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Manatū Ahu Matua

Overseer Redevelopment Programme Report

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Ministry for Primary Industries
Manatū Ahu Matua

Ministry for the
Environment
Manatū Mō Te Taiao

Overseer Redevelopment Programme Report

August 2023

Executive summary

1. A redevelopment programme for Overseer to address key concerns raised by the Science Advisory Panel (SAP) review was established following advice from a technical advisory group (TAG) in late 2021.
2. The Overseer redevelopment programme addressed the following issues raised by the SAP:

   - *assessment and testing of different model development approaches to improve the use of climate data.*

     This work has been published on the Overseer website. The work concluded that nitrate-loss estimates using different datasets were statistically comparable. Overseer also updated the 30-year average data used in the model to the most recent 30-year period and a more spatially representative dataset (i.e., farm-level simulated weather compared with a regional average).

   - *improving the model to improve both the representation of deeper rooting plants and crop parameterisation for new and existing crops, work to examine N-mineralisation.*

     In December 2022 and April 2023, new versions of the OverseerFM software were released that incorporate the crop model work.

     Overseer has prepared two reports on N-mineralisation that are being peer reviewed. These will be released by Overseer when the peer review process is complete.

   - *developing and testing approaches to improve the current hydrology model to incorporate transport of water and nutrients through different soil layers.*

     This work was published on the Overseer website and Overseer is working to see how this can be further improved and incorporated into future versions of OverseerFM.

   - *improved sensitivity, uncertainty and sensibility analyses for the farm systems modelled in Overseer.*

     The sensitivity, uncertainty, and sensibility analyses have been published on the Overseer website. The work quantifies uncertainty in the N-loss estimates related to key climate parameters, and identifies the model parameters that most significantly alter Overseer's N-loss estimate at the farm level.

   - *greater transparency of the model assumptions and basis, including the development of a managed transparency policy to allow publication of previously unpublished model technical manual chapters, and establishment of a process for allowing the viewing of the science model code.*

     Overseer has established a managed transparency policy to allow access to the Overseer code, and it has published the remaining technical manual chapters and the reports from the redevelopment work.

3. The development programme was delivered by Overseer in conjunction with researchers from NIWA, Plant & Food Research, Manaaki Whenua/Landcare Research, and AgResearch.

Technical Advisory Group meetings

4. MPI reconvened the TAG in July 2022 and September 2022 to review the Overseer redevelopment work. The TAG noted that the redevelopment work was completed to a high standard. Further, the TAG agreed, in principle, that the redevelopment work improved the Overseer model and addressed the key technical concerns raised in the SAP review around Overseer's ability to estimate nitrate loss. This increased their confidence in the use of Overseer for the proposed limited-use case of estimating nitrate leaching.
5. The TAG, however, suggested that validation work, comparing the Overseer modelled nitrate loss against observed nitrate loss, should be completed before they were comfortable endorsing Overseer's use as an input into freshwater farm plans. The TAG noted that this validation work should be used to inform guidance material for regional councils.
6. Overseer completed validation work that compares Overseer modelled N-loss against N-loss observations. The work was peer-reviewed by AgResearch and shared with the TAG in mid-June 2023.
7. The validation used internationally accepted performance measures for nutrient models. These performance measures show that the Overseer model produces "very good" results in estimating nitrogen leaching from grazed pastures and "satisfactory" and "good" results for cropping data. This analysis further improves the confidence in the use of Overseer for estimating nitrate loss from grazing systems

and, importantly, in cropping systems used for summer and winter feed on dairy and drystock platforms, a key source of nitrate loss in some dairy systems.

8. The Overseer validation work is comparable with other work that shows a strong correlation between measured and modelled nitrate loss data. This provides further confidence for users of the Overseer model.
9. MfE has revised its guidance for how Overseer may be used to support regulation. The guidance has been revised considering the outputs from the Overseer redevelopment programme.
10. The TAG considered how the redevelopment programme addressed the SAP concerns in the Government Response to the findings of the Overseer peer review report. The TAG discussion has been captured in a revised table that has been copied below.

