouped together and termed attenuation. Therefore, the total amount of nutrient that is lost from the farm boundary or root zone is generally not the same as that which is measured in the receiving environment of specific interest. Understanding the likely magnitude of this attenuation is important in establishing freshwater objectives and setting and managing to freshwater limits. Catchment attenuation is expected to vary spatially and with time because the biophysical processes that contribute to attenuation vary spatially and in time. A range of estimates for catchment attenuation factors has been reported in New Zealand for N[21]. A factor in the order of 50% is common but much smaller and greater rates of attenuation have been estimated and used in New Zealand (e.g., Howard-Williams et al., 2010).

Catchment models can use OVERSEER outputs in two ways in estimating receiving environment loads. OVERSEER estimates can be used in conjunction with other information such as monitored receiving water quality, to derive a catchment attenuation factor (CAF)[22]. Or if a catchment attenuation factor has already been developed empirically or independently, it can be applied to a source load estimated by OVERSEER (for a catchment) to estimate the amount of nutrient likely to enter a receiving environment e.g., from future land uses.

A derived catchment attenuation factor is a term used where the amount of N or P attenuated during travel down a catchment is roughly estimated by subtracting the measured receiving environment load at the measurement point at the bottom of the catchment from the modelled source loads. The difference is expressed as a factor i.e., the CAF is 'derived' from these two sources of information and will include both attenuation and the uncertainty in the modelled and measured estimates.

An empirical catchment attenuation factor is a term used where there has been some scientific effort to quantify the attenuation processes through measurement, either at the individual process level or collectively. In some locations, considerable scientific effort has been applied to quantify individual attenuation processes in a catchment e.g., nitrate concentrations have been measured along a section of the Tukituki River in Hawkes Bay where conditions are conducive to large growths (and therefore large nutrient uptake) of periphyton (Wilcock, 2013). However, attenuation factors can be highly complex, and spatially and temporally variable (e.g., Howard-Williams et al., 2010), and there are often multiple types of attenuation processes occurring; therefore, collecting robust data can be time-consuming and costly.

In catchments with no significant lag times (i.e., the time taken for nutrients to move down a catchment to the receiving environment of concern), deriving the catchment attenuation factor estimates the total amount of attenuation. This method does not attempt to quantify the relative contribution of various complex biophysical attenuation processes such as the amount of denitrification versus uptake by riparian vegetation or periphyton. The derived catchment attenuation factor is thus a lumped catchment estimate of all attenuation processes. Importantly, it also includes the uncertainties in the modelled[23] and measured loads. In catchments where there are significant

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[21] For example, Singh et al. (2014) reported N attenuation factor estimates in Manawatu catchments ranging from 0.2 to 0.7, and an attenuation factor of 0.5 is assumed in both the Taupo catchment (Waikato Regional Council's Variation 5) and in the Manawatu-Wanganui (Horizons' One Plan); more than ten-fold reductions in nitrate concentrations have been measured along a section of the Tukituki River in Hawkes Bay (Wilcock, 2013).

[22] Also termed a catchment coefficient.

[23] This relationship is usually derived using predictive OVERSEER nutrient budgets not historical. If historical OVERSEER nutrient budgets are used here, then consideration needs to be given to how representative that historic period was (see Section 8).

lag times, deriving the catchment attenuation factor must also account for that load which is expected to arrive in the receiving environment at some point in the future. Otherwise, there is a risk of overestimating the attenuation factor and therefore underestimating the nutrients that are likely to enter the receiving environment.

OVERSEER estimates change (improve) each time a new updated version is released, and measurement-based estimates improve with more frequent sampling and/or a longer period of monitoring record. Thus, a derived catchment attenuation factor is also expected to continuously improve over time i.e., if either the OVERSEER estimates of the catchment source nutrient losses (for a given land use mix) or the measurement of the receiving environment nutrient estimates change, then the derived catchment attenuation factor will also change. If the attenuation factor has been wholly derived from or based on empirical data, it is not expected to change with updates to modelled information.

Recommendations – estimating catchment nutrient loads

1 Where source loads calculations are used to inform source and receiving environment nutrient load limits, use information and methods with low or moderate uncertainty, as outlined in Table 4.

2 There needs to be targeted long-term nutrient water quality monitoring to progressively test the modelling assumptions used in the catchment modelling, including attenuation factors, and a process for assessing and, where appropriate, updating those factors as new information becomes available. This would then enable that new information to be considered in a plan review process.

3 The implications of OVERSEER version changes on source nutrient load estimates and calculations used as a basis for setting catchment nutrient load limits should be assessed as soon as practicable after each version change.

6 OVERSEER version change issues

6.1 Introduction

This section is written primarily for RMA practitioners involved in the plan-making and/or resource consent processes.

The purpose of this section is to clarify what is involved in an OVERSEER version change, the implications of that for some applications of OVERSEER, and to provide an analysis of options to address version change issues.

OVERSEER is being used in a range of ways in the development and implementation of regional plans and resource consents. Many of these approaches and some of the issues associated with them have been summarised in Arbuckle (2015). An ongoing, potentially significant issue with some of the uses of OVERSEER in regional plans and resource consents is the implications of regular version changes. There are two key issues:

Catchment source nutrient loss estimates and related plan provisions	A version change could result in a different estimate of source nutrient loss compared to an earlier estimate and the relevant policies and rules (including limits) developed (in part) on the basis of those estimates would need to be re-examined to ensure that they would still achieve the plan's water quality objectives. A consequence could be that the implementation of those policies and rules may result in more nutrients entering the receiving water than originally anticipated (meaning the plan is not strict enough), or alternatively, resulting in fewer nutrients entering the water body (meaning that the plan may impose unnecessarily strict policies and rules).
Regional rules and/ or resource consent conditions	Where a regional rule or resource consent condition has a threshold and/ or limit defined by (an implicit or explicit) reference to the current version of OVERSEER, a version change could result in an activity status changing from one activity class to another e.g., from a land use activity being defined as a permitted activity to being defined as requiring a resource consent application, or from a land use being defined as a non-complying activity to being defined as a prohibited activity, or a consented activity, potentially changing from compliance with a condition to non-compliance as a consequence of a condition threshold effectively changing.

Box 11 Key messages – OVERSEER version changes

1 OVERSEER version changes are an essential consequence of improvements to the accuracy of OVERSEER estimates, broadening of its applicability and improving its usability and/or user interface.

2 OVERSEER version changes (excluding usability and user interface changes) can result in significant changes to estimates of N and/or P loss. The consequential changes in nutrient loss estimates can vary significantly from property to property, depending on the level of similarity of soils, climate, climate patterns, topography, farm systems, etc.

3 OVERSEER version changes can potentially affect the understanding of source nutrient losses that was relied on in the plan-making process.

4 A significant change in the S-map soils database can also result in changes to important OVERSEER inputs and consequential changes to estimates of N and/or P loss.

5 A range of methods can be used in regional plan provisions and resource consent conditions to avoid or minimise the consequences of version changes (see Sections 3 & 4, & Appendix 6).

6 There would be advantages in having RMA processes that provide additional methods for incorporating OVERSEER version changes into a regional plan.

6.2 OVERSEER version change

OVERSEER is usually updated twice per year, with one significant version change usually in May, and a minor one later in the year, usually in November. A version change can involve relatively minor matters such as the model user interface wording or an output report wording, improving the data entry methods, fixing an insignificant software bug, or adding some functionality that doesn't change the 'engine' calculations. These types of changes would not have any impact on nutrient loss estimates. Conversely, a version change can involve a significant new or upgraded module, such as happened in April 2015 with the introduction of the new irrigation module.

A significant version change can also result from incorporation of new research information, changes resulting from reviews of model components, responses to investigations into reported anomalies, updating a model component with new data (e.g., N content of pasture species), addressing a significant software defect or bug, improving an algorithm with new information, etc. These types of changes can result in significant changes in estimates of nutrient loss.

There are also important linkages with information sources such as the S-map soils database (http://smap.landcareresearch.co.nz/home) that is a recommended (BPDIS, 2016) source of soil characteristic input data for OVERSEER. Those soil characteristic inputs can affect the estimates of nutrient loss. The soil characteristics information in the S-map soils database can change as a consequence of improved information, and new S-map information used as an input into OVERSEER can result in changes in OVERSEER nutrient loss estimates.

Version changes that result in changes in estimates of nutrient loss should be considered as moving towards a closer approximation of what the actual losses are likely to be i.e., reducing the uncertainty associated with nutrient loss estimates.

OVERSEER version numbering follows generally accepted software revision control protocols[24] with the numbering (e.g., 6.2.2) indicating the degree/extent of the significance of changes i.e., major. minor.maintenance[25].

The current OVERSEER Limited policy[26] is that when OVERSEER is updated previous versions are made unavailable. The internet version (https://secure.overseer.org.nz/live/) is updated to the new version and older internet versions are archived and not maintained. The standalone version has an expiry date built into it, which ensures that that version expires at the end of the month that is scheduled for the new version to be made available for downloading and installation.

OVERSEER Limited has agreed to allow the Waikato Regional Council to continue to use the standalone OVERSEER 5.4.3 version that is specified in the current (2016) version of the Waikato Regional Plan. In exceptional circumstances an archived version has been made available for limited use e.g., to complete a major technical or research investigation.

Over time, it is possible that OVERSEER's development will become so refined that the significance of version changes will reduce until there are no issues for the application of OVERSEER under the RMA. However, given the complexity of the model, the complexity of many farming systems and the complexity of nutrient cycles, this is unlikely to occur in the foreseeable future.

Model version change issues are not unique to OVERSEER; many other models (e.g., groundwater allocation models, air quality dispersion models, river flow estimation models, etc.) used under the RMA also undergo version changes. Therefore, methods developed to address OVERSEER version changes may be of benefit in other similar situations.

6.3 OVERSEER version change issues

A key issue with OVERSEER version changes is that they can result in changes to estimates of nutrient loss compared to those made with a previous version, and those changes can vary from situation to situation depending on the detailed version changes and the farm systems being modelled. Some changes may only affect some farm systems or a specific component, while some changes may be more broadly applicable. For example, an enhancement of a sub-model related to dairy cow urine N may have an effect on estimates of N loss for a dairy farm but won't affect P loss estimates for an arable cropping farm.

The likely consequences of version changes for nutrient loss estimates are usually investigated and signalled in advance by OVERSEER Limited if they are likely to be significant. However, because of the complexity and range of farm systems, because of the range of soils and climate in New Zealand, and because version changes often incorporate multiple changes to the software, it can be extremely difficult to predict all the consequences of all changes on nutrient loss estimates for all farm systems.

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[24] https://en.wikipedia.org/wiki/Software_versioning

[25] OVERSEER is referenced by a three number sequence numbering system, currently (July 2016) version 6.2.2. However, these terms (major, minor & maintenance) are relative and because of the complex nature of OVERSEER and the range of farm systems and locations in New Zealand, the relative scale of change signalled by a 'minor' or 'maintenance' change will frequently not indicate the significance of potential changes in estimates of nutrient loss for all farm systems in all locations.

[26] The updating of OVERSEER is managed by the OVERSEER General Manager, on behalf of OVERSEER Limited who seeks advice on model development priorities from three advisory groups. Science and software development services are outsourced primarily to AgResearch and Rezare Systems using robust quality assurance requirements. There is a process is already in place for OVERSEER development: "OVERSEER Limited identifies and prioritises the development programme with input from three independent advisory groups (science, user and stakeholder). Development activities follow structured Science and Software Development Lifecycle processes that are specifically designed to maintain quality and understand the impacts of development on the model outputs and communicate these to users" (Caroline Read, OVERSEER General Manager, Personal Communication, March, 2016).

In some catchments with similar soils, similar topography, similar climate and similar farm systems, the effects of a version change on nutrient loss estimates are likely to be similar. Conversely, in a large catchment with many different soil types, different topographies, different climates, and a wide variety of farm systems, the effects of a version change can vary significantly.

There are potentially very significant policy, regulatory and implementation resourcing implications of OVERSEER version changes depending on the specific way(s) that OVERSEER is explicitly or implicitly applied in regional plans and/or resource consents. Three very broad types of application of OVERSEER are summarised below (Table 5), with an explanation of the potential consequences of an OVERSEER version change and the consideration that should be given to these consequences.

Table 5
Potential consequences of an OVERSEER version change for different applications of OVERSEER

Application of OVERSEER	**To assist in the estimation of current and/or future source and receiving environment nutrient loads**
Example	OVERSEER is used as part of catchment modelling to estimate an acceptable catchment source nitrogen load.
Potential consequence of a significant OVERSEER version change	If plan provisions are developed on the basis of the catchment modelling undertaken, a significant change in OVERSEER estimates could result in a catchment load underestimate or overestimate. Provisions developed on the basis of that estimate could accordingly be either ineffective or overly restrictive.
Consideration to address (see Section 6.5)	As part of the plan-making process, the potential impact of version changes should be considered in determining the most appropriate set of plan provisions. Where plan provisions are based on OVERSEER estimates, a regular assessment should be undertaken after significant OVERSEER version changes to assess the extent to which that change impacts on the appropriateness of the provisions[27]. The results of such an assessment can be used to determine whether or not it would be appropriate to undertake a specific review of a plan's provisions.

[27] The appropriate frequency and extent of such an assessment will largely depend on the nature of the regional plan provisions and the extent of model engine changes with a version change. For example, a relatively simple plan for a catchment with no significant current water quality issues, a robust version updating system and only minor OVERSEER engine changes in a version change, would indicate that a detailed assessment would not be needed for those plan provisions in response to that version change.

Application of OVERSEER	**To define the primary method to use for determining compliance with nutrient loss thresholds in the plan**
Example	Catchment source load limit, numerical or narrative regional rule thresholds or numerical or narrative resource consent condition thresholds
Potential consequence of a significant OVERSEER version change	If a regional rule or resource consent condition that is not locked to one OVERSEER version specifies a nutrient loss threshold, a version change could result in a change in the status of an activity e.g., from permitted to requiring a resource consent, or from compliance to non-compliance with a resource consent condition.
Consideration to address (see Section 6.5)	As part of the plan-making process, consideration needs to be given to how the impact of version changes is managed, particularly in relation to the drafting of rules that set out different activity status. Methods should be used in regional plan provisions and resource consent conditions, to minimise the consequences of version changes. Methods that provide for an OVERSEER version change to update a component of a regional rule or resource consent condition need to be carefully formulated to minimise the potential for an OVERSEER version change to result in a change in activity status for a land use/discharge.

Application of OVERSEER	**As a tool specified to be used by landholders to estimate and report nutrient losses from a farm.**
Example	A rule or resource consent requires the reporting of nutrient loss using OVERSEER but does not specify a maximum threshold. This can also include the specification of OVERSEER as one optional method of providing information.
Potential consequence of a significant OVERSEER version change	This type of specification is generally unlikely to result in immediate significant version change management issues.
Consideration to address (see Section 6.5)	No issue to address.

6.4 OVERSEER version specification approaches

Current practices for specifying the use of OVERSEER in regional plans and resource consents can be grouped into the following general approaches:

- Specific version number e.g., Waikato Regional Council – version 5.4.3.
- Current/latest version e.g., Environment Canterbury.
- Partial version number e.g., Otago Regional Council – version 6 (effectively the current version).
- No version specified e.g., Horizons Regional Council – effectively the current version.

Because previous versions of OVERSEER are not generally available, the last three approaches are essentially the same i.e., the only version generally available is the current version.

The Waikato Regional Council has developed policies and rules (in the Waikato Regional Plan) for the management of nitrogen loss to Lake Taupo and is the only regional council that has specified a precise OVERSEER version in an operative regional plan i.e., version 5.4.3. This was done to meet the need for outcome, community and legal certainty (Barns & Young, 2013). However, one disadvantage of this approach is that it makes it challenging to readily take account of model improvements that might, for example, include new N loss reduction strategies or enhance the accuracy of N loss estimates.

6.5 OVERSEER version change response approaches

Response to implications for the information base for regional plan development

The most appropriate approach to respond to an OVERSEER version change that may change the understanding of the relationship between nutrient source losses and receiving water objectives is to undertake a technical examination of the implications of changes for the objectives sought by the plan. The results of such an assessment should identify the significance of changes and assist in determining an appropriate response.

Responses to implications for regional plan provisions and resource consent conditions

A range of approaches have been adopted or proposed to date to respond to the implications of OVERSEER version changes for thresholds that require an OVERSEER estimate to determine compliance specified in regional plans and/or resource consents. These are summarised in Appendix 6 together with the advantages and disadvantages of each approach. Many of these approaches are not mutually exclusive. The appropriateness or otherwise of a specific method is likely to depend on the specific circumstances, for example, the objectives of a plan and the preferred types of rules.

Additional methods have been suggested by various parties that are beyond the current options available to regional councils. These include a change to the version change process and an additional 'fast track' method for incorporating changes to models specified in regional plans. These would require significant consultation with other organisations i.e., OVERSEER Limited (version change processes) and the Ministry for the Environment, and the Ministry for Primary Industries (a new fast-track plan change provision). However, because these possible approaches do have some significant potential advantages they are included in Appendix 6.

It is important to distinguish between how a version change may change the estimate of a nutrient loss from a current land use and how a version change may or may not change the interpretation of different types of rule or resource consent thresholds. The consequence of a version change may be different for a rule or resource consent depending on the type of threshold. For example, a threshold could be defined as:

- a numerical maximum defined with the current version of OVERSEER,
- the average nutrient loss for a property during a specified ("baseline") period using a reference input file for that property and for that period which is recalculated using any new version of OVERSEER, or
- a defined GMP for the current farm system.

In the final example, the risk of an activity changing status solely as a consequence of an OVERSEER version change would be removed because the effect of a version change would be 'neutralised'.

Different types of OVERSEER version management methods may more suited to different types of rules, and related issues such as the risk of an activity changing activity status would need to be considered. It is not feasible to identify version management systems that would be robust and suitable for all situations. Some methods will be suited to some situations, while others may be more suited to other situations (see Appendix 6).

It is important to appreciate that an OVERSEER version change may affect nutrient loss estimates from properties in different ways depending on the farm system, soils, climate, etc., and the implications of this for different types of rules. For example, where a threshold is defined in terms of a baseline estimate for an earlier period, a version change may result in significant differences between nutrient loss estimates for properties for both the baseline and a current land use. This could result in a version change causing some properties changing activity status while other properties might not change activity status. Depending on the intent of the plan, this may or may not be a significant issue. If for example, the plan is endeavouring to significantly reduce nutrient loss in a catchment then a change in activity status as a consequence of a version change may not be a significant concern. Conversely if the intent of a plan is to not increase a catchment/property nutrient load then a change in activity status as a consequence of a version change may be a significant issue.

Therefore, a threshold based on an historical baseline can be suitable for a range of situations, including where a catchment nutrient loss reduction is a priority and the issues associated with properties potentially changing activity status as a consequence of a version change is understood. Conversely, a threshold based on current land use GMP may be appropriate where a plan is not seeking significant reductions in catchment nutrient loss; a version change in this situation would not result in an activity status change.

OVERSEER version updating methodologies that use linked external mechanisms

A key broad OVERSEER version management approach, outlined in Appendix 6, that has relatively recently been included in proposed plan changes by the Bay of Plenty Regional Council and Environment Canterbury involves use of a mechanism referenced from a plan provision that takes account of the effects of an OVERSEER version change. This is done by having a suite of files (reference files) or a website-based calculator that is referenced from a regional plan provision and can be updated by OVERSEER version changes. More detailed analyses of these two approaches is detailed in the respective section 32 analyses[28].

The linkage to an external mechanism to allow both the current nutrient loss estimate and the comparative threshold to be updated with a version change means that the core plan provisions can remain unchanged but an OVERSEER version change could be accommodated with generally only a small risk that an activity status and/or compliance status of an activity could change as a consequence.

The reason that there could still be a small risk of an activity status and/or compliance status changing under such updating systems is firstly because there is some scope for data inputs to change slightly while still complying with the BPDIS, and secondly because a version change may not result in a proportional change in both the actual land use nutrient loss estimate and the comparative threshold when moving from one version to another. As indicated in the averaging section (see Section 8), OVERSEER has a number of non-linear and stepped processes incorporated into the model that mean that model changes can result in non-linear output responses. Therefore, it is possible for example, that as a consequence of a version change, estimated nutrient loss from a land use might increase proportionally more than an increase in a comparative threshold estimate.

[28] Bay of Plenty Proposed Plan Change 10 Section 32 analysis: https://www.boprc.govt.nz/media/509000/s-final-section-32-lake-rotorua-nutrient-management-plan-change-10-pdf-copy.pdf
Environment Canterbury Proposed Plan Change 5 Land and Water Regional Plan: http://ecan.govt.nz/publications/Council/09.2-S32-pc5-report-plan-change-5-nutrient.pdf

A potential disadvantage of OVERSEER version updating systems that sit outside a plan is that they are different from the way that RMA plans have conventionally operated and there is very limited case law to provide guidance on these systems. It is also important to appreciate the difference between the resource consent process and the regional plan process. For example, there is significantly more scope in the resource consent process for an applicant to propose and/or agree to an OVERSEER updating system that may not provide the level of certainty needed for a regional rule condition.

The two broad types of regional plan OVERSEER version updating methods that have been proposed are summarised below (Table 6).

Table 6
Two examples of recent proposed regional plan OVERSEER updating methods that use an external mechanism

Threshold	External link and calculator	Example
Comparative thresholds e.g., current N loss estimate compared against specific numerical thresholds, specified in a regional plan.	Reference files are rerun using a new version of OVERSEER and published on a council website.	Bay of Plenty Regional Council Proposed Plan change 10 (BOPRC, 2016).
Current N loss estimate compared to various thresholds e.g. Baseline GMP N loss, GMP N loss, the percentage of a threshold, etc., specified in a regional plan.	Thresholds updated using a website-based calculator that provides for specific farm systems, climate and soil inputs modelled by OVERSEER and uses the current OVERSEER version.	Environment Canterbury Proposed Plan Change 5 (ECan, 2016).

Key legal issues related to version change management

The currently available legal advice and analysis have been reviewed and a number of key conclusions can be summarised as follows:

1 Where 'incorporation by reference' of OVERSEER into a regional plan is intended, achievement is problematic because OVERSEER may not be 'written material' as required by the Schedule 1 Part 3 process of the RMA.

2 There are no significant legal impediments associated with including a reference to OVERSEER in a regional plan provision as one of the optional methods to provide for nutrient loss estimates.

3 The level of legal certainty required for permitted and prohibited activities indicates that the use of thresholds in such rules that require the use of OVERSEER to determine compliance should be avoided unless a robust version management method is used.

4 Regional plan provisions and any associated OVERSEER version updating methodology used in a plan should be designed carefully, recognising the potential for an activity to have its status changed as a consequence of an OVERSEER version change.

5 There are possible additional processes that could be explored and developed, such as national planning templates and/or regulations to create consultative processes for the purpose of providing for and including updating of models such as OVERSEER, which are increasingly important in the RMA context.

This legal advice and analysis has been considered in this section and also in the development of Sections 3 and 4.

6.6 Other models

OVERSEER is only applicable to a range of land uses (Watkins & Selbie, 2015). Therefore, most regional plans provide for other models to be used to estimate N and/or P loss estimates for those land uses or discharges that are not currently modelled by OVERSEER e.g., outdoor piggeries. However, care is needed to ensure that such alternative models are comparable to OVERSEER. This would require such models to comply with appropriate technical criteria and/or specifications.

Recommendations – OVERSEER version change issues

1 The implications of OVERSEER version changes for regional plan provisions where OVERSEER was used to inform the development of those provisions should be assessed as soon as practicable after each version change e.g., by checking the effects of the version change on any source nutrient loss estimates and calculations used in developing plan provisions, and checking the effects of the version change on regional rule thresholds that require OVERSEER estimates.

2 OVERSEER version change issues should be taken into account in the development and implementation of regional plans and resource consent conditions (see Sections 3 & 4).

3 The specification of nutrient loss model alternatives to OVERSEER in regional plan provisions or resource consent conditions should be complemented with technical criteria and/or specifications to enable an appropriately qualified person acting on behalf of the regional council (e.g., a senior officer, consultant/commissioner) to certify or not that an alternative model complies with those criteria and/or specifications.

4 OVERSEER Limited should consult with OVERSEER stakeholders and users to review the frequency and content of OVERSEER version changes e.g., to consider the option of having only one version change per year that involves an OVERSEER 'engine' change that could affect N and/or P loss to water estimates.

5 Regional councils, the Ministry for the Environment, and the Ministry for Primary Industries should review the options for developing robust processes for the incorporation of changes to models such as OVERSEER that are regularly updated with new versions and are specified directly or indirectly in regional plan rules or resource consent conditions.

7 Uncertainty

7.1 Introduction

This section is written primarily for scientists and RMA practitioners involved in the plan-making and/or resource consent processes.

The purpose of this section is to briefly outline the sources of uncertainties associated with OVERSEER and to provide guidance on managing some uncertainties by focussing on how OVERSEER and OVERSEER outputs are used in establishing freshwater objectives and setting and managing to freshwater quality limits and resource consents.

Box 12 Key messages – uncertainty

1 Uncertainty in OVERSEER nutrient loss estimates is inevitable and regional plan and resource consent decisions need to acknowledge and endeavour to reduce uncertainty. Uncertainty is not a reason to take no action. Rather, the higher the uncertainty, the greater the need for robust monitoring and review processes for plan provisions and resource consents.

2 Some uncertainty in OVERSEER nutrient loss estimates will be reduced by undertaking and incorporating further science e.g., collecting more evaluation data under different soils and climates. Other forms of uncertainty are essentially irreducible e.g., biological variability.

3 There are options and methods for using OVERSEER and OVERSEER outputs in a way that recognises and manages uncertainty in planning and resource consent processes.

4 The importance of sources of uncertainty are different for different stages in the planning process.

7.2 Uncertainty in the OVERSEER model

Uncertainty is the situation involving imperfect and/or unknown information. It applies to physical measurements that are already made, to predictions of future events, and to the unknown (MfE, 2016). Uncertainty in the context of modelling can be defined as a potential limitation in some part of the modelling process that is a result of incomplete knowledge (Shepherd et al., 2013) and it is inevitable with any model. The other source of model uncertainty is a function of natural variability. The distinction is important, and uncertainties as a result of incomplete knowledge are reducible, whereas those which are a function of natural variability, while they can usually be better characterised by more sampling for longer, are generally considered not to be reducible (Der Kiureghian & Ditlevsen, 2007) and therefore need to be acknowledged and managed in another way.

Uncertainty (cf. accuracy) is the most useful term to use when talking about annual whole-farm nutrient loss estimates because it is not usually practicable or possible to directly measure whole-farm nutrient losses and, therefore, there is no measured value to compare with a modelled estimate (Shepherd et al., 2013). The sources of model uncertainty are outlined in Table 7.

Table 7
Sources of model uncertainty relevant to OVERSEER (after Shepherd et al., 2013 based on Walker et al., 2003).

Sources of modelling uncertainty	Brief description and comment
Context and framing	This can include choices about the physical boundaries of the system being modelled, the range of factors to incorporate into a model, and specific prediction choices.
Inputs	Uncertainties about inputs that drive the model.
Model structure	Models simplify reality and may be based on an incomplete understanding of the processes and structure(s) being modelled.
Parameters	Parameters used in the model need to be estimated or inferred from sometimes very limited data.
Model implementation	This includes technical modelling choices and software bugs.

Watkins and Selbie (2015) also outline the sources of variability in data input and modelling procedures in OVERSEER that contribute to modelling uncertainty and describe opportunities to reduce uncertainty in the model outputs as well as detailing the level of evaluation of OVERSEER sub-models that has occurred to date. These recommendations for reducing the uncertainty in OVERSEER are focussed on improving data inputs, improving understanding and description of farm systems, and using best practice calibration and evaluation, processes including increasing the number and range of field measurements and farmlet studies.

There are some sources of uncertainty described in Table 7 and in Watkins and Selbie (2015) that can only be reduced with new knowledge. The next sub-section addresses the requirements for new knowledge. However, there are some sources of uncertainty that are essentially irreducible and therefore, the remainder of this section focusses on how OVERSEER can be used in a way that recognises and manages uncertainty in setting and managing to water quality limits.

7.3 Reducing uncertainties in the OVERSEER model

Those uncertainties in the OVERSEER model that are based on incomplete knowledge can be progressively clarified and reduced through undertaking prioritised science. The choice of what additional science to do, and the way it is undertaken and incorporated can have significant impacts for the model and its use. It is, therefore, important to have good, transparent processes for reviewing current model components, deciding what science is needed, establishing the priority of work, and ensuring the robustness of the science. While the OVERSEER development processes and concomitant funding is beyond the scope of this project, they are critical factors in enabling a reduction in uncertainty in OVERSEER outputs.

The science and development processes outlined above are a critical, ongoing and long-term requirement. However, regional councils need to continue to develop plans and make resource consent decisions.[29] Therefore, for the purposes of this section, it is assumed that good and strategic policy for science going into OVERSEER is in place and leading to a continual and incremental reduction in uncertainty of the model outputs.

[29] Ongoing and active involvement by regional councils and other stakeholders in the OVERSEER Ltd development process is an important part of OVERSEER's development.

7.4 Reducing and managing uncertainties in establishing freshwater objectives and setting and managing to freshwater quality limits

In the Ministry for the Environment's draft guidance (MfE, 2016) on communicating and managing uncertainty, a three-stage iterative process is suggested for managing uncertainty in NPS-FM processes: assessing and reducing uncertainty, communicating uncertainty, and incorporating uncertainty into decisions with a feedback loop for monitoring, evaluating and revising to incorporate new knowledge (Figure 6).

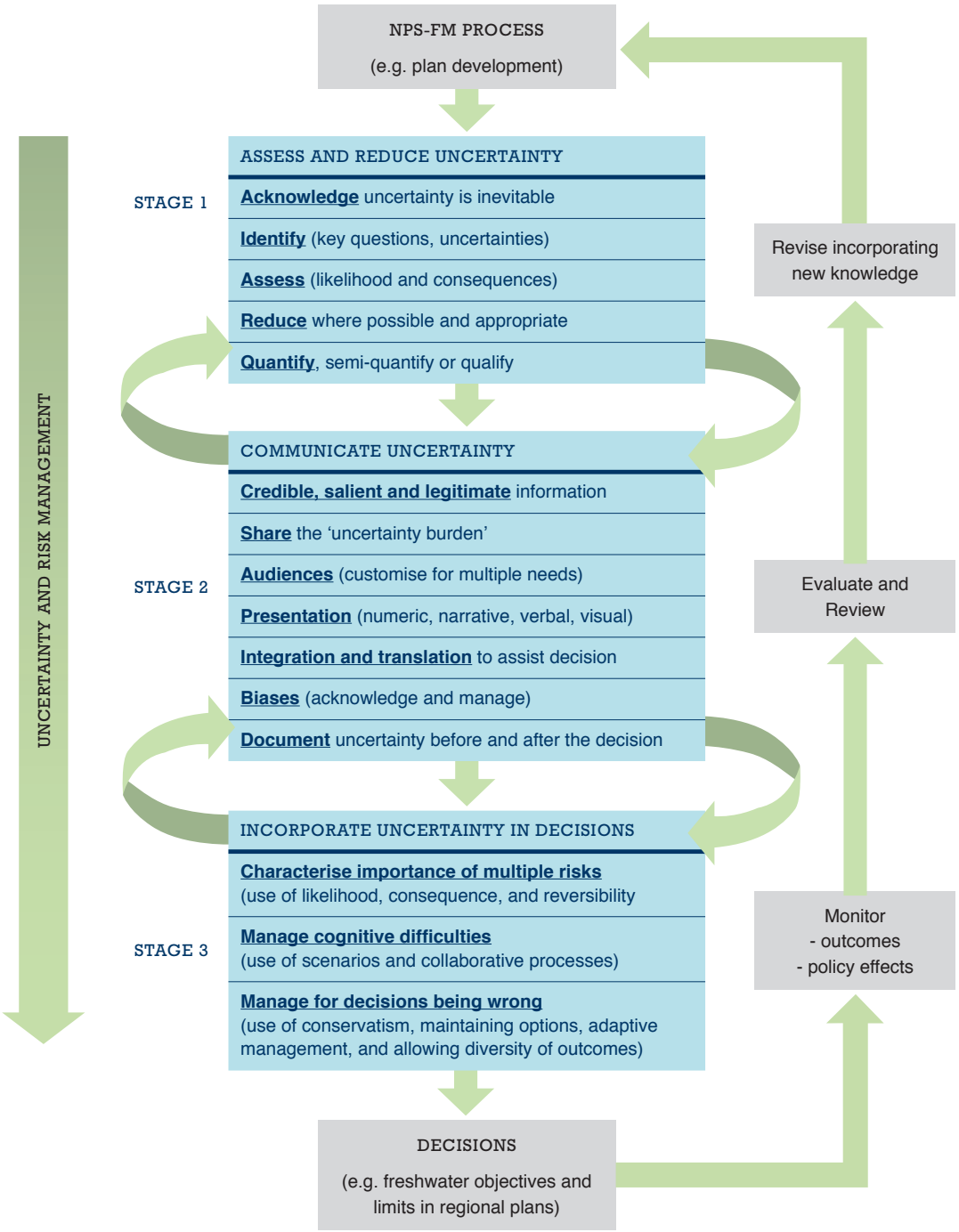

Figure 6
Three-stage iterative process for managing uncertainty in NPS-FM processes from MfE (2016) A draft guide to communicating and managing uncertainty when implementing the National Policy Statement for Freshwater Management.

The stages detailed in Figure 6 illustrate the uncertainty can be managed in different ways and at different stages of a planning process. It is also important to note that the importance of sources of uncertainty and how they can be managed change depending on the stage of the planning process. During plan development, when OVERSEER may be used to estimate nutrient losses, it is important to manage both the quality of inputs as well as how the outputs are used. However, these uncertainties are considered along with all the other uncertainties inherent in setting freshwater limits (MfE, 2016). Once a decision has been made (in light of all the uncertainty) and a plan is in place, OVERSEER may be used more as a calculator and the relevant sources of uncertainty arise from the quality of data inputs and version change (Section 6).

The following sub-sections outline some options and methods for managing uncertainty in the use of OVERSEER at different stages in a setting and managing to freshwater limits process. These options and methods are summarised in Table 7.

7.5 Identifying, reducing and managing uncertainty in model inputs

Quality of data inputs

In simple terms, the quality of what goes into a model affects the quality of what comes out.

The use of unreliable input data (i.e., data that is inputted by the user) is regarded as the major source of uncertainty in modelling. Cichota and Snow (2009) and Watkins and Selbie (2015) have identified a list of the main inputs that OVERSEER nutrient loss estimates are sensitive to.

Uncertainty can be partially managed by using good quality user data inputs that are supported (and/or verified) through accurate record keeping or supported by using other data (e.g., improved soil mapping), other modelling tools (e.g. crop calculators, Farmax, pasture modelling tools) or farm system expertise. As an illustration of the potential impact of quality of data, Figure 7 shows the difference in N losses from 74 farms modelled using OVERSEER with two different levels of soils information: level 1[30] and level 2[31] (Robson et al., 2015). Different sources of soil inputs had a significant impact on the losses predicted by many of these example farm systems.

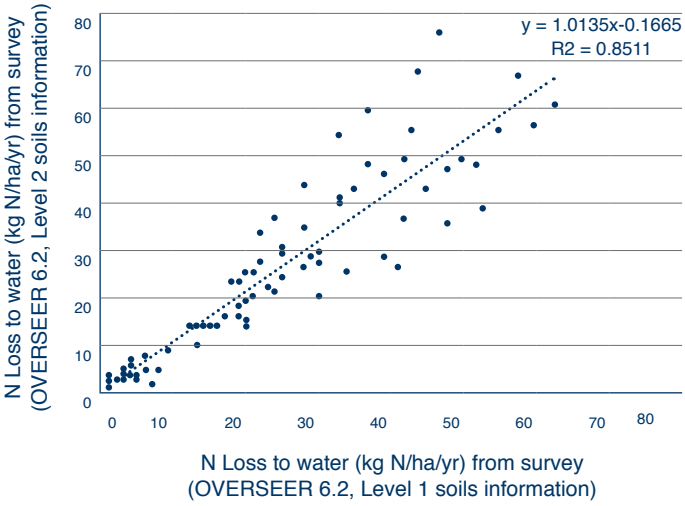

Figure 7
Relationship between N losses from 74 farms when using level 1 and when using level 2 soils information (Robson et al., 2015)

[30] Level 1 soils information is the use of qualitative OVERSEER soil profile categories (Pollacco et al., 2014).

[31] Level 2 soils information is the use of quantitative soil moisture inputs (Pollacco et al., 2014).

In some cases, high-quality data e.g., model inputs that reflect actual management or verifiable records, may not exist. This may occur when trying to establish a benchmark determined by historic activities but where there are no records. In these cases, careful consideration needs to be given to how to generate data for benchmark files, including the quality of data and the resources implications. In some circumstances, the use of generic or reference farm systems has been proposed as a means of generating files to fill these gaps.

Expertise of model users

Wheeler and Shepherd (2013) describe OVERSEER as an expert user system, and the outputs are dependent on many inputs that rely on expert judgement and understanding of NZ farm systems.

Watkins and Selbie (2015) describe differences in user input of data as a source of uncertainty in OVERSEER outputs. The development and use of the Best Practice Data Input standards (e.g. OVERSEER, 2015) are recognised to be an important aspect of managing the uncertainty in outputs created by variations in users' input of data (Watkins & Selbie, 2015; Wheeler & Shepherd, 2013). It is also important to ensure that the correct version of BPDIS is used with the correct OVERSEER version and that the BPDIS version is consistent if OVERSEER is being used in multiple parts of a planning process, or if there are multiple sources of OVERSEER files.

Even with appropriate expertise and qualifications, different users may make different assumptions and judgements, particularly if, for example, they are estimating practices for periods where data are missing. Further development of the minimum expertise requirements for modellers, BPDIS and guidance on potential issues (see Section 11) will assist to reduce uncertainty in model outputs associated with the expertise of modellers.

Representativeness of modelled information

The closer the farm system in OVERSEER is to the actual farm system being modelled, the more the uncertainty about the model outputs will be reduced.

At an individual farm level, the differences between actual and modelled outputs may arise from different sources e.g., quality or source of data inputs (addressed above), assumed level of practice not being achieved, or systems/practices that are beyond the model's current capabilities.

Uncertainty in model outputs may in part arise from the assumed practices or levels of practice that are built into the model not reflecting real farm practice. This can be managed by being explicit about the assumed practices being used in scenario modelling and in other situations e.g., using a farm environment plan to ensure that any differences are identified and addressed to ensure that assumed model practices are implemented.

Differences may also come from constraints in the model where current management practices, cultivation, fertiliser application, irrigation or crop types cannot be fully and accurately represented in the OVERSEER model e.g., a specific fruit crop that is not available in OVERSEER, the exact timing of fertiliser applications in a month relative to OVERSEER assumptions, etc. This uncertainty will only be reduced as the OVERSEER model evolves and more farm systems and management practices are able to be captured. However, the BPDIS (OVERSEER, 2015) contains some strategies, such as surrogate crop types, that can be used to reduce possible inconsistencies when a system can't be fully represented.

At a catchment scale, where OVERSEER is used to estimate nutrient losses for catchment assessments, there are additional scale, resourcing, and practical considerations that impact on uncertainty. For example, in a catchment with 500 farms, generating a source load from actual, high-quality[32] nutrient budgets may have the least uncertainty, but the resource implication of this approach would be great (unless the information was already being generated for other purposes such as catchment accounting). In addition, if policy or land-use scenarios are run, this may involve individual manipulation of each of the 500 files. Therefore, although the uncertainty with individual estimates increases the further away the model is from the actual farm systems, at the catchment scale, especially with large numbers of farms, a pragmatic approach is likely to be needed. The strengths and challenges of different approaches are shown in Table 8.