11. SAP concerns listed in the Government Response to the findings of the Overseer peer review report.

SAP concerns	Programme generated additional knowledge?	Additional gaps for consideration	Has the work been published or incorporated into the OverseerFM model?
1. *uses average climate data and, therefore, cannot model episodic events, or capture responses to climate variation.*	Yes, additional knowledge generated. No significant difference found between daily averaged and annual averaged data. Terms of use generated to clarify appropriate use-case of the model.	Additional validation work would further improve confidence. Work is required to understand the potential to add episodic events to the current scope of the model. See considerations relating to SAP concerns #5 and #6 below.	Yes – the work is available on the Overseer website. https://www.overseer.org.nz/our-science See appendix of 2023 model assessment report for terms of use.
2. *does not account for variation in water and nutrient distribution in the soil profile.*	Yes, additional knowledge generated through development of multi-layer soil hydrology model. The single-layer hydrology model was validated but a multi-layer approach has potential to add value once research into nutrient transport is available.	Additional validation work would further improve confidence in the current hydrology model.	Yes – the work is available on the Overseer website. https://www.overseer.org.nz/our-science Additional research is required before the multi-layer hydrology model can be incorporated into OverseerFM.
3. *does not adequately accommodate deep-rooting plants.*	Yes, additional knowledge generated through new versions of Overseer that incorporate results. Additional crops added and new way of adding crops developed.	Additional validation work would further improve confidence.	Versions of OverseerFM released in December 2022 and April 2023 incorporate this work into the OverseerFM model. The work is available on the Overseer website. https://www.overseer.org.nz/our-science

4. *lacks consideration of surface water and nutrient transport, as well as critical landscape factors.*	None generated.	Government decision to limit use case for Overseer in regulation to subsurface drainage losses of nitrate and with no extreme episodic events (landslips, severe flood etc) largely removes this as a material concern.	Overland runoff is already modelled as a part of the hydrology model (see section 3.5 of hydrology Technical Manual Chapter). Representing sediment runoff is out of scope for a steady-state model (see #6 below). The hydrology TMC is now available on the Overseer website. https://www.overseer.org.nz/our-science
5. *focuses on nitrate and omits ammoniacal nitrogen and organic matter dynamics.*	Yes, some aspects of this concern were addressed. Overseer is drafting reports on N-mineralisation. No additional work on ammoniacal nitrogen.	Further research required to identify when ammoniacal nitrogen is a significant contributor to N-loss on the farm. Government decision to limit use case for Overseer in regulation to subsurface drainage losses of nitrate largely removes this as a material concern.	N-mineralisation work will be published in 2024.
6. *is a steady state model was attempting to simulate a dynamic, continually varying system.*	Terms of use generated to clarify appropriate use-case of the model. See appendix of 2023 model assessment report.	Acknowledged that the model is a steady state model that uses long-term averages. This does not undermine the model's validity. The model provides a longer-term average of nitrate loss from subsurface drainage. The validation work demonstrates that Overseer does a good job of modelling nitrate loss against observations.	Yes – the work is available on the Overseer website. https://www.overseer.org.nz/our-science
7. *uses monthly time-steps.*	See SAP concern #1 above.	Government decision to limit use case for overseer to subsurface drainage losses of nitrate largely removes this as a material concern.	Yes – the work is available on the Overseer website. https://www.overseer.org.nz/our-science

8. does not balance mass.	Terms of use generated to clarify appropriate use-case of the model. See appendix of 2023 model assessment report.	The SAP report noted that *"If mass is not balanced, the user cannot have confidence in the model outputs…"*. Overseer modelled results have been tested against observations for losses of nitrate via leaching. This work shows that Overseer is a useful decision support system for modelling nitrate leaching in grazed and cropping systems. The Government's limited use case for overseer to subsurface drainage losses of nitrate helps to limit this concern.	Yes – the work is available on the Overseer website. https://www.overseer.org.nz/our-science

Contents

Introduction

This document provides details of the Overseer redevelopment programme, the outputs from the work and the process that MPI followed to review the work. The report is intended to be able to be used as a reference document for the Overseer redevelopment work from its inception to completion.

Context for Overseer redevelopment programme

In 2018, the Parliamentary Commissioner for the Environment raised concerns about the use of Overseer in freshwater regulation. In response to these concerns, the Ministry for Primary Industries (MPI) and the Ministry for the Environment (MfE) commissioned a review of Overseer. A Science Advisory Panel (SAP) was convened for the review and released its report in August 2021. The Government convened an Expert Advisory Group (EAG) to provide advice regarding next steps based on the findings of the report.

One of the Government responses to the SAP review and the advice from the EAG was the "*development of a next generation Overseer to address the issues raised by the Review Panel and ensure that it is fit for purpose as a tool to use in appropriate regulatory settings*".

Establishment of Overseer redevelopment programme

In September 2021, MPI convened a technical advisory group (TAG) to provide advice on the establishment of a redevelopment programme. The TAG comprised science experts, regional council representatives and policy people from MPI and MfE.