Similarity of farm system/soil/climate to calibration dataset

Shepherd et al., (2013)[33] describe OVERSEER as a part-empirical, part-mechanistic model. Therefore, OVERSEER can be used beyond the land uses, soils, and climates that were used in the field studies used to calibrate OVERSEER sub-models. However, the greater the difference from these calibration field studies, the more uncertainty there is likely to be in the estimated losses. Most of the field studies used in the N calibration and evaluation to date were carried out on flat, pastoral, dairy enterprises with primarily free-draining soils and moderate rainfall (Watkins & Selbie, 2015).

A way of partially managing the uncertainty of using OVERSEER to estimate nutrient losses for systems, soils and climates that are beyond the calibration range or where the system cannot be described in OVERSEER is to use well-calibrated process-oriented models such as SPASMO (Soil Plant Atmosphere System Model) and APSIM (Agricultural Production Systems sIMulator)[34] to provide supporting information. Models with a higher level of detail, such as process-oriented and mechanistic models can often be set to describe systems with greater specificity, which seems to generally increase the confidence in the model simulations, even though specificity does not necessarily mean greater accuracy (Cichota and Snow, 2009).

7.6 Managing uncertainty in use of model outputs – plan development

Significance analyses of variables to give ranges

Uncertainty can be partially quantified, communicated and accounted for in plan development by the use of statistical tools to identify the possible range of model outputs. For example, significance analyses can be used to indicate the relative influence that changes to key inputs have on outputs. Where there is uncertainty or variability in critical OVERSEER inputs (or a land-use configuration), multiple OVERSEER files can be run to explore the implications of that variability or uncertainty and to produce a range of possible nutrient losses. These ranges can be translated into possible impacts on outcomes, and in particular, assist with understanding the potential impact on the achievement of freshwater objectives. Communicating these ranges helps decision-makers to appreciate the extent of some uncertainties and take that into account in the decision-making process. Significance analyses have been used in some limit setting processes in combination with qualitative uncertainty assessments (Robson, 2014).

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[32] E.g.,model users are experienced, a consistent input standard is used (e.g. BPDIS) and high-quality data sources are used.

[33] Shepherd et al. define empirical models as statistical descriptions of observed data and mechanistic models as aiming to construct mathematical representations of the behaviour of a system based on descriptions of processes.

[34] SPASMO and APSIM are more often used as research tools due to their complexity and greater expertise needed to use them. See Cichota and Snow (2009) for further information on these models.

A significance analysis is neither a full uncertainty analysis nor a full sensitivity analysis, both of which would require significant resources. Watkins and Selbie (2015) acknowledge that although an uncertainty analysis on OVERSEER could usefully be undertaken, it is not possible to quantify all the sources of uncertainty in the nutrient loss value produced, and therefore suggest that reducing uncertainty might be a more appropriate use of resources.

Multiple sources of evidence

The Ministry for the Environment (MfE, 2016) indicate that "employing more than one model to make independent parallel predictions can be useful for establishing converging lines of evidence, thus potentially increasing confidence (i.e., reducing uncertainty) in the predictions". Where OVERSEER has been used to estimate source nutrient losses, well-calibrated process-oriented models such as SPASMO and APSIM (APSIM, 2016) may be useful for providing an independent parallel estimation for nutrient losses. These other models do not necessarily model at a farm systems level and are likely to require expertise to use and draw comparisons. The concept of multiple sources or independent parallel lines of evidence is also useful for reducing uncertainty around key inputs to OVERSEER where 'like with like' outputs can be predicted.

Using model outputs in a relative sense

Models are often better at describing relative differences, such as the increase or reduction of N leaching after a management change, rather than providing the absolute values of leaching (Cichota & Snow, 2009)). The uncertainties in the use of OVERSEER outputs can be partially managed by using OVERSEER to indicate relative changes using the same model version. For example, if incorrect soil information and, therefore, the estimated profile available water (PAW) was used in OVERSEER, the absolute nutrient loss is unlikely to be accurate. However, the relative impact on N leaching of activities such as changing stock type, using a different crop rotation or improving irrigation would be less uncertain.

At a catchment scale, this could involve the use of different land use or policy scenarios to explore the relative rather than absolute changes in estimated catchment nutrient losses.

At a farm scale, this could involve relative change from a known point, e.g., land use during a period of time or benchmark, or loss estimates monitored over time to indicate a trend. A condition of using the model in a relative sense is that all scenarios need to be in the same version of OVERSEER.

The relative sense concept can be used for plan-making and/or resource consent conditions by having provisions that e.g., compare nutrient losses over two separate time periods using the same model version, or that require a percentage improvement beyond a benchmark. However, there is limited case law on this approach.

7.7 Managing uncertainty in use of model outputs – plan-making, re source consents and implementation

Using the Precautionary Principle

In the guide to managing uncertainty in NPS-FM processes, MfE (2016) discuss the approaches to 'managing the certainty of being wrong' and suggest that "all the commonly used elements (of the precautionary principle) can be useful for managing uncertain situations: conservatism, a consideration of irreversibility and adaptive management." Of these, conservatism and adaptive management are specifically relevant to the use of OVERSEER. A consideration of irreversibility is a key factor in the wider limit-setting process, but not specific to the use of OVERSEER.

Conservatism

Conservatism can be exercised when using OVERSEER through e.g., using valid but conservative input data or using the conservative end of ranges of outputs. Conservatism can also be incorporated into decisions about limits as a way of managing uncertainty in model outputs. It is important to be transparent about what conservatism means in the specific context (e.g., environmentally conservative or economically conservative) and also to avoid conservatism being unintentionally used at each stage when conservative estimates or assumptions are used in the processes.

Adaptive management

Adaptive management is often used as a tool for managing uncertainty and involves a cycle of decisions, implementation of decisions, monitoring, review, and changes. It can be used as a mechanism to manage uncertainty in OVERSEER outputs used in setting and managing to freshwater quality limits and resource consent decisions. For example, by setting limits that include environmental triggers (e.g., mg/L of N) that if met by a specified date allow for further land-use change or intensification. If the triggers are not met, further development is restricted or additional requirements are placed on existing users. Adaptive management can also be used in consent conditions e.g., consent conditions that set an environmental trigger that, if exceeded based on monitoring data, prompt a course of action that is detailed in the consent.

This could be used in plan provisions e.g., by specifying that if a freshwater quality objective is not met by a certain date, a specific set of provisions apply; conversely, if a freshwater quality objective is met, a different set of provisions apply. Conceptually this is not different from specifying provisions that apply if a river drops below a prescribed minimum flow, and statutory plans with minimum flow provisions have been in use in New Zealand for over 30 years. Resource consents would need to have adaptive management conditions that align with those provisions, and water permits and discharge permits can be reviewed for purposes specified in such resource consents and more generally as a consequence of new 'minimum standards of water quality' (S128 of the RMA). However, land use consents are not subject to the same broad resource consent review provisions (S128 of the RMA).

Similarly, resource consents can include adaptive management conditions that require certain things to be done e.g., to reduce an estimated nutrient loss in response to an environmental quality threshold level being breached. While this approach is not common, there are examples e.g., water permits in the Lake Benmore catchment in Canterbury. Similarly, resource consent conditions have been applied to require investigations and a response action plan (that might require OVERSEER modelling) with a prescribed timetable set to implement the action plan to improve water quality to above the trigger concentration.

Averaging

Natural variability in the biological system that OVERSEER is modelling is a source of uncertainty. Section 8 on Averaging, illustrates some methods to manage some of this variability through averaging the model outputs over a period of time. These methods may be useful when setting baseline or benchmark nutrient losses, or when testing for compliance with a nutrient discharge threshold.

Short duration resource consents

A short duration resource consent (what constitutes 'short duration' will depend on the specific circumstances) is sometimes used as a mechanism to address uncertainties about potential negative effects and may be appropriate where the receiving environment is likely to become more sensitive

over time, or adverse effects are only acceptable for a limited period (Freeman, 2011). However, such short-term resource consents must include specific conditions that require relevant information to be obtained to ensure that there is an adequate body of knowledge available prior to the expiry of the resource consent to assist future decision-making.

Resource consent review conditions

Consent review conditions can be used to address uncertainty, where a general or specific review condition provides for a review in the event of a specific situation and/or an adverse effect occurring. Freeman (2011) notes that there are several limitations to relying on consent reviews as a primary mechanism to address uncertainty and suggests that a review condition be used as a 'backstop' for long-term resource consents. Review conditions would need to be very carefully worded to ensure that the review circumstances are clear and the limitations of the review process are fully understood.

Using Farm Environment Plans and OVERSEER together

Some of the uncertainty in OVERSEER outputs can arise from poor input data or where OVERSEER assumes certain practices that are not actually happening. These sources of uncertainty may be partially managed by using an audited Farm Environment Plan (FEP) together with OVERSEER, where records that are used for the model can be verified and an assessment made as to whether the sought-after practices or level of practice is being achieved. In some cases, the FEP that includes farm system information and practices is relied on as the primary resource consent condition instead of an OVERSEER loss rate (see Sections 3 & 4). However, this requires care to ensure that such conditions are certain and enforceable. Farm Environment Plans may also be a tool to manage the uncertainty associated with version change.

7.8 Ongoing targeted monitoring and revision

Decisions on water quality limits are made with imperfect information and should be regularly revisited through efficiency and effectiveness monitoring and plan reviews. A key way of managing uncertainty when OVERSEER outputs have been used to estimate or calculate catchment loads is to ensure ongoing, targeted monitoring and data collection. This information can be used to test (and revise if necessary) the modelling and assumptions that underpin the catchment load calculations and the understanding of the relationship between source losses and the water quality in the receiving environment.

7.9 Summary of options and methods for reducing uncertainty

Table 8 shows a summary of the options and methods for managing uncertainty in the use of OVERSEER and how these options manage uncertainty using categories from MfE (2016).

Table 8

Summary of methods for managing uncertainty in the use of OVERSEER in setting and managing to freshwater limits against categories from MfE draft guidance on managing uncertainty (MfE, 2016)

Methods to manage uncertainty in use of OVERSEER	How uncertainty is managed					
	Assess and reduce uncertainty	Communicate uncertainty	Incorporate uncertainty in decisions	Reflect uncertainty in plan	Implement and monitor	Evaluate, review, revise
Managing data inputs						
Quality of data inputs	✓			✓	✓	✓
Expertise of model users	✓	✓		✓	✓	✓
Representativeness of modelled information	✓	✓				✓
Similarity of farm system/soil/climate to calibration dataset	✓	✓			✓	
Using OVERSEER outputs – plan development						
Significance analyses and use of ranges	✓	✓	✓			✓
Alternative sources of evidence	✓	✓			✓	✓
Model outputs used in a relative sense	✓	✓	✓	✓	✓	✓
Using OVERSEER outputs – plan-making, resource consents and implementation						
Precautionary Principle	✓		✓	✓	✓	✓
Shortened consent term				✓		
Resource consent review conditions				✓	✓	✓
FEP and OVERSEER used together	✓		✓	✓	✓	
Ongoing monitoring						
Ongoing targeted monitoring and revision	✓			✓	✓	✓

Recommendations – uncertainty

1 Uncertainty in OVERSEER nutrient loss estimates is inevitable and the development and implementation of regional plans and resource consent conditions should acknowledge uncertainty and endeavour to reduce uncertainty by:

   (a) acknowledging in the plan-making process that catchment modelling and OVERSEER modelling involves significant uncertainties and communicating which options and methods are being used to manage uncertainty (see Table 8)

   (b) using good quality data inputs, in particular for the more influential inputs (which will vary from situation to situation e.g., by spending more time in sourcing these data, using expert verification and/or independent modelling sources

   (c) using qualified and experienced OVERSEER model users, using appropriate standards and guidelines e.g., the appropriate BPDIS, and taking account of other quality factors (see Table 12)

   (d) endeavouring to use independent parallel sources of information where OVERSEER is being used significantly beyond its calibration range (system/soil/climate) e.g., through other models and/or relevant robust information

   (e) using OVERSEER outputs in a way that minimises the impact of uncertainty e.g., using model outputs in a relative sense or using adaptive management methods (see Sections 3 & 4)

   (f) communicating the potential consequences of uncertainties in OVERSEER outputs e.g., undertaking significance analyses and considering the impact of ranges of possible nutrient losses

   (g) considering the use of policy, rule and resource consent condition frameworks that support adaptive management (see Sections 3 & 4) and are driven by appropriate indicators, such as the status of the receiving environment, and as more information comes available including from future modelling.

   (h) ensuring ongoing targeted monitoring and data collection within a catchment where OVERSEER has been used to generate nutrient source load estimates, and if necessary, testing and revising the modelling and assumptions that underpin the catchment load calculations.

2 Additional investment should be made in research and investigations in priority OVERSEER science to reduce uncertainties, particularly for those situations that are significantly different from original calibration studies used in the development of OVERSEER e.g., locations with different soils, more or less annual precipitation, different farm systems, etc.

8 Averaging

8.1 Introduction

This section is written primarily for scientists and RMA practitioners involved in the plan-making and/or resource consent processes.

The purpose of this section is to review and summarise information on when OVERSEER estimates should be averaged and over what periods.

When plan rules and/or resource consent conditions specify the use of OVERSEER and require the provision of OVERSEER estimates based on actual farm data, the question is often asked whether the use of one year of data is appropriate or whether output estimates or inputs should be averaged over a number of years. A critical aspect of this is whether the purpose is for estimating long-term source loads to a catchment, developing some reference benchmarks, and/or for assessing compliance with some specified threshold.

Box 13 Key messages – averaging

1 It is important to be aware of potential mismatch issues when mixing long-term climate data with annual management data.

2 There are a number of reasons why it might be useful to average either OVERSEER inputs or outputs, including as a response to the mismatch issue and minimising annual variation in nutrient losses.

3 When considering averaging inputs, it is important to understand and consider several points, including the underlying steady state assumption, model non-linearity and biological feasibility. Another approach is to define a typical long-term farm system.

4 In a compliance setting, a rolling average of estimated nutrient losses over a minimum of the prior 3–5 years helps estimate the long-term trend and reduce variation in annual nutrient loss estimates.

8.2 The critical importance of climate inputs

OVERSEER inputs include three climate values: rainfall, potential evapotranspiration (PET) and temperature. These are generally obtained by using the 'climate station tool' in OVERSEER, which provides three annual long-term mean values from a NIWA generated data layer of 30-year average annual values based on the period from 1981–2010 (Wheeler, 2015a). These annual climate data values can also be specified by the user.

The monthly pattern of the rainfall and temperature variables is also important. The annual rainfall and temperature values are distributed into monthly values based on the temporal pattern of 30-year monthly data for the region or nearest town. The monthly values are in turn distributed into daily values according to 15 climate modifiers describing the range and seasonality (Wheeler, 2015a). In previous versions of OVERSEER, these climate modifiers have been set by default. Since version 6.2.2, monthly climate values can be specified by the user; however, this is not a recommended practice (BPDIS, 2016).

This use of long-term climate data and distribution patterns means that there can be a mismatch between climate and farm management when annual management data is entered into OVERSEER, especially where annual differences in management are due to changes in the actual climate. For example, irrigation inputs in any given year are normally driven by the actual climate in that year, and may not match the long-term climate pattern. Thus, too little irrigation might be applied in a drier than normal year or too much in a wetter than normal year. This mismatch can lead to underestimates or overestimates of nutrient losses (Wheeler et al., 2014).

OVERSEER is driven by user-specified levels of production. This has "an important effect on the calculation of feed and nutrient intakes" (Watkins & Selbie, 2015). OVERSEER assumes the farm is operating in a 'steady-state' and actual and reasonable inputs have been entered. If e.g., annual production, irrigation, and fertiliser inputs are combined with long-term climate data, the resulting farm system may not be viable as the long-term climate may not be consistent with the specified level of annual production.

The impact of using different annual rainfall inputs is illustrated by Journeaux (2014) in a numeric analysis of a dairy farm case study in which the effects of different averaging strategies were compared. Separate OVERSEER runs were made under three annual rainfall inputs of 800 mm, 1200 mm and 1600 mm with corresponding changes to the production, stocking number and fertiliser applications. There was a decrease in nitrogen losses of 51% and 54% for the drier year under two soils, and an increase of 54% for the two soils in the wetter year. Figure 8 shows the smoothing effect of averaging the annual losses over 3 and 5 years where drier and wetter rainfall years are randomly distributed over 20 years. Similarly, an analysis of annual variability in estimated nitrogen losses using actual farm inputs from Lincoln University Dairy Farm found a range in nitrogen loss estimates of 55% (Pellow et al., 2013).

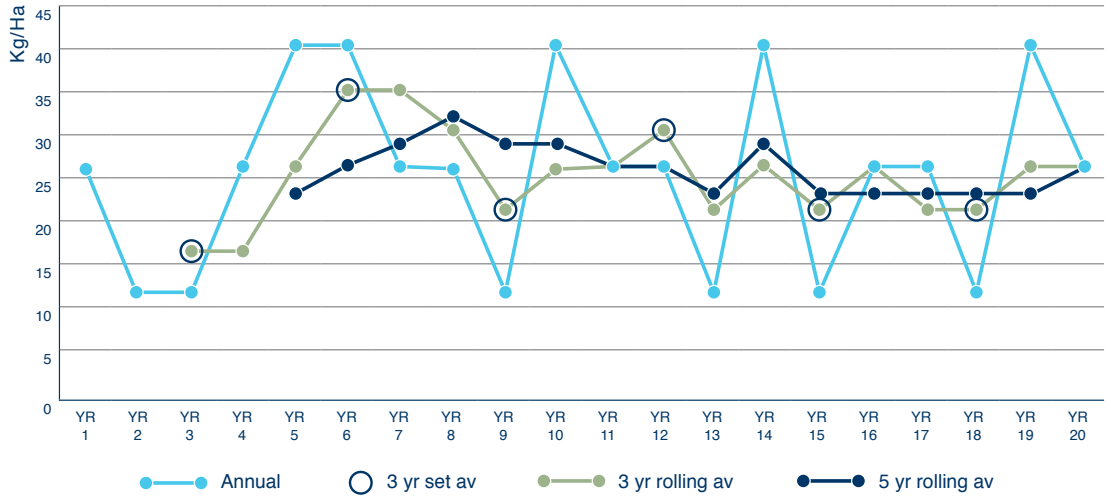

Figure 8
Nitrogen loss estimates (kg/ha) under a random rainfall pattern on a sedimentary soil type where management is changed to reflect the change in rainfall. Annual estimates of nitrogen loss are compared with an average taken every 3 years, and rolling 3- and 5-year averages. Reproduced from Journeaux (2014).

8.3 Existing recommendations for averaging

Regional councils have variously been recommended or advised (e.g., Park, 2014; BPDIS, 2016; Wheeler, 2013) to average OVERSEER inputs or outputs as follows:

a) that farm system inputs from more than one year be averaged to develop average input values for that multi-year period, then those inputs be entered into OVERSEER

b) that an average or typical farm system be defined

c) that annual nitrogen losses for a farm be estimated for more than one year, then averaged.

The rationale for this advice varies but essentially the main reasons behind these recommendations are as follows:

1 Averaging the farm system inputs or otherwise defining an average or typical farm system is a means of:

- defining a typical year that represents the long-term farm management, and is thus a better fit with the long-term climate data used in OVERSEER
- managing missing or unknown data e.g., where historical farm management information is too difficult to obtain, or when defining a future farm system for predictive purposes
- minimising data entry by farmers.

2 Averaging the nutrient loss outputs is a means of:

- managing the ups and downs in an individual's estimated annual nutrient losses due to year-to-year variations in farm management, particularly in a benchmarking, consenting or monitoring context
- ameliorating the effects of the mismatch between annual farm data and long-term climate data used in OVERSEER.