The TAG included:

> Ken Taylor (independent co-chair and Chair of the EAG), John Roche (MPI), Ed Butler (MPI), David Burger (DairyNZ), Hamish Brown (Plant & Food Research), Jacquie Harper (Overseer), Andrew Tait (NIWA), Donna Giltrap (Manaaki Whenua Landcare Research and member of the SAP), Damian Diack (MPI), Martin Workman (MfE), Richard Muirhead (AgResearch), Dave Clark (independent and member of the SAP), Mike Scarsbrook (Waikato Regional Council and member of the EAG), Brent Clothier (Plant & Food Research and member of the SAP), Emily O'Connell (MfE), Tim Davie (Environment Canterbury and member of the EAG).

At the September 2021 meeting, the TAG discussed a number of issues raised in the SAP report and came up with several recommendations to explore with Overseer. MPI worked with Overseer to develop a programme of work that addressed key concerns that would be achievable within nine months. The proposed programme of work was circulated to the TAG. The programme of work was agreed between Overseer and MPI in December 2021.

The description of the Overseer redevelopment programme can be found in Appendix 1.

The meeting notes from the September 2021 TAG meeting can be found in Appendix 2.

Overseer redevelopment programme and delivery

Following establishment of the redevelopment programme, Overseer assembled a group of experts to undertake parts of the redevelopment programme work including personnel from AgResearch, NIWA, Manaaki Whenua Landcare Research and Plant & Food Research.

TAG meeting 7 September 2022 – presentation of results

The TAG met on the 7 September 2022. Presentations on the redevelopment projects were delivered to the TAG. These presentations included:

- Climate – Jean-Paul Tavernet
- Model sensitivity and uncertainty – Jean-Paul Tavernet
- Deeper-rooted plants and improved crop parameterisation – Hamish Brown
- Multi-layer hydrology sub model – Donna Giltrap.

The notes from the 7 September 2022 meeting can be found in Appendix 3. The reports related to the presentations are available at the following links.

1. Climate
    - an analysis of the impact of using different climate datasets. The work concluded that nitrate-loss estimates using different datasets were statistically comparable. Overseer also updated the 30-year average data used in the model to the most recent 30-year period and a more spatially representative dataset (i.e., farm-level simulated weather compared with a regional average).

      Link to work: Link to climate data work on Overseer website
2. Model sensitivity and uncertainty
    - publicly available uncertainty and sensitivity analyses. The sensitivity, uncertainty, and sensibility work quantifies uncertainty in the N-loss estimates related to key climate parameters, and identifies the model parameters that most significantly alter Overseer's N-loss estimate at the farm level.

      Link to sensitivity work: Link to sensitivity work on Overseer website

      Link to uncertainty work: Link to uncertainty work on Overseer website
3. Deeper rooted plants and improved crop parameterisation
    - new and improved Overseer model components including, a deeper-rooted plants model and improved crop parameterisation. In December 2022 and April 2023, new versions of the OverseerFM software were released that incorporate the crop model work.

      Link to deeper rooted plants work: Link to deeper rooted plants work on Overseer website
    - Overseer has also prepared two reports on N-mineralisation that are being peer reviewed. These will be released by Overseer when the peer review process is complete.
4. Multilayer hydrology sub model
    - development and testing of a multi-layer hydrology model. This work was published on the Farmed Landscapes Research Centre (FLRC) website and Overseer is working to see how this can be further improved and incorporated into future versions of OverseerFM.

      Link to work: Link to multi-layer hydrology model work on FLRC website

TAG meeting 29 September 2022

The TAG was reconvened on the 29 September 2022 to discuss a number of questions related to the redevelopment programme. These included:

- How has the redevelopment programme has addressed the key concerns raised in the SAP report. The discussion was guided by the SAP concerns that were listed in the Government's response to the SAP review.
- What data gaps exist for Māori and how does data inequity impact Māori Overseer users? What next for the Māori work?
- Given the reports and potential for changes to Overseer, how could Overseer be used to support regulation? What limitations does the TAG consider are warranted in the use of the redeveloped Overseer within the regulatory environment?
- Is the uncertainty acceptable for a model? (a key issue that the SAP raised in the report).
- Given the potential options for the redevelopment work – can the model be relied on to determine direction of travel? (another issue the SAP raised in the report).
- Previous Guidance- what worked well or didn't with the previous guidance – does it need to be more specific, less specific etc.