Looking at the advice in more detail, the OVERSEER Best Practice Data Input Standards (BPDIS) recommend that the long-term climate data, climate patterns, and production are used when the model is being applied in a long-term predictive mode (BPDIS, 2016). Where OVERSEER is being used in annual mode (e.g., for monitoring purposes) the guidelines recommend that the annual farm inputs be used with long-term climate data and that a rolling average be calculated of the nitrogen losses from multiple years. Note the BPDIS also contains some more specific recommendations e.g., averaging annual fertiliser use over a minimum of 3 years.

Wheeler (2013) in his evidence for the Board of Inquiry into the Tukituki Catchment Proposal recommended the use of rolling averages for monitoring purposes to reduce the effect of year-to-year variability, and suggests a minimum period of 3 years. For forward prediction purposes, he recommended that a farm system that describes typical management in the future be used with long-term average climate data and patterns. Millner (2013) concluded that a 3-year period is appropriate for benchmarking pastoral systems and 7 years for arable farming and cropping. In his evidence for the same Board of Inquiry, van Voorthuysen (2013) supported the use of a rolling 3-year average whilst noting Roberts' (2013) suggestion of averaging estimates over 6 or 7 years for some arable land uses. Van Voorthuysen recognised the long rotation period for forestry might require averaging over an even longer time frame. The final Decision by the Board of Enquiry determined that a 4-year rolling average should be used (EPA, 2015). Park (2014) writes that the expert consensus at a Bay of Plenty Regional Council workshop was to estimate an average nitrogen loss over 3 consecutive years for livestock farm systems, and over 7 years for cropping systems due to the greater variability across crop rotations. Journeaux (2014) recommended averaging input data for a minimum period of 3 years

and averaging outputs over a 3–5 year period. The various recommendations highlight that currently the wide range of situations and the limited information available mean that it is not possible to make a firm recommendation for the minimum number of years for averaging inputs or outputs.

8.4 Points to consider when averaging inputs

Steady-state assumption

Wheeler et al. (2014) explain that when calibrating the N sub-model of OVERSEER, farm management inputs for field trials were averaged and put into OVERSEER to compare predicted losses with the mean measured losses. They note that the relatively constant management of the field trials and the lack of long-term trials makes it very difficult to test the effect on model outputs of averaging input data over different time periods e.g., 2 years, 5 years etc., without further investigation.

OVERSEER is a steady state model that has been developed on the basis that, particularly for pastoral farm systems "inputs and site characteristics are in equilibrium with farm production and stock policy". Farm management is assumed to be constant i.e., OVERSEER does not model transitions from one farm system to another (Watkins & Selbie, 2015). This clearly stated assumption means that it may not be appropriate to estimate nitrate losses from a farm system in a major transition by averaging the inputs to a 'halfway' farm system, particularly where nutrients may be carried over from year to year.

Model linearity

While it is interesting that in Journeaux's (2014) analysis, running OVERSEER on averaged rainfall gave a very similar result to the average of the modelled outputs for each of the three rainfall levels for his specific case study farm system, in general, averaging model inputs is only successful where the model response is linear with respect to the input. This concept is illustrated in Figure 9.

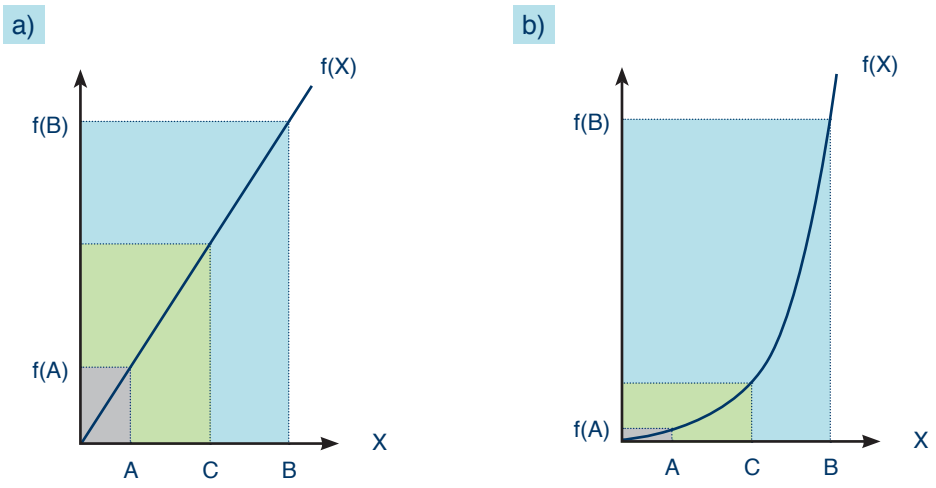

Figure 9
Schematic to show the effect of non-linearity of model response f on averaging. Point C is the average of input values A and B. In plot a) the model response is linear so f(C) (i.e., the point where the red dashed line intersects the vertical axis) is the same value as the average of model outputs f(A) and f(B). In plot b) however, the model response is non-linear, and f(C) is not the same value as the average of model outputs f(A) and f(B).

OVERSEER comprises many modules and algorithms. In some cases, the model response is linear (as illustrated by Journeaux (2014) and Wheeler & Bright (2015). In other situations, it may not be e.g., denitrification is a non-linear process (Wheeler, 2015b, 2015c). Averaging farm inputs that impact on the modelled wetness of the soil into a single OVERSEER file might result in a different nitrogen loss compared to the average of the estimated nutrient losses where each set of farm inputs is modelled separately. In general, the smaller the difference between the farm system inputs that are being averaged, the more likely the model response will be approximately linear (and so averaging inputs may be possible), the larger the difference between farm inputs, the more inappropriate averaging inputs is likely to be.

Biological feasibility

A key point is that OVERSEER assumes that the user-specified farm production is achieved with the specified farm inputs, soil and climate (Watkins & Selbie, 2015). Consequently, changing farm inputs by averaging them, or defining a representative farm system, requires considerable expertise to ensure that the resultant model represents a long-term biologically feasible farm system where levels of production are consistent with the specified inputs. Some of the OVERSEER farm inputs do not lend themselves to being averaged e.g., cropping rotations. Wheeler et al. (2014) also comment that it is not clear how to average some management inputs such as stock numbers and supplement feeding.

A common approach (particularly when the OVERSEER outputs are required for predictive purposes) is to derive a 'typical' farm system under typical climate conditions. The Matrix of Good Management (MGM) project followed this approach by defining a set of farm types based on industry surveys of actual farms in Canterbury (Robson et al., 2015). Hawkes Bay Regional Council developed representative farm systems from a range of sources for use in predicting nutrient loads (Millner, 2013). Bay of Plenty Regional Council defined a set of reference files that describe typical farm systems, although these are used for compliance rather than predictive purposes (BOPRC, 2016). Similarly, where actual historical farm input data are not available, it can be appropriate to develop a set of data inputs that are representative of the long-term farm system for benchmarking or regulatory purposes.

Regardless of how the typical farm systems are derived, it is essential to verify that they are long-term biologically feasible farm systems.

8.5 Use of output averaging by councils

Many regional councils have used an averaging approach or selection from a multiple year period for defining 'baseline' nitrate losses in regional plans. The various output time frames are detailed in Table 9.

Table 9
Time periods that define 'baseline' nitrogen losses as applied by regional councils

Council	Plan	Baseline time period
Waikato Regional Council	Waikato Regional Plan Variation 5 – Lake Taupo catchment (WRC, 2011)	"the single best year (year with the highest leaching value) of nitrogen leached between July 2001 and June 2005"
Canterbury Regional Council	LWRP proposed Plan Change 5	Average of 2009–2013 losses i.e., 4 years
Bay of Plenty Regional Council	Regional Land and Water Plan Rule 11 & Proposed Plan Change 10 (BOPRC, 2016)	For benchmarked properties - average of losses between July 2001– June 2004 i.e., 3 years or For land in catchment not previously covered by nutrient rules: losses from actual land use for 3 years prior to 1/1/2016

Regional councils have, for compliance purposes, adopted different rules that specify how many years of estimated nutrient losses are required (Table 10).

Table 10
Time periods specified in regional rules for OVERSEER-estimated nitrogen losses

Council	Plan	Time period specified in regional rule
Canterbury Regional Council	Canterbury LWRP Plan Change 5	Rolling average of modelled nitrogen losses from the most recent 4 years
Bay of Plenty Regional Council	Regional Policy Water and Land Plan Change 10 – Lake Rotorua Nutrient Management (BOPRC, 2016)	Three-year rolling average of modelled nitrogen losses but also may be assessed on an annual basis
Hawkes Bay Regional Council	Plan Change 6 – Tukituki River Catchment	Losses from each property should be calculated as a 4-year rolling average, derived from nutrient budgets prepared after 1 June 2013
Otago Regional Council	Otago Water Plan Change 6A (ORC, 2014)	One year losses
Waikato Regional Council	Waikato Regional Plan Variation 5 – Lake Taupo catchment (WRC, 2011))	One year losses
Horizons Regional Council	One Plan. Chapter 14	"Cumulative nitrogen leaching maximum" is defined as the total kilograms of nitrogen leached per hectare per year for the total area of the farm (Horizons, 2011) i.e., one-year losses.

8.6 Averaging in the plan-making process

The relevance of each of the three approaches (averaging inputs, defining a typical (or average) farm system, and calculating a rolling average of outputs) to the process for establishing freshwater objectives and setting and managing to freshwater quality limits depends on how OVERSEER is being used. Defining and using typical farm systems is particularly relevant when used in a predictive sense e.g., estimating future catchment loads or deriving benchmark values under good management practices. It is also useful where information on historical or current farm management is unavailable. Averaging outputs is relevant when there is a need to smooth annual variation in estimated nutrient losses e.g., in a compliance or monitoring setting.

8.7 Summary

OVERSEER incorporates a number of significant assumptions based on a stable, long-term farm system with similarly stable average climate conditions. Therefore, any modelling application that does not match these assumptions must be undertaken with extreme care and with a detailed understanding of the issues and implications. An estimate obtained with one single year's actual inputs may not represent the long-term N loss unless the farm system is constant, the climate that year matched the relevant long-term climate data in OVERSEER, and the farm inputs are consistent with the long-term climate from both an annual and monthly perspective.

Recommendations – averaging

1 The development of regional rules and resource consent conditions should recognise that one year's actual annual farm system data, as input into OVERSEER, may not be consistent with long-term climate data. Where they are inconsistent, nutrient loss estimates are likely to be highly uncertain and unlikely to represent the actual nutrient loss in that year.

2 Typical representative farm systems or averaging OVERSEER outputs can be used to endeavour to address the potential inconsistency that is otherwise likely to occur using one year's actual annual farm system data with OVERSEER's long-term climate data. If the climate over that averaged period is significantly different from the long-term climate, the result may overestimate or underestimate actual nutrient losses.

3 Any typical representative farm systems used for predictive purposes (e.g., when developing plan provisions) should be well defined e.g., as in the Matrix of Good Management (Robson et al., 2015).

4 Generally, OVERSEER outputs rather than inputs should be averaged. OVERSEER inputs should only be averaged if there is a clear understanding of the limitations and risks involved.

5 For the purpose of assessing compliance with a threshold in a regional rule or resource consent condition, a rolling average of a minimum of the previous 3–5 years of OVERSEER outputs should generally be used to provide a less variable and more meaningful indication of long-term nutrient loss from that farm system.

6 OVERSEER estimates of nutrient losses for farm systems undergoing a significant farm transition period e.g., dryland to irrigation, will have a relatively high uncertainty compared to stable farm systems. Therefore, reporting of nutrient losses should generally not be done for a farm system during a significant farm transition or, if this cannot be avoided (e.g., where reporting is required and a significant farm transition has occurred), appropriate assumptions should be incorporated to reduce that uncertainty (e.g., if the transition is to a more intensive land use with higher nutrient loss, to model that more intensive land use for the transition year).

7 The new capability (in OVERSEER version 6.2.2) to enter monthly climate data should not be used for the development or implementation of regional rules or resource consent condition until the BPDIS indicate that the capability is appropriate for non-research purposes.

8 Where short-term estimates of nutrient losses are required, e.g. seasonal estimates or for target water bodies that respond very quickly to changes in nutrient loading, an alternative to the currently available OVERSEER version should be considered, such as a more process-based model e.g., APSIM (2016).

9 Further investigation of appropriate averaging periods should be undertaken e.g., by reviewing the available pasture farmlet experiments that have measured N leaching and especially by reviewing the data available for non-dairy farm systems.

9 Nitrogen and phosphorus modelling

9.1 Introduction

This section is written primarily for scientists and RMA practitioners involved in the plan-making and/or resource consent processes.

The purpose of this section is to look at the implications of the differences between N and P loss modelling for the application of OVERSEER in regional plans and resource consents. The earlier section on uncertainty (see Section 7) provides an outline of the broad sources of uncertainty and the methods to manage uncertainty. The report by Watkins and Selbie (2015) discusses the broad assumptions and limitations of OVERSEER. This section focusses specifically on differences between N and P modelling.

Box 14 Key messages – OVERSEER modelling of N and P

1 There are fundamentally different processes driving actual N versus P loss.

2 OVERSEER uses very different sub-models to estimate N versus P loss, and consequently there are some specific limitations and assumptions that apply to OVERSEER N versus P loss estimates.

3 For OVERSEER modelling situations within the respective original sub-model calibration conditions, the uncertainties associated with OVERSEER N and P loss estimates are likely to be of a similar order of magnitude.

4 Modelling of catchment source nutrient loads in OVERSEER is unlikely to include all nutrient sources. This is particularly significant in modelling P source losses as there are generally a significant number of P sources that are not modelled by OVERSEER.

5 Provided that the relevant assumptions, limitations (Appendix 3) and principles (Table 1) are taken into account, OVERSEER is suitable to model P as well as N source loss at a property and catchment level.

9.2 Nitrogen and phosphorus – different processes and different sub-models in OVERSEER

There are fundamentally different processes driving N loss to water i.e., primarily N in drainage water, compared to P loss to water, which is predominantly via run-off to surface water (OVERSEER includes P leaching to sub-surface flows but excludes deep drainage (Gray et al., 2016). The report by Watkins and Selbie (2015) outlines the differences between the methods used by OVERSEER to estimate N and P losses to water.

It is also important to appreciate that P is assumed to run off (defined as surface flow, interflow, and subsurface flow that doesn't drain to deep groundwater) from all blocks of a property to a surface water body. Therefore, significant care is needed in considering P loss estimates for individual properties in a catchment context because clearly, for some properties, this may not be the case.

A recent review of the P loss sub-model (Gray et al., 2016) has identified a number of gaps and limitations in the current P loss sub-models, and opportunities for enhancing OVERSEER's P loss modelling.

It is critical to appreciate the different approaches to N and P sub-models to understand whether or not there are any significant differences in the uncertainties associated with the approaches taken in OVERSEER to modelling P versus N losses. It is therefore also important to appreciate the significance of this for RMA applications. Roberts (2013) notes that OVERSEER models "…N loss to water (leaching), P run-off risk…". It is important to appreciate that a P loss risk approach does not inherently result in greater uncertainties than the drainage estimation basis for the N sub-model. The 'risk' component of the P sub-model involves linking well-established factors that drive P loss e.g., rainfall, topography, soil properties, etc., into a model that has been shown to calibrate well with measured P loss for 23 locations (McDowell et al., 2005).

Occasionally questions are asked about the extent to which OVERSEER models all forms of N or P discharges. For example, is there a significant form of N, e.g., dissolved organic nitrogen, lost from agricultural land that is not modelled by OVERSEER? The current evidence (e.g., Shepherd & Wheeler, 2012; McDowell et al., 2005), particularly the original calibration studies, strongly indicates the forms of N or P that are not modelled by OVERSEER are generally not a significant component of the source nutrient loss[35]. However, a recent study (Smith et al., 2016) reported unexpectedly high contributions of dissolved organic N and P in drainage from a crop and pasture study.

9.3 OVERSEER, phosphorus and CSAs

There is a range of existing publications that highlight the options available for reducing both N and P losses to water e.g., Mackay and Power (2012). Many of these mitigation strategies are focussed at the farm level, block level or at a specific action, such as a riparian strip or wetland, and can be directly or indirectly modelled in OVERSEER. One potentially significant issue with P loss reduction options is that the combination of critical source areas (CSAs) (relatively small areas that can be responsible for a relatively large proportion of P loss) and normal 'blocking' guidelines (basis for identifying the blocks that make up an OVERSEER farm system – refer to BPDIS), can make it extremely challenging to model mitigation strategies that target CSAs. Development of blocking specifically to target CSAs is currently outside OVERSEER's scope. This has been a key driver behind the development of complementary models (e.g., Ballance's MitAgator and Ravensdown's Smart Maps) with a higher resolution that could estimate the consequences of mitigation strategies aimed at CSAs.

[35] The original N leaching calibration was predominantly undertaken using studies where only nitrate N was measured (Wheeler D, Pers. comm.). However, there is strong evidence to support the conclusion that the concentrations of ammonia N or other dissolved organic N in drainage water are usually very low (Wheeler D, Pers. comm.). For P, the model estimates dissolved and particulate P in overland (surface) run-off, or that is leached in some situations (McDowell et al., 2005). The model reports total P loss in overland flow.

9.4 Is OVERSEER suitable for modelling catchment phosphorus loss?

Catchment modelling studies have noted the greater uncertainties associated with catchment P loss estimates (e.g., Rutherford, 2013). However, this report was specific to the estimate of total loading to the receiving water body and recognised the limited sources of P loss that OVERSEER models and the limited simple mitigation options available in OVERSEER for P loss mitigation, rather than an observation of any inherent difference in the uncertainties of OVERSEER-estimated N loss versus OVERSEER-estimated P loss. In a similar manner, Parfitt et al. (2007) used both OVERSEER and NZEEM® (NZ Empirical Erosion Model) to discriminate between P inputs to the upper Manawatu River during major flood events and during the rest of the time.

The issue of N versus P modelling has been commented on through regional plan-making processes. For example, the section 32 analysis for one proposed regional plan change concluded that "For phosphorus, there is a model that we can use for the sources - OVERSEER. The phosphorus module is, however, not as well developed as the nitrogen module." (ECan, 2014). The concept of the P sub-model developed using a risk component appears to have been interpreted as meaning that there is an inherent quantitative difference in the relative uncertainties of N versus P loss estimates. The results of the original calibration work on these sub-models do not support this interpretation.

A combination of factors (possibly misunderstanding of the use of the term 'risk' in the P sub-model calibration, misinterpreting what P sources are modelled, and confusing the drivers for a focus on N) appears anecdotally to have resulted in a relatively common view that OVERSEER is more suitable for modelling N loss than P loss. The technical evidence does not support this simplistic view.

The work of Rutherford (2013) and Parfitt (2007) highlights that it is critical to understand what proportion of a total catchment source load OVERSEER can model and therefore to consider the need to ensure other nutrient sources can be adequately modelled.

Nitrogen loss to water has been the predominant focus of the application of OVERSEER to nutrient water quality management in New Zealand. This has generally been because of catchment specific studies that have identified N as the primary limiting nutrient for plant growth in a specific receiving surface water body (e.g., Lake Taupo & Lake Rotorua). In New Zealand, there is evidence that "… lakes N-limitation and co-limitation occur with greater frequency than P-limitation (Abell et al., 2010; Larned et al., 2011). While in streams and rivers, P-limitation is more common than either co- or N-limitation (McDowell et al., 2009)" (McDowell et al., 2013). In the case of groundwater, the focus on N is generally because of concerns about the concentrations of nitrate-N in groundwater that is used as a source of drinking water.

There have been significant enhancements of, and additions to, OVERSEER sub-models relevant to both N and P since approximately 2009. While the predominant focus has been on N, there have also been improvements to P sub-models e.g., incorporation of P-specific aspects of deer wallowing and fence-line pacing, the use of reactive phosphate rock, winter forage crops, and dairy shed effluent management.

The conclusion from this brief analysis is that provided that the relevant assumptions and limitations are taken into account, OVERSEER can be used to model P as well as N source loss in a catchment.

Table 11 highlights the key differences in how OVERSEER models P loss to water compared to N loss to water and the implications of that for the application of OVERSEER under the RMA.

Table 11
Key differences in N and P modelling in OVERSEER and their RMA implications

Key modelling difference/ consideration	Comments	Significance for application of OVERSEER under the RMA
1. Different sub-models used to model different processes that transport N and P to water. Surface run-off is often the most important pathway for P loss; N is primarily transported in drainage.	P loss sub-model uses a rainfall event risk model compared to N loss sub-model, which uses drainage estimates as a key driver. Significant opportunities available to enhance the detailed P loss sub-models. However, there are also recognised opportunities to enhance the calibration range of N loss studies.	Two very different processes and two very different models don't necessarily mean that either method has an inherently higher uncertainty.
2. Broader range of farm systems and farm management practices modelled that include consequences for N loss but not P loss.	P loss is not adequately modelled for some farm systems. More detailed information is in Gray et al., (2016). However, similar issues apply to modelling N loss from cropping farm systems (FAR, 2013).	Care is needed in modelling P loss from some farm systems e.g., arable and vegetable cropping systems, cut and carry systems and fruit crop blocks. Similarly, care is needed in modelling N loss from cropping farm systems. OVERSEER does not provide for all possible nutrient loss mitigation practices. It is currently relatively easy and intuitive to apply various N mitigation options in OVERSEER (e.g., reduce N fertiliser), while P mitigation options often require more knowledge and understanding of farm systems (e.g., installing riparian strips). This needs to be considered in property or catchment modelling.

Key modelling difference/ consideration	Comments	Significance for application of OVERSEER under the RMA
3. Limited calibration and evaluation studies have been undertaken for both N loss and P loss sub-models.	The primary P loss calibration was undertaken with pastoral, forestry and two arable farm systems and there is a recognised need to extend the calibration and evaluation studies for a broader range of farm systems, soils and locations. More detailed information is in Gray et al. (2016). It has also been recognised that there is a need to update and extend the N loss calibration and evaluation for a broader range of farm systems, climates and soil types (FAR, 2013; Watkins & Shepherd, 2014)	It is not feasible or appropriate to make any generalisations comparing the uncertainties associated with OVERSEER N loss estimates with OVERSEER P loss estimates. However, the closer the modelled scenario is (farm system, climate, soil type, etc.) to the calibration studies, the smaller the uncertainties associated with nutrient loss to water estimates.
4. Farm system transition may be less of an issue for modelling P loss than for modelling N loss.	Transition effects may be less significant for P loss estimates. However, this would depend on the type of transition.	Expert advice would be needed to assess the potential impact of specific likely farm system transitions on catchment modelling. The potential effects of farm system transitions would need to be taken into account in developing specific regulatory approached and their implementation.
5. Methods used to 'block' up a farm for OVERSEER modelling	The current guidelines for developing farm blocks for OVERSEER may not always be the best method for estimating and mitigating P losses e.g., blocks may not be setup to 'capture' critical P source areas.	If the primary concern is P loss to water, then a P-specific approach to 'blocking' a farm would be appropriate.
6. Phosphorus modelling assumes that block run-off will leave the property and enter surface water.	Some blocks or properties may not directly border a surface water body. However, there may be a route for run-off to move to a nearby surface water body.	Significant care is needed to interpret losses from blocks and/or properties with no surface water boundary, and consequently the consideration of source P loss estimates at any catchment scale.

Key modelling difference/ consideration	Comments	Significance for application of OVERSEER under the RMA
7. Phosphorus loss to water from some types of river/ stream /lake bank erosion and mass flow events are not modelled.	These processes require additional different modelling approaches (Gray et al., 2016). These processes can also be an issue for N loss but generally at a much smaller scale.	If an assessment of all significant catchment P sources is needed, these additional sources must also be considered and, where appropriate, estimated by using appropriate methods/models.
8. Limited spatial resolution recognition	The focus of OVERSEER on relatively large block scale nutrient loss limits the ability to focus mitigation on smaller scale priority contaminant source areas, which are often particularly relevant to P loss to water.	The resolution scale needed to identify mitigation opportunities for relatively small critical source areas is not currently available in OVERSEER i.e., OVERSEER will not necessarily give 'credit' for a mitigation aimed at a CSA. Additional, more spatially appropriate models are being developed that should allow the estimation of mitigation measures to specific high-risk contaminant source areas e.g., Ballance's MitAgator and Ravensdown's Smart Maps.

Recommendations – OVERSEER modelling N and P

1 The use of OVERSEER should take into account the different processes involved in N and P loss, the different modelling approaches taken in OVERSEER for N and P, and the assumptions and limitations that apply specifically to N and/or P (see Table 11 and Appendix 3) e.g., it is critical to appreciate the specific nutrient loss sources that OVERSEER models in a catchment and the need to use other methods to estimate other nutrient loss sources.

2 The current evidence strongly indicates that OVERSEER modelling of P loss is not inherently more uncertain than OVERSEER modelling of N, and therefore, provided that the relevant assumptions, limitations (Appendix 3) and principles (Table 1) are taken into account, OVERSEER modelling of P is suitable to be used in the modelling of property and catchment P loads.

3 Investigations should be undertaken to assess the feasibility of developing guidance for 'blocking' a farm on the basis of P critical source areas. This may also assist with linkage to complementary models with the resolution needed to identify, and target mitigation to, critical source areas.

10 Data provision and security

10.1 Introduction

This section is written primarily for RMA practitioners and IT staff involved in the development and implementation of plans and/or resource consents that specify the use of OVERSEER and the provision of OVERSEER data to a regional council.

The purpose of this section is to identify the issues that arise when councils need to receive and manage individual OVERSEER property outputs/files provided as part of voluntary programmes, regulatory requirements or occasionally, catchment modelling investigations. Key issues include the level of prescription on the information required, the criteria for auditing, and receipting, managing and using OVERSEER files for compliance and/or catchment management planning purposes. In addition, privacy and security protocols are identified to ensure that any data collected by a regional council for a specific purpose are not used for any other purpose.

Box 15 Key messages – data provision and security

1 The receipt and long-term management of individual OVERSEER property files need well-designed data management and security systems to ensure that all legal, technical, and long-term information needs are met.

2 Significant resources are required to develop and implement the necessary data provision and security measures.

3 A full OVERSEER XML file is needed to assess the extent of compliance of OVERSEER modelling with the BPDIS and any other relevant standards/guidelines, and to undertake auditing.

4 The quality and fitness for purpose of OVERSEER modelling can be assessed by assessing the modelling against a suite of quality assurance factors.

5 Documented protocols and controls for management of OVERSEER XML files will give farmers and advisors confidence in supplying information. Accreditation under the Farm Data Code of Practice would further enhance confidence in the management of OVERSEER XML files.

6 Enhancing the interoperability of models used in RMA processes that involve OVERSEER inputs or outputs has significant potential to reduce uncertainties in those model outputs and enhance the effectiveness of those RMA processes.

10.2 Legal framework

There are a number of significant pieces of legislation that apply to the collection of information by a regional council that may also contain personal information (i.e., information about an identifiable natural person, as distinct from a company or partnership). The key acts are the Local Government Official Information and Meetings Act 1987 (LGOIMA), the Privacy Act 1993, and the Public Records Act 2005. This section does not review all the detailed relevant legal requirements for how information provided to, or collected by, a regional council should be managed. However, given the importance of Privacy Act principles a summary is provided below (Privacy Commissioner website March 2016):

1 Only collect personal information if you really need it

2 Get it straight from the people concerned where possible

3 Tell them what you're going to do with it

4 Collect it legally and fairly

5 Take care of it once you've got it

6 People can see their personal information if they want to

7 They can correct it if it's wrong

8 Make sure personal information is correct before you use it

9 Get rid of it when you're done with it

10 Use it for the purpose you got it

11 Only disclose it if you have a good reason

12 Only assign unique identifiers where permitted.

There are some additional dimensions to the management of OVERSEER data provided to a regional council e.g., if OVERSEER data and or output information is provided to a regional council as part of a voluntary programme, how would any potential compliance issues be managed? This would need to be managed at both an organisational policy and technical information management system level.

There are also potential intellectual property issues associated with OVERSEER files. Some OVERSEER modelling of complex farm systems can take many days to develop the inputs to accurately represent the farm system, and concerns have been expressed about the risk that such files could be accidentally released to competitors unless appropriate security provisions are established.

10.3 Different sources and types of OVERSEER data provided to regional councils

OVERSEER data is obtained by regional councils from a wide range of sources and for various uses, from specific property information provided as part of a specific resource consent application, to broad-scale catchment information used as part of a catchment modelling process. The context and technical specifications of these data have implications for the methods used to store, access and utilise such information. For example, the scale used to identify soil characteristics for properties at a catchment scale means that that soil data are likely to be inappropriate to use as an input for individual property modelling. Similarly, OVERSEER files provided to meet a specific regulatory requirement may not be able to be used for another purpose, unless permission was obtained.

Similarly, OVERSEER file information (e.g., a full XML file) and/or specific output information (e.g., kg N/ha/yr loss to water for a property) may be provided to a regional council as part of different programmes undertaken for different purposes e.g., averaged over different periods and/or with different levels of quality assurance. Therefore, great care is needed in the interpretation of such data and information management systems need to be developed to ensure that any differences are recognised and catered for.

Regional councils need to:

- specify the information requirements and establish systems for entering and/or transferring data into information management systems, and the subsequent analysis of those data
- have quality management systems to ensure that data comply with the specified requirements and have systems in place for dealing with data that do not fully comply with those requirements
- have data management systems that provide for all information needs.

For example, there is increasing recognition that in many situations only the full OVERSEER XML files contain enough information for an independent assessment of the quality assurance of a provided budget and associated nutrient loss estimate.

10.4 Methods to ensure OVERSEER input data are fit for purpose

There has been significant input into developing standard protocols for all users for the input of data and the specific parameters for the use of OVERSEER. To this end, the OVERSEER Best Practice Data Input Standards (BPDIS) were developed. "The OVERSEER Best Practice Input Standards (the Standards) were developed by a group of seven technical expert users, who drew on their personal knowledge plus that contained in the DairyNZ Input Protocol, the AgResearch Expert User Group Guidelines and the Waikato Regional Councils Protocol for Variation 5 (West Taupo Catchment). The standards are a consensus of the views of the seven technical experts" (BPDIS, 2016).

Although compliance with the BPDIS is a significant part of ensuring consistency across users, adherence to these standards will not guarantee that the files accurately reflect a farm system. The additional following factors are important for ensuring a high level of integrity and accuracy in OVERSEER model inputs.

Assessment of risk and level of input accuracy

If there are significant catchment nutrient loss reduction requirements and/or specific catchment nutrient water quality issues, this increases the requirement for a very high standard of OVERSEER model file preparation i.e., a high accuracy of model inputs. If the total losses, by property, are significant, either because of the size of the property or the losses per hectare, this also increases the need to have a high standard of file preparation.

File Provision

The data to be reviewed as part of a regulatory requirement will generally be a full XML file. There are a large number of variables within an OVERSEER file that can potentially have conflicting impact on the outputs, thus creating an inaccurate file. Therefore, the robustness of the outputs must be viewed in the context of the quality of the data within the XML file.

Other Supporting Data

The provision of additional data to support the XML file can also be used to provide a level of confidence that actual information has been used. These could include:

- annual taxation accounts showing opening and closing stock numbers, stock transactions, feed inputs, cropping and fertiliser usage (However, it is important to appreciate that this information may not have been independently audited.)
- annual fertiliser statement of use
- a summary of cropping activities undertaken.

Once an OVERSEER XML file has been provided as part of a regional plan or resource consent requirement, and it has been determined that an independent audit is needed, the following key audit checks and assessments (Table 12) need to be performed by a person with qualifications and experience at least equivalent to a Certificate in Advanced Sustainable Nutrient Management (see Section 11 - Qualifications and auditing), to determine an audit rating of the modelling:

Table 12
Proposed OVERSEER modelling auditing methodology

Modeller attributes	Protocol Checks
Qualification of modeller	Does the modeller have the minimum qualification of the Advanced Sustainable Nutrient Management Certificate or an equivalent qualification? If not, do not proceed.
Experience of modeller	Does the modeller have sufficient experience in farm systems modelling to ensure that the system being modelled is a long-term biologically feasible farm system? If not, proceed with additional caution.

Key OVERSEER Inputs	Protocol Checks	Model audit rating		
		High	Med	Low
Professional judgement is needed to score some responses into a high/medium/low rating e.g., if the annual average rainfall input is accurate, an audit rating of "high" would be appropriate.				
Best Practice Data Input Standards (BPDIS)	Have the BPDIS been fully complied with and any departures or 'second choices' justified?			
Farm area	Does the total farm area match any relevant FEMP/FEP, copy of title provided to show area, no obvious errors?			
Rainfall	Is the average annual rainfall used representative of the specific location? Was the climate station tool used to generate the rainfall data?			
Block set-up and scale	Has the farm been appropriately split into blocks to represent variable soil type, contour, intensity, and land use including cropping? Are any departures from normal blocking justified? Is the time scale correct?			
Soil inputs	Do the soil inputs used appear to be appropriate for the farm location? Was S-map used? If data was transcribed manually, was it done accurately? If a regional council prescribes a method was that method used?			
Irrigation	Do the irrigation inputs look appropriate (system, management option & application depth)? Are they the long-term averages? Are they normal for such farm systems in that location? If irrigation inputs appear relatively low, have corroborating data been provided e.g., water meter data?			
Stock Numbers / Type	Do the opening and closing numbers match the annual accounts (if provided) and the stock classes (gender and age) appear normal?			
Stock Sales / Production	Do the total sales and purchases and/or farm production figures match those provided within the annual accounts or typical productivity parameters?			
Fertiliser inputs	Do these closely match the annual nutrient statement provided by the fertiliser company (if provided)? Do they match normal industry practice for this farm system in this location? Are they the long-term averages?			
Soil nutrient status	Are soil tests based on three-year average data to ensure this is an accurate reflection of potential P losses? Does this create any issues for an annual nutrient loss estimate?			
Effluent management (Dairy)	Is the system, as reflected in OVERSEER, a workable and realistic effluent solution?			
Clover fixation	Is the input justified? Is it similar to other similar farm systems in that location?			

Key OVERSEER Outputs	Note: these are checks to help ID any issues, and to assist in resolving issues.	Model audit rating		
		High	**Med**	**Low**
Nitrogen losses	Are nitrogen losses per hectare within accepted/ published/measured ranges for the type of system being modelled for those soils/location?			
Phosphorus losses	Are phosphorus losses per hectare within accepted/ published/measured ranges for the type of system being modelled?			
Pasture production	Is annual pasture production within accepted/ published/ measured/modelled ranges for the locality, soil and pasture involved?			
Stocking rate	Are the stocking rates representative of the system being modelled? Are they within the normal range for the farm system and location? If the stocking rate is relatively low or high, have corroborating data been provided?			
Soil moisture, drainage & run-off	Do these estimates make sense? Are they consistent with information from other relevant reliable/published sources?			
N block pools	Do the estimated values make sense? Are they consistent with information from other reliable/published sources?			
		High	**Med**	**Low**
Overall audit rating Professional judgement needed and explanation required for the overall audit rating.				
Any unusual outputs?	Are there any unusual outputs that might indicate an input error, an unusual situation, or defect/bug in OVERSEER? If any significant anomalies are observed, they should ideally be resolved before an overall rating is made.			
Audit comments	Audit comments should be added to explain any unusual findings and to summarise the reasons for the overall audit rating.			

There may be additional audit requirements set by individual regional councils.

It is acknowledged that further development of this proposed audit system is needed e.g., to develop a process for ensuring consistency between auditors.

Data and Results Manipulation

It is imperative that the audit process removes the ability for any party to manipulate the results or outputs for the gain of one party. Provided that the same methodology is used each year, it is difficult to manipulate results on a year-on-year basis. Therefore, the level of scrutiny of a file must be at its highest for the first audit. Subsequent audits would have that first file and audit as reference points.

OVERSEER version changes

Where OVERSEER files have not been completed to the highest audit rating possible there is a risk of additional variability in outputs occurring between version changes and/or between comparisons with any regulatory thresholds. See Section 6 - OVERSEER version change issues.

Cross check dataset

Regional councils could collectively or individually create datasets that contain information such as typical range of stocking rates or pasture grown (or consumed) for different soil types of land classes to act as a quick check for OVERSEER file information. Specific additional methods could include the following:

1 Development of an anonymised dataset that calculates distributions of stocking rate (or pasture consumed) and other parameters by land class (utilising council GIS systems to locate farms and approximate land class). New farm models received could be checked against these statistical data and outliers flagged for more in-depth review.

2 Use of the Pasture Growth Forecaster (http://www.pasturegrowthforecaster.co.nz/) with NIWA VCSN climate data for the last 40 years to establish a 90th percentile potential pasture growth for each farm model, and compare that to the monthly pasture consumed as calculated by OVERSEER (livestock demand less brought in/stored feed consumed). Again, outliers would be flagged for more in-depth review.

10.5 Database systems for storage and use of OVERSEER data

Farm models are a representation of a specific farm system in a format that can be utilised by systems such as OVERSEER. When a farm system is modelled in OVERSEER the detailed input and output information is stored in an XML file (a type of file that enables data to be readily inputted into the OVERSEER engine and stores key outputs).

Currently, regional councils employ a variety of techniques for storing and utilising OVERSEER farm model data:

- Store source data (farm questionnaires and support documents such as invoices) and build farm models as required. This approach is likely to be most applicable to specific catchments where a regional council has a very proactive role. This approach can require significant resources to build accurate farm models for all properties.
- Store only the outputs of a farm model supplied by a primary producer or their advisor. This approach has advantages from a privacy perspective but means the regional council is unable to utilise the data to assess the impacts of an OVERSEER version change or other plan change. In addition, output data alone do not enable a regional council to undertake any quality assurance checking of the farm system information.

- Store the farm model XML file in a council file system folder. This approach could provide granular access control (folders can be protected) but would not typically record accesses. This would simply be an electronic filing system with no efficient mechanism to manage or analyse the data.
- Store the farm model XML file in a document management system, along with the other supporting documents relating to a property or a resource consent. This can be a useful approach as long as the document management system supports the appropriate level of controls and logging. Catchment analysis or analysis of OVERSEER version changes must be accomplished in this case by identifying and checking each relevant farm model, a process that becomes complicated as the number of farms and files to be assessed grows. A document management system will not typically provide detailed search functions able to identify OVERSEER files with specific sets of parameters.
- Store the farm model in a dedicated database or in a separate table or structure in an existing database. This approach allows versioning and bulk selection and use of data, but may risk disconnecting the farm model from other supporting documents.

These techniques highlight the advantages and disadvantages of different approaches and a number of recommendations are made at the end of this section.

It is also important that there is a high level of backwards compatibility when a new OVERSEER version is released, so that an OVERSEER XML file created under a previous version of OVERSEER can be run successfully on a new version of OVERSEER. However, it is acknowledged that there could be technical challenges in achieving this e.g., for files that may have run successfully on a previous version but a new version identifies actual input errors. Additional measures will be required to appropriately address these types of issues.

Forward compatibility (the ability to run an XML file created or modified with a new version of OVERSEER using an old model) is not required. While full long-term backwards compatibility would be an ideal situation, it appears that a 4-year period would enable most regional council requirements to be met. The need to incorporate a significant new module or function may make full backwards compatibility difficult, but in most cases recoding data to a new format or prompting the user for additional information should allow an old file to be updated to the new format. If changes that break compatibility are needed, prior consultation should occur with regional councils to discuss measures needed to achieve effective backwards compatibility.