The TAG noted that the work was complete to a high standard and had improved the confidence in the model. To provide evidence of Overseer's performance, the TAG requested that Overseer complete validation work, comparing modelled nitrate loss against observations of nitrate loss.

The notes from the 29 September 2022 meeting can be found in Appendix 4.

Validation work and close-out meeting

At the 29 September 2022 meeting, the TAG requested validation work to provide some evidence on the model's performance against measured data. Overseer completed the validation work in June 2023 and this was presented to the TAG on the 19 June 2023.

The validation work used internationally accepted performance measures for nutrient models outlined in a paper published in the Transactions of the ASABE (American Society of Agricultural and Biological Engineers) in 2015. This is the link to the paper: Hydrological and Water Quality Models Performance Measures and Evaluation Criteria.

These performance measures show that the Overseer model produces "very good" results in estimating nitrogen leaching from grazed pastures and "satisfactory" and "good" results for limited the cropping data available. The Overseer validation work is comparable with other work that shows a strong correlation between measured and modelled nitrate loss data. This provides further confidence for users of the Overseer model.

At the meeting, MPI noted that the 19 June 2023 meeting would represent the final meeting of the TAG. The TAG was convened to review the redevelopment work, which was now complete.

The notes from the 19 June 2023 meeting can be found in Appendix 5.

Following feedback from the TAG at the 19 June 2023 meeting, Overseer prepared an addendum to the validation report that covered:

- distributions of the measured and modelled N leaching
- outlier management
- updating graphs with the latest version of Overseer (6.5.2 – 25 June 2023)
- comparison with some cropping systems, and
- short notes on scenario analysis.

The final validation report is being prepared by Overseer to include the additional information. This will be available on the Overseer website in September 2023.

MfE advice on the use of Overseer

Following the completion of the Overseer redevelopment programme, MfE updated its guidance for councils on the use of Overseer in a regulatory environment.

The updated guidance can be found at this link: Responding to the overseer model redevelopment review a guide for councils

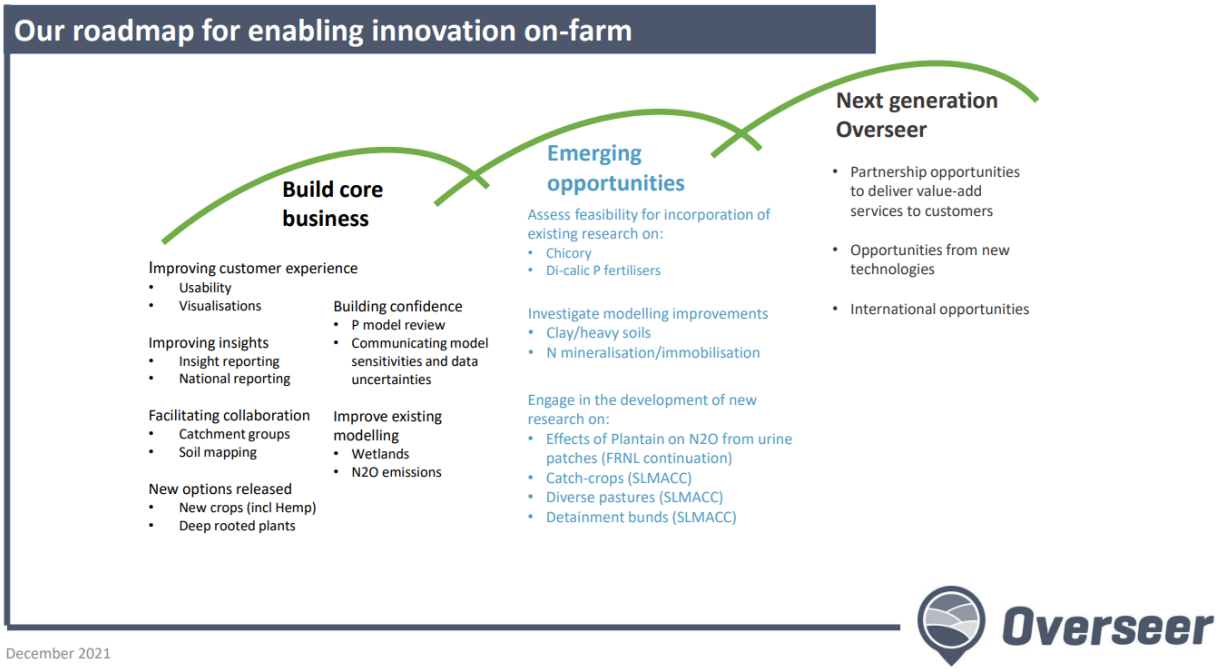
Consideration of Māori in Overseer

The SAP and the EAG both made recommendations around the involvement of Māori in the development, testing and deployment of nutrient management tools. During the TAG meetings, the issue of inequity of coverage of SAMP on Māori land was raised. This has a greater effect on whenua governed under Te Ture Whenua and may impact regulatory decisions resulting from use of the nutrient tools (including Overseer). The TAG noted that there was a need to better understand the scale and scope of the issue as it relates to Overseer, including uncertainty and sensitivity tests associated with Māori land.