10.6 Privacy and security requirements and systems

In addition to the controlled document frameworks implied by the Local Government Official Information and Meetings Act, the Resource Management Act, and the Archives Act, use of farm information in OVERSEER farm models raises privacy and data control issues (under the Privacy Act and more broadly) for primary producers, advisors or consultants who have been involved in the preparation of farm models.

Regional councils and contractors or advisors will need to show that they have:

- an information security policy for the organisation (as documented in ISO 27001) that defines appropriate policies and controls for the type of data held and allows the organisation to audit or check that those policies and controls are implemented
- a mechanism to determine the identity of any person attempting to access farm model data (authentication) and to provide appropriate access controls (authorisation) for that person. Access controls might include denying access, allowing read access, or allowing modification

- a mechanism for logging all access to farm model data (including read access) to provide confidence that privacy requirements are being followed, and appropriate policy guidance for staff and contractors. A similar approach is used by banks, police and government service organisations to log access to individual accounts or case files.

In addition to the above, there are three principal areas of concern for farmers and advisors that should be addressed:

- Primary producers are concerned that information from other sources or even ad-hoc observations (e.g., of stock numbers on farm) might be incorporated into a farm model without their knowledge. Regional councils could address this by making farmers aware of their processes for monitoring, triggers, and response protocols.
- Advisors invest their reputation in developing OVERSEER farm models for their clients (farmers or regional councils). They are concerned that later unauthorised modifications to farm models might damage their reputation, or that they may be held responsible for inappropriate use of the farm models they have created.
  OVERSEER Limited and regional councils could address this by developing and implementing a publishing protocol that identified the purposes for which an advisor had created and released a farm model, and by implementing additional 'digital signing' so that later modifications could be identified and repudiated.
- Advisors invest their intellectual property in the process of collecting data and transforming this into a biologically feasible and accurate steady-state model of a farm system. Some advisors are concerned that a farm model might later be released by a regional council or a primary producer to a competing advisor or organisation, without recognition of their efforts. Regional councils could address this by ensuring they have appropriate controls for the use and redistribution of farm models. Advisors who are developing farm models for primary producers could address this by appropriate agreements and by utilising a publishing protocol such as that identified above to assert their authorship of the farm model.

10.7 Farm Data Code of Practice

In 2015 the Farm Data Code of Practice was created and endorsed by a number of industry organisations to provide leadership and increase transparency about the use of detailed farm data by organisations. The Farm Data Code of Practice encourages organisations to become accredited by having clear terms and conditions and supporting documents that tell primary producers their rights and responsibilities and how organisations will utilise and manage the data they collect, and by having policies that support those terms. A key focus of the Farm Data Code of Practice is to provide confidence around datasets that may not be covered by the Privacy Act, as these data pertain to a (farm) company or trust rather than a natural person.

The Farm Data Code of Practice is administered through an independent review panel, appointed by its shareholding organisations: Beef+Lamb New Zealand, Dairy Companies Association, DairyNZ, Federated Farmers, Meat Industry Association, Te Tumu Paeroa (The Maori Trustee), and the Veterinary Association.

Regional councils implementing the information security policy and controls described above would find it straightforward to achieve accreditation under the Farm Data Code of Practice, which would provide further assurance to farmers and advisors.

10.8 OVERSEER data and model interoperability

There are a large number of models used in agriculture, water quantity and water quality management (e.g., TRIM, CLUES, Farmax, Pasture Growth Forecaster, Mike 11, IrriCalc, S-map, etc.). The majority of these models operate either independently or have limited interoperability e.g., S-map and OVERSEER. Given the significance and importance of some common data sources, e.g., climate data, farm data, and soil information, there is a need to enable enhanced model interoperability to enhance the efficiency and consistency of modelling. There are significant potential benefits to regional councils if there is enhancement of interoperability between models that are relied on directly or indirectly by regional councils.

An example of the issues that can arise is regional plan and resource consent hearings being provided with evidence from expert witnesses using models that use different climate data and farm management data. Similarly, components of one model or dataset can be incorporated into another but over time models and datasets are developed and enhanced on different timeframes, which can result in older components remaining in other models. This can lead to inconsistencies in model outputs that can be significant e.g., the estimate of annual drainage from a water resource model may differ significantly from that of OVERSEER (possibly because of different climate datasets and/or soil information used in each model). In addition, currently, outputs from one model have to be manually entered or manipulated prior to use in another model e.g., outputs from OVERSEER used in catchment modelling, or data from Farmax used in OVERSEER. This may require additional adjustments to make the models somewhat consistent, which means that the original source of the data can become hard to trace.

Some work has been done on these issues (e.g., Snow et al., 2014; Elliott et al., 2014). Two overall conclusions of those studies are summarised here:

1 There is a need for technical advisory committees to provide advice on data standardisation including the potential for common datasets that could form the basis for a number of models e.g., Farmax and OVERSEER.

2 Enhanced interoperability of freshwater modelling has been demonstrated as possible. However, there are a number of significant technical, institutional and resourcing challenges that need to be addressed before significant improvement of model interoperability occurs.

From the perspective of endeavouring to enhance the accuracy, interoperability and efficiency of OVERSEER inputs, three key model inputs stand out: climate data, soil data and farm system data. Given the importance of these inputs to OVERSEER and other farm system modelling, there would be significant potential benefits in developing and enhancing model interoperability with e.g., common datasets that could be inputted to different models.

Where other datasets are utilised in OVERSEER farm models, it will become increasingly important to trace the source of these data. In some cases, this is possible by a policy (e.g., input protocols that specify a common source and use of climate data), but more generally it would be advantageous to include a reference to source data in the OVERSEER farm model XML file. OVERSEER should consider a simple linking or reference mechanism to enable documentation of data provenance and assist traceability of data from multiple sources.

10.9 Land subdivision

Land subdivision can create issues for OVERSEER data management and regional rules and resource consents with 'OVERSEER conditions'. These generally arise when a title is 'split' during a subdivision process and where a resource consent has been granted, it may not be clear how a land use consent property nutrient allowance should be 'split' between the resultant titles. Apportionment issues are best addressed on a case by case basis and data management systems need to be designed to enable splitting and transfer to new properties.

Recommendations – data management, security and quality assurance

1 Regional councils should:

(a) Store OVERSEER XML files using a method that enables file data to be extracted using an automated process, and that provides for access controls and logging e.g., in a controlled system (document management system or database) or in a dedicated database table or store machine-readable references to the document, which may be stored in a document management system.

(b) Include additional database information to track:

(i) the provenance (original source) and date of the farm model,

(ii) the OVERSEER version used to develop the farm model/outputs,

(iii) for audit reviewed OVERSEER XML files, the reviewer, date of review, OVERSEER version used, audit rating, and any review notes, and

(iv) for any modification to OVERSEER XML files (e.g., after an audit review or to ensure the farm model complies with required practices), the date, originator and purpose of the modification, as well as the OVERSEER version used.

(c) Consider automated extraction of key farm model data or calculated outputs (such as farm areas, stocking rates, N and P nutrient budgets) to a separate table or area to enable rapid reporting without needing to extract individual results from XML or recalculate (OVERSEER version and date of calculation would also need to be stored with the extracted data).

(d) Consider developing methods to export anonymised OVERSEER file data from the database via a secured process to support use for purposes such as auditing, catchment studies or sensitivity analyses.

(e) Ensure that an information security policy for the organisation defines appropriate policies and controls for the type of data held and allows the organisation to audit or check that those policies and controls are implemented, including mechanisms to determine the authentication or identity of people accessing farm model data along with their authorisation to access such data, and to record such data access.

(f) Once the above information security policy and controls are implemented, consider seeking accreditation under the Farm Data Code of Practice, which would provide further assurance to farmers and advisors regarding the rights and controls surrounding identifiable farm data.

(g) Implement processes to ensure that all parties who provide OVERSEER XML files as part of a regulatory requirement are advised of the processes and protocols used to manage that information.

(h) Consider collectively or individually creating datasets that contain information such as typical range of stocking rates or pasture grown (or consumed) for different soil types of land classes to be used as a quick check for OVERSEER file information.

(i) Develop criteria for apportioning nutrient loss allocations specified in resource consents, if needed as a consequence of property subdivision.

(j) Ensure that OVERSEER modelling undertaken to meet a regional plan or resource consent requirement in a location of particular significance, e.g., for estimating nutrient losses in a catchment with significant nutrient water quality issues with regional plan objectives and policies that require reductions in nutrient source loads, is audited against a comprehensive suite of factors, such as those detailed in Table 12. Only those model outputs that have a modelling audit rating of High or Medium should be accepted for a regulatory requirement. (Also see Section 11).

(k) Consider development of processes to provide detailed guidance for the OVERSEER file audit process outlined in Table 12 e.g., to ensure consistency between auditors.

2 OVERSEER Limited and users such as regional councils and advisors should consider development and implementation of a mechanism that allows the creator of an OVERSEER XML file to identify the purposes for which it was created and released, supported by 'digital signing' so that later modifications could be identified and repudiated.

3 OVERSEER Limited and regional councils should consider developing a simple linking or reference mechanism to assist traceability of data from multiple sources. This could be implemented within the nodes or sections in an OVERSEER XML file.

4 OVERSEER Limited should endeavour to maintain backwards compatibility for at least 4 years i.e., to ensure that OVERSEER XML files generated 4 years previously can still be successfully run on the current OVERSEER model. If the need for significant model improvement/enhancement means that this cannot be achieved, there should be prior consultation between OVERSEER LIMITED and regional councils to enable the development of a methodology to achieve backwards compatibility.

5 Regional councils and OVERSEER Limited should support initiatives to enhance the interoperability of models used in Resource Management Act processes that involve OVERSEER inputs or outputs.

11 Qualifications and auditing

11.1 Introduction

This section is written primarily for RMA practitioners involved in the development and implementation of plans and/or resource consents.

The purpose of this section is to outline the need for qualifications and experience in OVERSEER modelling and the recommended qualification requirements for those preparing and auditing OVERSEER files.

The importance of OVERSEER modelling estimates and the complexities involved in ensuring that inputs and associated assumptions are as accurate and realistic as possible means that only appropriately qualified and experienced practitioners should prepare or audit OVERSEER file information that is being used in a significant RMA regulatory or planning process. However, as in financial accounting, it is also critical that reliance is not placed solely on qualifications and experience. There is also a need to have transparent auditing processes available so that all involved in processes that rely on OVERSEER modelling can have an appropriately high level of confidence in the output results while appreciating the inherent uncertainties in OVERSEER modelling (see Section 7).

Box 16 Key messages – qualifications and auditing

1 OVERSEER modelling requires a detailed knowledge of the New Zealand farming system being modelled and a detailed understanding of OVERSEER. This is particularly significant for scenario modelling.

2 A high level of assurance about the fitness for purpose of an OVERSEER estimate of nutrient loss needs independent auditing by a person with significant knowledge of the modelled farming system and OVERSEER.

3 The use of OVERSEER requires an understanding of the functions and relationships of component parts of the model. This requires regular publication of the details of those functions and relationships.

11.2 Experience and understanding of New Zealand farm systems

OVERSEER is not a fully 'self-adjusting model' i.e., it does not automatically change all aspects of a farm system in response to inputs. For example, adding fertiliser or irrigation does not cause OVERSEER's estimates of pasture production to increase. This is particularly important in the application of OVERSEER to scenario analyses. Therefore, it is critically important to have a detailed understanding of both how the model operates and the farming systems that it models.

Many of New Zealand's farm systems have become increasingly complex over the past 50 years and there are also many mixed farm systems. Many complex factors combine to explain why, for example, adjacent dairy farms may operate differently, and modelling those differences appropriately in OVERSEER requires detailed knowledge of both OVERSEER and dairy farming systems. Therefore, a fundamental requirement for appropriate OVERSEER modelling is a full understanding of relevant farm systems and what is required to operate and model a long-term biologically feasible farm system. Similarly, it is critical that those involved in the use of OVERSEER have a sufficient knowledge of the functions and relationships of component parts of the model.

11.3 Currently available qualifications relevant to OVERSEER

The key currently available qualifications are the following:

- Massey University Intermediate and Advanced Sustainable Nutrient Management
- The Nutrient Management Adviser Certification Programme.

Massey University describes the Intermediate Sustainable Nutrient Management Course:

To be up to the challenge, participants should have completed at least one tertiary level course in Soil Science or Land Resource Management or have significant practical or professional experience in production agriculture/horticulture or environmental science. You need a good understanding of farm systems; it should not be your first introduction to the concepts of nutrient cycling and you should have prior knowledge of the Overseer Nutrient Budgets software. You may need to confirm with us that your qualifications and experience are appropriate.

Two options have been developed:

- Pastoral agriculture - with a focus in the case studies predominantly on dairy systems, and

- Orchard and Arable - with case studies including tree, vine, vegetable and cropping systems.

Participants on the Intermediate SNM course must complete a short pre-course assignment, attend a three-day contact course and sit a two-hour examination on the final day.

Massey University describes the Advanced Sustainable Nutrient Management Course:

To enrol in this course, participants must have successfully completed the Intermediate SNM Course. [Note: An exemption may be granted if an applicant can demonstrate prior equivalent learning and/or an in-depth knowledge of sustainable agricultural practices and use of the Overseer Nutrient Budgets software. Please contact us if you think you may qualify for being exempt the Intermediate SNM course as a pre-requisite.]

Participants must complete four assignments over a five-month period, attend a three-day contact course and pass a two-hour examination. The assignments are case studies using the latest version of Overseer Nutrient Budgets software and include both pastoral and arable examples. These are intended to assist participants to develop nutrient management plans that meet production goals for actual farm enterprises whilst minimising the negative effects of nutrient losses on the environment.

The Fertiliser Association of New Zealand run the Nutrient Management Adviser Certification Programme and describe its purpose as:

… to build and uphold a transparent set of industry standards for nutrient management advisers to meet, so that they provide nationally consistent advice of the highest standard to farmers.

These courses and their related qualifications can progressively develop the knowledge to undertake OVERSEER modelling for a range of farming systems. However, expertise in modelling one type of farming system, e.g., dairying, is not a guarantee that a person would have an equivalent level of expertise in modelling another type of farming system e.g., complex arable cropping systems.

11.4 Auditing of OVERSEER modelling

As the potential significance of OVERSEER modelling increases for both freshwater quality objectives and potential consequences for land owners/managers, so too does the need for appropriate auditing with transparent criteria to ensure that there is an appropriate level of confidence in the output results (see Section 10 – Data provision and security).

If OVERSEER modelling results are only being used for information purposes or if the scale and significance of nutrient loss are trivial, there would generally not be a need for independent auditing. However, independent auditing against clear and transparent criteria is usually needed for more critical modelling where the results may have particularly significant implications for regional plan development, determining a regional plan activity status or resource consent compliance status of an activity (see Section 10).

When considering whether auditing is required and the qualifications and/or experience needed for auditing a file, the complexity of the farm system being modelled should be considered. For example, a relatively small existing farm with a recognised low nutrient loss per hectare (e.g., dryland sheep) in a large catchment is unlikely to require independent auditing, while a large farm undergoing a new significant farm system change (e.g., to irrigation) in a small catchment would likely require an experienced and qualified person (e.g., a Certified Nutrient Management Adviser) to be able to adequately audit an XML file.

Industry audited self-management systems are appropriate in many situations if there is an acceptable level of independence, transparency and reporting, and the auditors are suitably qualified and experienced. However, there are a number of significant quality assurance benefits that can be provided by independent auditing.

The recommended criteria for auditing OVERSEER modelling are set out in Table 12 in Section 10 of this report.

Recommendations – qualifications and auditing

1 The minimum qualification requirement for undertaking OVERSEER modelling should be a Massey University Certificate in Advanced Sustainable Nutrient Management, an equivalent qualification, or extensive experience in a specific farming system and detailed understanding of OVERSEER.

2 For OVERSEER modelling of particular significance, e.g., for estimating property nutrient losses in a catchment with significant nutrient water quality issues with regional plan objectives and policies that require reductions in nutrient source loads, independent auditing of modelling should be undertaken by a person with the minimum qualification specified above, against the factors and process outlined in Table 12.

3 The functions and relationships of component parts of the OVERSEER model need to be published and those publications updated regularly by OVERSEER Limited to ensure that they are understood by those involved in the use of OVERSEER.

12 References

Abell, J., Ozkundakci, D., & Hamilton, D. (2010) Nitrogen and phosphorus limitation of phytoplankton growth in New Zealand lakes: Implications for eutrophication control. Ecosystems 13: 966-977.

APSIM (2016) "APSIM Initiative" Retrieved 16 March 2016, from http://apsim.info

Arbuckle, C. (2015) Stocktake of Regional Council Uses of OVERSEER®. Report no.001. Report prepared for MPI and BOPRC.

Barns, S & Young, J. (2013) Cap-and-trade of diffuse emissions of nitrogen in Lake Taupo Catchment. Reviewing the policy decisions and the market, Waikato Regional Council Technical Report TR2013/34.

BOPRC. (2016). "Plan change 10: Lake Rotorua Nutrient Management." Retrieved 16 March 2016, from http://www.boprc.govt.nz/media/508998/n-lake-rotorua-nutrient-management -plan-change-10-version-4-for-notification-29-february-2016-copy.pdf.

BPDIS (2016) OVERSEER Best Practice Data Input Standards, OVERSEER version 6.2.2, May 2016, OVERSEER Limited. Retrieved 18 June 2016 from http://overseer.org.nz/ files/download /13ea6744fc16324.

Cichota, R. & Snow, V. (2009) Estimating nutrient loss to waterways - an overview of models of relevance to New Zealand pastoral farms. New Zealand Journal of Agricultural Research, 52, 239-260.

D'Arcy, B., Ellis, J., Ferrier, R., Jenkins, A., & Dils, R. (2000) Diffuse pollution impacts: the environmental and economic impacts of diffuse pollution in the UK. Terence Dalton Publishers.

Der Kiureghian, A., & Ditlevsen, O. (2007) Aleatory or epistemic? Does it matter? Special Workshop on Risk Acceptance and Risk Communication March 26-27, 2007, Stanford University.

ECan (2012) The preferred approach for managing the cumulative effects of land use on water quality in the Canterbury region A working paper, January 2012.

ECan (2014) Proposed Variation 1 to the Proposed Canterbury Land and Water Regional Plan, Section 32 Evaluation Report, February 2014.

ECan (2016) "Proposed Plan Change 5 Retrieved 16 March 2016 from: http://ecan.govt.nz/publications/general/002%20Part%20B%20Plan%20Change%205%20Nutrient%20Management%20and%20Waitaki.pdf

Elliott, S., Turek, G., Rutledge, D., Ritchie, A., Herzig, A., & Snow, V. (2014) Framework for Interoperable Freshwater Models: Testing and Recommendations, Prepared for Ministry of Business, Innovation and Employment.

EPA, 2015. Plan Change 6 to the Hawke's Bay Regional Resource Management Plan - Tukituki Catchment. Retieved 27 May 2016 from: http://www.epa.govt.nz/resource-management /NSP000028 /NSP000028_Final%20Decision%20-%20Post%20High%20Court%20Referral%20-%20 Plan%20Change%206%20-%20CLEAN%20-%20June %202015.pdf

FAR (2013) A peer review of OVERSEER® in relation to modelling nutrient flows in arable crops, A report commissioned by the Foundation for Arable Research.

Freeman, M. (2011) The resource consent process: Environmental models and uncertainty. Resource Managment Law Association Journal, August, 1-8.

Gray, C., Wheeler, D & McDowell, R. (2016) Review of the phosphorus loss submodel in OVERSEER®, Report prepared for OVERSEER® owners under AgResearch core funding contract A21231(A), RE500/2015/050, February 2016.

Horizons. (2011). "One Plan - Glossary." Retrieved 16 Mar 2016, from https://www.horizons.govt.nz/assets/one-plan-august-2010/HRC_OP_Vol3 Glossary.pdf.

Howard-Williams, C., Davies-Colley, R., Rutherford, K., & Wilcock R (2010) Diffuse pollution and freshwater degradation: New Zealand Perspectives, 14th International Conference of the IWA Diffuse Pollution Specialist Group, DIPCON 2010, 126 – 140.

Journeaux P. (2014) Overseer "Averages" Analysis, Report for Ministry for Primary Industires, AgFirst.

LAWF (2010) Report of the Land and Water Forum: A Fresh Start for Freshwater.

Larned, S., Hamilton, D., Zeldis, J., & Howard-Williams, C. (2011) Nutrient limitation in New Zealand rivers, lakes and estuaries. Discussion paper prepared for Land and Water Forum, September 2011, Wellington.

McDowell, R., Monaghan, R., & Wheeler, D. (2005) Modelling phosphorus losses from pastoral farming systems in New Zealand, New Zealand Journal of Agricultural Research, 48:1, 131-141.

McDowell, R., Larned, S., & Houlbrooke, D., (2009) Nitrogen and phosphorus in New Zealand streams and rivers: control and impact of eutrophication and the influence of land management. New Zealand Journal of Marine and Freshwater Research 43:985-995.

McDowell, R., Wilcock, B., & Hamilton, D. (2013) Assessment of Strategies to Mitigate the Impact or Loss of Contaminants from Agricultural Land to Fresh Waters, Report RE500/2013/066, Prepared for the Ministry for the Environment.

Mackay, A., & Power, I. (2012) Mitigation options for reducing N and P losses from intensive dairy and arable and process vegetables farm systems on the Ruataniwha Plains, Report prepared for Hawkes Bay Regional Council Ruataniwha Plains Water Storage Project.

McSwinney, C., & Robertson G. (2005) Nonlinear response of N2O flux to incremental fertilizer addition in a continuous maize (Zea mays L.) cropping system, Global Change Biology, 11: 1712-1719.

MfE (2014) National Policy Statement for Freshwater Management 2014. Ministry for the Environment.

MfE (2015) A Guide to the National Policy Statement for Freshwater Management 2014, Ministry for the Environment.

MFE (2016) A draft guide to communicating and managing uncertainty when implementing the National Policy Statement for Freshwater Management (2014). March 2016, Ministry for the Environment.

Millner, I. (2013) "Board of Inquiry (Tukituki Catchment Proposal) Statement of Evidence " Retrieved 16 March 2016, from: http://www.epa.govt.nz/resource-management/NSP000028/NSP000028_14%20Ian%20Millner%20-%20Evidence.pdf

Novotny, V. (2003) Water Quality Diffuse Pollution and Watershed Management, Hoboken, New Jersey, John Wiley and Sons, Inc.

ORC. (2014) "Water Quality Rules (Plan Change 6A)." Retrieved 16 Mar 2016, from http://www.orc.govt.nz/Publications-and-Reports/Regional-Policies-and-Plans/Regional-Plan-Water/Water-Quality-Rules-Plan-Change-6A/.

Parfitt, R., Dymond, J., Ausseil, A-G., Clothier, B., Deurer, M., Gillingham, A., Gray, R., Houlbrooke, D., Mackay, A., & McDowell, R. (2007) Best practice phosphorus losses from agricultural land, Landcare Research Contract Report: LC0708/012, Prepared for Horizons Regional Council.

Park, S. (2014) Using OVERSEER within Rules for the Lake Rotorua Catchment. Headway Ltd., Report prepared for Bay of Plenty Regional Council.

Pellow, R., Lee, S., Metherell, A., McCallum R., Moir J., Roberts A., & Wheeler D. (2013) Assessing the impact of input choices within Overseer (v6) on the modelled N losses to water for Lincoln University Dairy Farm (LUDF). Accurate and efficient use of nutrients on farms. L. D. Currie and C. L. Christensen. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand.

Pollacco, J., Lilburne, L., Webb, T. & Wheeler, D. (2014) Preliminary assessment and review of soil parameters in OVERSEER® 6, Report for AgResearch, Landcare Research Report No. LC2002.

Roberts, A. (2013) "Board of Inquiry (Tukituki Catchment Proposal) Statement of Evidence" Retrieved 6 May 2016, from http://www.epa.govt.nz/resource-management/NSP000028/NSP000028_Fertiliser%20Association%20of%20New%20Zealand%20Incorporated%20Evidence%20Antony%20Roberts.pdf

Robson, M. (2014) Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios: Overview Report. Environment Canterbury Technical Report.

Robson, M., Brown, H., Hume, E., Lilburne, L., Mcauliffe, R., Pinxterhuis, I., Snow, V., Williams, R., B+LNZ., Developmentmatters., DINZ., ECAN., HORTNZ. & NZPORK. (2015) Overview Report – Canterbury Matrix of Good Management Project. Report no. R15/104

Rutherford, C. (2013) "Board of Inquiry (Tukituki Catchment Proposal) Statement of Evidence" Retrieved 16 March 2016, from http://epa.govt.nz/resource-management/NSP000028/NSP000028_22%20Kit%20Rutherford%20-%20Evidence.pdf

Shepherd, M., & Wheeler, D. (2012). Technical Note No.5 (August 2012): Changes to the pastoral N model. Retrieved from http://overseer.org.nz/files/download/ ac9380fbd3fb379 on 31 May 2016.

Shepherd, M., Wheeler, D., Selbie, D., Buckthought, L. & Freeman, M. (2013) OVERSEER®: accuracy, precision, error and uncertainty. In: Currie, L. D. & Christensen, C. L. (eds.) Accurate and efficient use of nutrients on farms. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand: http://flrc.massey.ac.nz/publications.html.

Singh, R., Rivas, A., Espanto, P., Elwan, A., Horne, D., Roygard, J., Mathers, A., & Clothier, B (2014) Assessment of transport and transformation of nitrogen in the subsurface environment of Manawatu River catchment – work in progress, Fertilizer and Lime Research Centre: Nutrient management for the farm, catchment and community. L. D. Currie and C. L. Christensen. Massey University, Palmerston North, New Zealand. Occasional Report No. 27.

Smith, C., Monaghan, R., McDowell, R., & Carrick, S. (2016) Nitrogen and phosphorus leaching losses from pasture, winter forage crop and native bush sites in the West Matukituki Valley, RE500/2016/013, March 2016, Report prepared for the Otago Regional Council.

Snow, V., Cooke, A., McEwen, G., & Freeman, M. (2013) Farmax-Overseer Integration Scoping, RE500/2013/096, Report prepared for AgResearch.

Walker, W., Harremoës, P., Rotmans, J., van der Sluijs, J., van Asselt, M., Janssen, P. & Krayer von Krauss, M. (2003) Defining uncertainty. A conceptual basis for uncertainty management in model based decision support, Integrated Assessment 4, 5- 17.

Watkins, N. & Selbie D. (2015) Technical description of OVERSEER for Regional Councils. AgResearch Contract Report RE500/2015/084.

Watkins, N. & Shepherd, M. (2014) A compendium of New Zealand pasture farmlet experiments measuring nitrogen leaching, Fertilizer and Lime Research Centre: Nutrient management for the farm, catchment and community. L. D. Currie and C. L. Christensen. Massey University, Palmerston North, New Zealand. Occasional Report No. 27.

Wheeler, D. (2013) "Board of Inquiry (Tukituki Catchment Proposal) Statement of Evidence " Retrieved 16 March 2016, from http://www.epa.govt.nz/resource-management /NSP000028 NSP000028_15%20David%20Wheeler%20%20Evidence.pdf.

Wheeler, D. (2015a) OVERSEER Technical manual: Climate, AgResearch Report, Retrieved on 23 Aug 2015 from http://overseer.org.nz/technical-information.

Wheeler, D. (2015b) OVERSEER Technical manual: Hydrology, AgResearch Report, Retrieved on 23 Aug 2015 from http://overseer.org.nz/technical-information.

Wheeler, D. (2015c) OVERSEER Technical manual: Calculation of nitrous oxide emissions, AgResearch Report, Retrieved on 23 Aug 2015 from http://overseer.org.nz/technical-information.

Wheeler, D. & Shepherd, M. (2013) OVERSEER: Answers to commonly asked questions. Agreseach Client report no:RE500/2012/027.

Wheeler, D., Shepherd, M., Freeman, M. & Selbie, D. (2014) OVERSEER® nutrient budgets: selecting appropriate timescales for inputting farm management and climate information. Fertilizer and Lime Research Centre: Nutrient management for the farm, catchment and community. L. D. Currie and C. L. Christensen. Massey University, Palmerston North, New Zealand. Occasional Report No. 27.

Wheeler, D. & Bright, J. (2015) Irrigation in OVERSEER. In: Moving farm systems to improved attenuation. (Eds L.D. Currie and L.L Burkitt). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 28. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand.

Wilcock, R. (2013) "Board of Inquiry (Tukituki Catchment Proposal) Statement of Evidence " Retrieved 16 March 2016, from http://www.epa.govt.nz/resource-management/NSP000028/NSP000028_21%20Bob%20Wilcock%20-%20Evidence.pdf

WRC. (2011) "Variation 5 – Lake Taupo Catchment. OPERATIVE Version." Retrieved 16 March 2016, from http://www.waikatoregion.govt.nz/PageFiles/3918/V5%20Operative %20Version.pdf.

APPENDICES

Appendix 1

Relationship with other OVERSEER documents

The following is an outline of the key documents and sources of information available to assist in understanding OVERSEER and its application to water quality management issues:

Report or information source	Brief description
http://www.overseer.org.nz	Website for OVERSEER with direct or indirect references to a significant collection of technical reports that explain the development, operation, and many applications of OVERSEER. This includes many science papers that explain specific technical aspects of OVERSEER.
OVERSEER Best Practice Data Input Standards, (Usually updated with each version change)	The purpose of these best practice 'standards' is to reduce inconsistencies between different users operating OVERSEER. They do not prescribe input requirements, but have been adopted by many organisations as a key reference.
Technical Description of OVERSEER for Regional Councils, Watkins, N. & Selbie, D., 2015.	A brief description of how OVERSEER works, including descriptions of the different methods used to estimate N leaching and P run-off, limitations, assumptions and uncertainties in model outputs.
Stocktake of Regional Council Uses of OVERSEER, Arbuckle, C., 2015.	A summary of the different ways that regional councils currently use OVERSEER
Individual regional council guidance on input requirements or preferences, e.g. Waikato Regional Council and Environment Canterbury.	These documents usually specify some information requirements to ensure that OVERSEER modelling is consistent and meets specified standards.
OVERSEER: Answers to commonly asked questions, Wheeler D. and Shepherd M., 2013	Responses to a series of questions posed by a variety of users, compiled into the following categories: general, uncertainty issues, performance for different sectors and policy development and application.

Appendix 2

Project brief

Outputs

The required output is a document providing guidance on the use of OVERSEER by regional councils in a regulatory context. The document must draw out the policy implications of the information collated in the 'Stocktake of regional council uses of OVERSEER' and 'Technical description of OVERSEER for regional councils' reports. The project board is looking for real strength in the analysis of potential policy approaches and an equally strong understanding of what that means for implementation and compliance on the ground. The tone should be informative and guiding rather than prescriptive.

This work is highly significant as it will inform future council practice. It is therefore critical that the guidance developed is robust and credible. We expect the expertise of experienced planners and implementers will be called upon and why approaches have been recommended will be fully justified. Finally, the guidance must take account of the objectives of regional councils throughout, in particular the protection or improvement of water quality.

Details of the outputs that will be produced by the contractor are outlined in the proposal and quotation dated 1 December 2015.

Report Scope

The following areas have been identified as requiring guidance:

1 ***Principles***
This section should outline any overarching principles that should be applied to the use of OVERSEER as a tool in a regulatory context. Specifically it must cover the need for a councils to have a clear Resource Management Act (RMA) planning rationale for why managing nutrient losses at the property scale (the scale at which OVERSEER functions) is appropriate in a particular catchment. Principles for the use of OVERSEER by councils must take account of:

- *The known modelling limitations, including any easing of those limitations through the adoption of recommendations in this guidance report.*
- *The need for supporting information e.g. the separate modelling of nutrient attenuation and (where relevant) groundwater lags.*
- *The potential implementation costs to councils and landowners.*
- *The need for councils to have considered alternatives to achieve the same/similar water quality objective(s). However, this section should not be an exploration of alternatives to OVERSEER-based regulation. Rather, the focus is on identifying the strengths and weaknesses of potential OVERSEER-based regulation which will need to be addressed in any accompanying Section 32 analysis and be used (as necessary) in relevant communication with stakeholders.*

2 ***Policy, Rules and Compliance***

This section will form a substantial part of the guidance and should provide detailed guidance on the range of appropriate ways OVERSEER can be used in policy and rules by regional councils. Rather than being overly prescriptive, the guidance should provide an analysis of the advantages and disadvantages of various possible approaches under different conditions, taking into account that

councils are operating in varying circumstances.

- *Potential policy pathways for the use of OVERSEER as a tool in regulating diffuse discharges, and the implications of different approaches.*
- *Potential rule frameworks that could incorporate OVERSEER generated information, and the implications and potential consequences of different frameworks.*
- *Model rule wording and/or model consent conditions.*
- *Compliance implications of different policy and rules frameworks.*
- *Pitfalls to be avoided.*
- *Data input requirements – how prescriptive councils should be.*
- *Requirements for receiving files from landowners (e.g. frequency).*
- *Qualification and certification requirements for those preparing and auditing OVERSEER files.*
- *Identification of appropriate security and file management requirements for councils.*
- *Advice on how OVERSEER can be used in conjunction with other software, tools and systems within policy frameworks:*
  - *Farm Environment Plans (e.g., the use of OVERSEER generated benchmarks to monitor the results of implemented farm plans)*
  - *Catchment or sub-catchment models*
  - *Tools with a spatial element such as Ballance's MitAgator and Ravensdown's Smart Maps.*

To inform this guidance, analysis will be needed of the policy implications of a number of recognised modelling limitations, including:

(a) Uncertainty

Uncertainty in the inputs and the modelled outputs of OVERSEER are broadly identified in the 'Technical Description of OVERSEER for regional councils' report. The guidance material should address how this affects the appropriateness of various approaches, what more could be done to understand uncertainty in OVERSEER, and how uncertainty can be managed.

(b) Version change management

Guidance should include:

- *Analysis of options to manage OVERSEER version changes within RMA rules.*
- *Analysis of options available to address issues arising from OVERSEER version changes (where OVERSEER is used to understand compliance with numeric discharge limits, at either a property or catchment scale). These issues may include impacts on activity status and land use change aspirations.*
- *Recommendations for OVERSEER owners, regional councils and all users on managing future version releases.*

(c) Input and output averaging methods

The guidance should include recommendations for developing optimal repeatable methods for averaging input and output data over time, where OVERSEER is used to assess compliance with or progress towards a numeric discharge limit. This should include how many individual years of results should be used to determine trends.

Appendix 3

Assumptions for principles of use of OVERSEER

Land use and water quality management assumptions

- The loss of N and P to water from agricultural (and urban) land use is contributing to significant water quality issues in many water bodies and estuaries in New Zealand.
- Soil type, climatic conditions, topography, land use and management practices can all impact on the magnitude of human-induced nutrient losses to water.
- Nitrogen and P have significantly different loss to water pathways. Nitrogen loss to water is predominantly via leaching while P loss to water is primarily via overland flow with soil /run-off, or shallow sub-surface drainage.
- Nutrient losses via overland flow are generally more visible than those lost direct to ground, and mitigation strategies for tackling losses via overland flow are generally more intuitive and easier to gauge success.
- Direct and reliable measurement of diffuse N and P loss from a farm is not generally feasible.
- Modelled or estimated nutrient losses can be useful in the management of diffuse nutrient loss from land.
- Information obtained from both modelling and measurements involves uncertainties.

Guidance for general use of models in environmental decision-making

The US EPA (2009) developed guidance for the effective development, evaluation, and use of models in environmental decision-making. These recommendations are summarised below:

- Sound science principles are used in model development.
- The model is supported by the quantity and quality of available data.
- Evaluation of the model is undertaken to assess how closely the model approximates the real system of interest and how well the model performs against a quality assurance objective.
- There is appropriately comprehensive documentation of all aspects of the model.
- There is effective communication between modellers, analysts, and those using the model.

Key OVERSEER limitations, assumptions and uncertainties

OVERSEER incorporates important limitations, assumptions and uncertainties that are outlined below (derived from Watkins & Selbie, 2015b):

Model scope

- The OVERSEER model boundary relevant to this report is the farm boundary and the root zone.

Limitations

- OVERSEER is not spatially explicit beyond the level of defined blocks.
- Not all management practices or activities that have an impact on nutrient losses are captured in the OVERSEER model.
- OVERSEER does not represent all farm systems in New Zealand.

- Components of OVERSEER have not been calibrated against measured data from every combination of farm systems and environment.

Key Assumptions

- OVERSEER assumes steady state conditions (i.e., inputs and site characteristics are in equilibrium with farm production).
- OVERSEER estimates annual average outputs assuming that the farm management and inputs are constant.
- OVERSEER assumes that the production did occur for the given inputs.
- OVERSEER assumes that certain practices or levels of practice are occurring e.g., fertiliser is spread evenly, dairy shed effluent ponds are sealed.
- OVERSEER assumes long-term average rainfall, PET and temperature and a specific rainfall pattern based on location. (Version 6.2.2 provides for monthly climate input for research purposes.)

Uncertainties

- Modelling uncertainty derives from:
  - imperfect input data
  - differences between users' input of data
  - variability in the representation of the actual farm system via data records
  - errors in input and boundary condition data, model structure, parameter values, observations used to calibrate or evaluate, errors of omissions, commensurability of modelled and observed variables and parameters
  - the unknown 'unknowns'.
- There is temporal and spatial variability in field measurement data used for sub-model calibration.
- Scientific knowledge has been used to add components and to extrapolate to circumstances where calibration data has not been collected. The uncertainty around the estimated losses is likely to increase in circumstances that are substantially different from those in the calibration range.

Version changes

- New versions of OVERSEER are usually released twice per year to improve estimates of nutrient losses, improve the ability to characterise farm systems, enhance the model user interface and associated reports, address software bugs/defects, etc.

Appendix 4

Guidance and pitfalls for specifying OVERSEER thresholds in resource consents

(Note: This material is not comprehensive and is solely intended to raise awareness of some possible resource consent condition examples and some potential pitfalls to consider.)

Required resource consent component	Explanation
A well-defined threshold	Need to specify with absolute certainty what the mandatory threshold(s) is (are). This will require a numerical or narrative quantitative specification with direct or indirect linkages to definitions contained within the resource consent. May also be useful to have an 'early warning' trigger threshold below this to ensure that appropriate action is taken to reduce the risk of breaching the threshold.

Some resource consent condition examples to consider and develop:

One approach:

The consent holder shall not exceed a Nitrogen Discharge Allowance (NDA) of a rolling three-year average (the mean value of the three most recent annual nitrogen loss estimates) of Z kilograms of nitrogen per hectare per year (as calculated using Version XYZ of OVERSEER) over the land area to which the consent relates.

Another approach that uses an early warning 'trigger':

(a) If the nitrogen loss calculation exceeds 0.9X kilograms of nitrogen per hectare per rolling three-year average, then a report shall be prepared by a suitably qualified person and provided to the ABC Regional Council, Attention: XYZ Manager within one month of provision of the information provided under condition (e). That report shall detail the measures that will be taken to ensure compliance with the threshold of X kilograms of nitrogen per hectare per rolling three-year average.

(b) The nitrogen loss calculation shall not exceed X kilograms of nitrogen per hectare per rolling three-year average.

General potential pitfalls:

- If the key resource consent condition requires a report to be submitted "that demonstrates losses meet" a threshold requirement rather than a condition that specifies the threshold requirement, then there may be some compliance/enforcement limitations because the focus of the condition is a report "that demonstrates" rather than a threshold. It is generally preferable to separate the threshold requirement from a requirement to provide information relevant to that requirement.
- A specific or wider policy is needed to ensure that there is a clear and transparent process for responding to any non-compliance with a threshold e.g., is there a documented 'tolerance' policy for trivial non-compliance? Have OVERSEER uncertainties been taken into account in developing the threshold, should they be built into resource consent conditions and/or a compliance/enforcement policy, etc.?
- A condition that states what should or must be done if a threshold is breached needs to be written very carefully with a clear understanding that this may limit enforcement options that would otherwise be available.

Required resource consent component	Explanation
A requirement to undertake OVERSEER modelling in accordance with appropriate standards and guidelines, e.g., the BPDIS (see Section 10), and in particularly sensitive situations, a requirement for independent auditing as outlined in Table 12.	Needs to be explicit that the consent holder has to ensure that OVERSEER modelling is undertaken in accordance with the BPDIS and other appropriate considerations (see Table 12). Some consent situations e.g., scale, significance and/or location, may not warrant independent auditing. The need for auditing will be related to rule wording including thresholds e.g., if set relatively high, auditing may be needed for all OVERSEER files; conversely, if set relatively low, may need to identify a threshold or policy for auditing.

A resource consent condition example to consider and develop:

OVERSEER modelling shall be undertaken by the consent holder to provide estimates of nutrient loss and shall be undertaken in accordance with conditions of this resource consent, the relevant OVERSEER Best Practice Input Standards, generally accepted good practice and shall be audited using the audit criteria and system outlined in Table XYZ, by a person independent of the person who undertook the original OVERSEER modelling.

General potential pitfalls:

- Leaving it implicit that the consent holder will ensure that modelling is undertaken, potentially leaves the task to be undertaken by the regional council.

Required resource consent component	Explanation
A defined period(s) of time over which the OVERSEER modelling must be undertaken.	This must be made clear and line up with any specific catchment limit requirements (see Section 8). Specifically, see the limitations with using one year's actual farm data.

A resource consent condition example to consider and develop:

"Nitrogen Loss" means the loss of nitrogen from the property towards water as estimated by OVERSEER output, averaged over the most recent 4-year 1 July to 30 June period and expressed in kg per hectare per annum.

General potential pitfalls:

- A condition that doesn't explicitly define the period over which the modelling should be undertaken is vulnerable to different interpretations, e.g., what does 'per year' mean, when does the year start, etc.?
- Specification of modelling to be undertaken for one 12-month period only has risks that the farm system management over those 12 months may not be consistent with OVERSEER's long-term climate data (e.g., rainfall) and lead to overestimates or underestimates of actual nutrient loss (see Section 8). In addition, OVERSEER has been designed to provide long-term annual average outputs and providing individual one-year annual estimates may not be consistent with those steady state assumptions.

See Section 8 for specific guidance on averaging time periods.

Required resource consent component	Explanation
An OVERSEER version management mechanism.	Essential to clarify how OVERSEER version changes will be managed.

Some resource consent condition examples to consider and develop:

"Benchmark Nutrient Discharge Allowance" means the Nitrogen Loss estimated using the current (at any given date) version of OVERSEER calculated using the information in the OVERSEER Input File XYZ prepared for the 2015/2016 season 1 July to 30 June, and dated 30 June 2016, including any necessary inconsequential modifications needed to run that file data on the current version of OVERSEER.

The consent holder shall not exceed a Nitrogen Discharge Allowance (NDA) of a rolling three-year average (the mean value of the three most recent annual nitrogen loss estimates) of Z kilograms of nitrogen per hectare per year (as calculated using OVERSEER Version XYZ) over the land area to which the consent relates.

General potential pitfalls:

See Section 6 for detailed guidance on version management.

Required resource consent component	Explanation
A minimum qualification requirement for the person undertaking the OVERSEER modelling, and if auditing is required, the minimum qualification for the person undertaking the auditing.	OVERSEER is a complex model that requires detailed knowledge of both how the model works and NZ farming systems. A minimum qualification is essential (see Sections 10 & 11).

A resource consent condition example to consider and develop:

The person undertaking OVERSEER modelling for the purpose of estimating nutrient loss and for that estimate to be compared with the requirements of condition X, shall have a minimum qualification of a Certificate of Completion in Advanced Sustainable Nutrient Management from Massey University or a qualification that is at least equivalent. Evidence of this shall be provided to the ABC Regional Council, Attention: XYZ Manager on request.

General potential pitfalls:

- Not including a qualification requirement for the person who undertakes the OVERSEER modelling can significantly reduce the confidence in the quality of OVERSEER estimates.
- Giving a council employee, including a Chief Executive, unfettered discretion to determine what qualifications are appropriate is inadvisable. That approach is generally accepted as ultra vires; see the QP website for more information. A reference to a specific qualification and an alternative 'equivalent qualification' is preferable. The power to make a determination on what constitutes an 'equivalent qualification' can be delegated to a senior technical officer. The courts could ultimately make a determination if required.

See Section 11 for more detailed information.

Required resource consent component	Explanation
A requirement to provide the OVERSEER XML file and supporting information by a specific date, on request, or if a specific event occurs.	It needs to be clear exactly what and when information must be provided to the regional council.

Some resource consent condition examples to consider and develop:

1 OVERSEER nutrient loss estimates undertaken in accordance with condition (3) shall be provided to the ABC Regional Council Attention: XYZ Manager, by 31 August each year.

2 The OVERSEER modelling undertaken for the purpose of estimating nutrient loss and assessing compliance with condition (2) shall be audited by a different and independent person than the person who undertook the original modelling, against the audit system detailed in Table XYZ. Only those OVERSEER file results with an overall audit rating of Medium or High shall be accepted by the ABC Regional Council as a nutrient loss estimate for the purposes of assessing compliance with Condition (2).

3 Detailed records shall be maintained of fertiliser application rates, location and crop type (including winter feed/forage crops), cultivation methods, stock units by reference to type and breed, and all other inputs to the OVERSEER, or an equivalent, nutrient budget model. A copy of these records shall be provided to the ABC Regional Council, Attention: XYZ Manager on request.

4 A copy of each OVERSEER XML file used to obtain nutrient loss estimates used to assess compliance with condition (2) shall be maintained and provided to the ABC Regional Council, Attention: XYZ Manager on request.

General potential pitfalls:

- Care is needed to ensure that XML files have not been changed since modelling was undertaken.
- Care is needed to not specify that information is provided after an event that the consent holder has control over. The date should be independent of actions of the consent holder.

See Section 10 for detailed guidance on information provision.

Required resource consent component	Explanation
Any circumstances that would trigger a requirement for a complementary FEP	An FEP or NMP can be useful to provide a comprehensive integrated plan of how nutrient loss thresholds will be achieved, and to provide information to support the OVERSEER nutrient loss estimates. An FEP can also address nutrient management and other contaminant issues that may not be covered by OVERSEER.

Some resource consent condition examples to consider and develop:

A nutrient management plan shall be prepared by a suitably qualified person in accordance with the minimum requirements specified below:

1 Property details:

(a) Physical address.

(b) Name of a contact person.

(c) Description of ownership structure.

(d) Legal description of the land and farm identifier as provided by Regional Council.

(e) Name and contact details of the person responsible for managing the property/farming enterprise if different from above.

2 A map(s) or aerial photograph at a scale that clearly shows:

(a) The boundaries of the property.

(b) A block map for the property/farming enterprise.

3 A description of how each of the following management objectives, where relevant, will be met….

"Suitably qualified person" is a person with a minimum qualification of a Certificate of Completion in Advanced Sustainable Nutrient Management from Massey University or a qualification that is at least equivalent, and at least X years' professional experience in providing land/fertiliser management advice.

General potential pitfalls:

- Care is needed to ensure that the status and role of the FEP/NMP is very clear. For example, is its purpose to complement other 'primary' conditions, or is it the 'primary' condition? The condition(s) requirements need to be certain and enforceable.

Appendix 5

Assessing methods to generate nutrient source loads against methods and tools to manage uncertainty

Methods to manage uncertainty		Methods to generate nutrient source loads				
		Generic or literature values	**Anecdotal case studies**	**Representative farms (few)**	**Representative farms (many)**	**Actual farm budgets**
Uncertainty of methods						
Managing data inputs	Quality of data inputs	High	Moderate	Low	Low	Variable
	Expertise of modellers	Unknown	Unknown/ moderate	Low	Low	Unknown/ variable
	Representativeness of modelled information	High	High	Moderate	Low	Low
	Similarity of system to calibration dataset	Unknown/depends on catchment				
Uncertainty of methods						
Using OVERSEER outputs	Significance analyses and use of ranges	Not possible	Generally not possible	Possible	Possible	Possible but resource intensive
	Alternative sources of evidence	Possible	Possible	Possible	Possible	Possible
	Model outputs used in a relative sense	Possible	Possible	Possible	Possible	Possible
	Precautionary Principle - conservatism	Not possible	Generally not possible	Possible	Possible	Possible but resource intensive
	Precautionary Principle - adaptive management	Possible	Possible	Possible	Possible	Possible
	Shortened consent term	Not possible for use in consents - - lacks specificity			Mod-high uncertainty - lacks specificity needed for consent	Possible
	Resource consent review conditions					Possible
	FEP and OVERSEER used together					Possible
	On-going targeted monitoring and revision	NA	NA	NA	NA	NA
Can incorporate updates to OVERSEER?		No	Possible	Yes	Yes	Yes

Appendix 6

Summary of approaches used to address various implications of OVERSEER version changes

Approach	Explanation	Advantages	Disadvantages
Options primarily relevant to regional plan development and implementation. They may have broad or partial application to a version change issue. Some options can be combined.			
Lock in a specific OVERSEER version number for regional rules and/or resource consent applications, e.g., a rule may state "…estimated using OVERSEER version 6.X.Y"	A regional rule can state that a specific OVERSEER version be used to determine for example, compliance with a nutrient loss threshold or that a specific version be used for resource consent applications. For example, OVERSEER version 5.4.3 is specified as the version to use for the Lake Taupo catchment since new regional plan rules became fully operative in 2011.	Provides certainty for land owners/managers that actual rule thresholds and/or resource consent thresholds won't change. Provides user certainty if nutrient allocation trading is established as occurs in the Lake Taupo catchment. No need to respond to OVERSEER version changes. Plan provisions can allow for resource consent applications or applications to change resource consent conditions to use a subsequent version of OVERSEER.	Can make it difficult to take advantage of model enhancements/ improvements/new mitigation options in a new version. Obtaining access to an old version needs permission from the OVERSEER owners. If this approach became common, it could result in multiple versions in use in a region and/or around the country. Can result in a significant implementation workload for council and land owners/ managers.
Explicitly or implicitly specify the current/most recent version for regional rules and/or resource consent applications e.g., a rule may state "…estimated using OVERSEER."	This is currently included in a number of regional rules that state a nutrient loss threshold and individual property nutrient loss estimates are to be determined using the current version. If the version is not specified, the same approach is implicit, because at any one time only one version is generally available.	Can take advantage of model enhancements/ improvements/new mitigation options in a new version. Updated versions generally involve model improvements that reduce the uncertainty involved in overall catchment nutrient source loss estimates. If a new version includes additional mitigation options, these can be used to both better reflect existing practices and encourage their uptake.	Unless robust version change management strategies are implemented this can create uncertainty for land owners/managers because numerical threshold rule compliance status could change with each version. The extent of this issue would vary depending on the specific plan provisions. The use of different versions over time could result in different actual consented losses for equivalent activities if consented under different versions.

Approach	Explanation	Advantages	Disadvantages
Specify in the appropriate rule that when a new OVERSEER version change occurs that results in a change to a relevant nutrient loss threshold or property nutrient loss estimate, that would not affect the exercise of specific existing resource consents (S68(7) RMA)	This is a relatively common approach used in similar situations to provide certainty to parties who may be potentially affected by a new rule that relates to minimum standards of water quality.	Could enable new OVERSEER versions to be applied over time. Could provide certainty for specific resource consent holders.	Depending on the application of such a provision, this would create challenges in estimating consented source loads, and potential for anomalies in treatment of similar resource consent applications.
Development of a plan framework that avoids or minimises the consequences of OVERSEER version changes	For example, use of rules that don't rely on thresholds that require an OVERSEER estimate to determine compliance, and rely instead on specific policies that utilise OVERSEER. For example, use of a limited number of activity class rules that can prevent an activity changing from one activity class to another as a consequence of an OVERSEER version change e.g., instead of having rules that include all activity classes defined on the basis of OVERSEER estimates, having a limited number of activity classes not defined on the basis of OVERSEER estimates. This is the approach in the Bay of Plenty Regional Council Proposed Plan Change 10	Can prevent OVERSEER version changes causing any activity class changes. Can assist in developing regional rule requirements that are easy to understand and apply. A clear policy framework and/or updating mechanism can minimise any inequities that could otherwise arise between any consents granted before and after an OVERSEER version change.	May not provide the degree of flexibility that a full range of activity classes would provide. Would put significant reliance on the resource consent process and would need a very clear policy framework to ensure plan objectives are achieved and farming sectors treated equitably.

Approach	Explanation	Advantages	Disadvantages
Provision of a version updating method specified via plan provisions but sitting outside the plan e.g., on a website, to address the effects of an OVERSEER version change on threshold estimated losses.	Such systems are being proposed to provide a transparent system to endeavour to address the effects of an OVERSEER version change by specifying via plan provisions a methodology e.g., a calculator, reference file system, or 'data input transfer' system. The methodology allows nutrient loss estimates to be recalculated with new versions of OVERSEER without changing the plan provisions, classification or compliance status of a farm system.	Depending on the details of the rule wording and the updating system, can be an effective method to address the effect of a version change on the status of an activity. Provides certainty to landowners/ managers about compliance after OVERSEER version changes. Would not appear to require a plan change or a Schedule 1 Part 3 process.	Updating systems may still result in a change in the status of an activity because a version change may not affect the activity and the threshold 'symmetrically'. Input updating systems rely on the input structures of OVERSEER remaining constant and establishing protocols for dealing with any minor model changes that may create technical challenges for 'transferring' input data. There does not appear to be any specific case law on these 'external plan linked' updating systems.
Provide the ability for a council or a council Chief Executive to approve or certify alternative models to estimate property nutrient loss.	An alternative model for an unusual land use that is not modelled by OVERSEER could be certified against public specifications or criteria.	Certification against clearly defined criteria or specifications could be a robust route to provide for alternative models and/or new versions. A plan would need to include clear technical criteria or specifications that a model or new version would be assessed against by an appropriately qualified person. Would provide options where the use OVERSEER may not be appropriate.	Would require resources to establish robust criteria or specifications and a certification process.
Use OVERSEER information to develop readily understood narrative rule thresholds e.g., maximum hectares of irrigation, maximum area of specified land use on a specified soil type, specific good management practices, etc.	This allows for OVERSEER information to inform the process of developing appropriate thresholds, e.g., permitted activity thresholds, but without reliance on an OVERSEER estimate to determine activity status.	This could address OVERSEER version issues for those activity categories where it is used (e.g., permitted activity threshold). Enables easily understood rule thresholds.	This could result in a narrow focus on specific inputs and less of a focus on outputs and effects. Would limit land owner/manager flexibility May not treat all situations equitably e.g., it would be a challenge to ensure that all possible land uses are recognised with equivalent narrative thresholds.

Approach	Explanation	Advantages	Disadvantages
Options primarily relevant to resource consents (many resource consent applications would be made under provisions of a proposed or operative regional plan with OVERSEER related provisions, many will also be made in circumstances where there are few provisions specific to OVERSEER)			
Lock in a specific version number for any granted resource consent	As described above for regional plan approach. Assumes that ongoing access to an old version would be provided, or a resource consent change or review process would be used to update to a new OVERSEER version.	Similar advantages as described above for a regional plan. An additional advantage is that it is significantly more straightforward (at least for limited numbers of consent holders) to apply for a change to a resource consent condition to take account of enhancements to OVERSEER in a new version. Resource consent conditions could specify a process for responding to version changes.	Similar disadvantages as described above for a regional plan.
No version or current version specified.	Where a resource consent is granted that explicitly or implicitly requires the most current version of OVERSEER to be used to estimate nutrient loss to water.	Similar advantages as described above for a regional plan. More flexibility in a resource consent process than regional plan process for parties to agree conditions that provide for future versions to be used and an updating process (i.e., Augier Principle, see QP website for more information).	Challenges in assessing resource consent applications over time using different OVERSEER versions. Potential challenges in using data provided as part of a resource consent requirement to estimate catchment source loads and wider catchment modelling. Depending on the detailed conditions, could result in uncertainty for the consent holder and other parties about future compliance e.g., a new OVERSEER version could change the compliance status in relation to a specified threshold.

Approach	Explanation	Advantages	Disadvantages
Include a condition in a granted resource consent that provides for a version updating method that provides for a calculator, reference file system, or 'data input transfer' system to address the effects of an OVERSEER version change on threshold estimated losses.	As described above for regional plan approach.	Similar advantages as described above for a regional plan. More flexibility in a resource consent process than regional plan process for parties to agree conditions that provide for a version updating method (i.e., Augier Principle).	Similar disadvantages as described above for a regional plan.
Condition wording that requires an OVERSEER estimate to be undertaken within a specified time frame while a specified OVERSEER version is available.	This would require modelling to be undertaken within a specified period of time while an OVERSEER version is available and records maintained and/or provided to the regional council.	This could be used with a 'batch' of resource consent applications to ensure that estimates were all undertaken within a specific time frame while one version is available. Would not be affected by an OVERSEER version change and would provide certainty. Could be complemented by conditions providing for OVERSEER estimates to be undertaken at a later period. May be applicable where there is no need for ongoing nutrient loss estimates.	Unlikely to be feasible for large catchments with many land owners or on a region scale. Would require significant coordination with many parties to be feasible. May require an additional mechanism to enable ongoing certainty for compliance monitoring.
Use OVERSEER to develop readily understood resource consent condition thresholds that do not require an OVERSEER estimate to determine compliance e.g., maximum hectares of irrigation, or maximum area of specified land use on a specified soil type, specific good management practices, etc.	Develop narrative statements of land management that are consistent with estimated property nutrient loss targets designed to achieve estimated catchment limits. Instead of using OVERSEER numerical thresholds, these are translated into narrative land use thresholds.	This would partly address OVERSEER version issues. Enables easily understood resource consent condition thresholds.	Would limit land owner/manager flexibility. This would result in more of a focus on inputs rather than outputs. Any narrative resource consent conditions that referred to, e.g., 'good management practices', would need to define exactly what is required to ensure that such conditions are certain and enforceable.

Approach	Explanation	Advantages	Disadvantages
General wider potential options			
Modify the current OVERSEER version change frequency and/or content, and availability of earlier versions.	This could include limiting intermediate version changes to matters that don't affect nutrient loss estimates e.g., user interface improvements. This could include a possible longer-term version change cycle e.g., every two or three years, that could tie in with a review of a regional or catchment nutrient management plan. The OVERSEER owners have also, under certain situations, made specific version(s) available.	Less frequent version changes would enable version response systems to be more manageable.	Less frequent version changes would limit the ability to quickly incorporate model improvements/enhancements. Achieving agreement on an ideal version change frequency/content between all key stakeholders would be difficult to achieve.
Amend Schedule 1, Part 3 of the RMA to allow for more effective incorporation of a new OVERSEER version into a regional plan. Or provide some other route such as that used to update a National Environmental Standard.	This has been suggested (Arbuckle, 2015) to develop a quicker process than that currently required by Schedule 1 Part 3. For example, if a specific consultative process has been followed to incorporate a new version change. This may provide an opportunity to develop a methodology for other important environmental models used under the RMA, e.g., air contaminant dispersion models, river flow estimation models, groundwater resource estimation models, etc.	If practicable and acceptable, would enable new versions of OVERSEER to be incorporated into regional plans faster than could currently occur, while still providing for input on the implications of a new version.	There are likely to be reservations about developing a 'fast-track' system solely to manage OVERSEER version changes, because this may conflict with normal RMA consultation processes.