A piece of work is continuing to be scoped with Overseer to examine this.

Overseer development roadmap

In December 2021, Overseer established a roadmap for the ongoing development and testing of Overseer. The roadmap is being updated to include the latest information from the redevelopment programme. The updated roadmap will be released on Overseer's website in the second half of 2023.



Appendix 1: Description of Overseer redevelopment programme

Overseer Science Redevelopment Plan

Following the publication of the Government's response to the Science Advisory Panel's Overseer whole-model review MPI has made a commitment to invest in redevelopment work on the Overseer science model.

The following Science Model Redevelopment Plan for FY 2022 has been agreed between Overseer Ltd and MPI. The Plan incorporates MPI's request to investigate:

(1) Daily climate data for each property, without any additional user input, with annual simulations averaged to provide a long-term annual average;

(2) A multi-layer soil hydrology sub-model that reflects soil hydrological dynamics during drainage;

(3) Modelling soil N mineralisation and immobilisation under arable/cropping as important processes influencing Nitrate leaching;

(4) Uncertainty and sensitivity reporting on the model;

(5) Model transparency.

The plan has been informed by the Overseer Technical Workshop (28 Sept 2021), Overseer Ltd's previous science projects and discussions with scientists at AgResearch, Plant & Food Research, NIWA, and Manaaki Whenua Landcare.

Project 1: Daily climate data and long-term climate averages

Goal: *To determine the impact and feasibility of changing the current modelling for climate.*

Aim: *To assess the impact of using daily climate data, and different climate data averaging approaches, on the N-leaching estimate from the Overseer science model.*

Project summary:

The Overseer science model predominantly uses long term climate averages and a monthly timestep to calculate N-loss estimates. The exception to the latter is the hydrology model which currently applies a scaled daily climate pattern.

This project will investigate:

1. *How different averaging approaches impact on long-term N-loss estimates.*

This work will compare the N-loss estimate using the current modelling approach (30-year averaged climate) with the N-loss estimate from averaging 30 individual climate years.

2. *The impact on long-term N-loss estimates using "real" daily climate data compared to the (current) daily climate pattern.*

This work will investigate the use of daily climate data compared with the current daily climate pattern in the hydrology model. It will determine the impact on N leaching estimates, and test the feasibility of using daily climate inputs in the hydrology model including the impact on both model functionality and uncertainty. This will also provide insight into the feasibility of using daily climate across the whole model.

The results of the project will provide key information on the impact of using daily climate and averaging individual climate years and identify feasible changes to the current modelling approach to inform any next steps in model analysis and development

Delivers:

- *Feasible pathway for climate model development identified and tested.*

Project team: Overseer Ltd, NIWA, AgResearch.

Project 2: Soil N mineralisation and immobilisation, and crop model developments

Goal: *To improve confidence in the representation of crop/arable systems in the Overseer model.*

Aim: *To deliver model development updates for soil N mineralistion, deeper-rooted plants and crop parameters.*

Project summary:

The Overseer review identified a need for improvement in the crop model including N-mineralisation and deeper-rooted plants. This project will undertake model development in the following:

1. Soil N mineralisation.

This work was scoped in FY2021. Model development will focus on two primary sources of organic matter that contribute to decomposition and release of mineral N- Plant Residues (N_{res}) and Soil Organic Matter (N_{SOM})

a. Plant residues – Review latest science (literature and data) to refine, redefine and/or confirm model coefficients and assumptions relating to N_{res}.

b. *Soil organic matter – Investigate replacing the current model for mineralisation with the latest Beare et al (2020) model that better represents the multiple factors that impact the N_{som} pool.*

Reference:

Beare MH, Curtin D, Tregurtha C, Gillespie R, Qiu W, Arnold N, McDougall S. Mineralisable nitrogen to improve on-farm nitrogen management: Year 1 field trials report. A Plant & Food Research report prepared for Ministry for Primary Industries and project partners. Contribution to Milestone No. 83146. Contract No. 37307. Job code: P/441011/01. PFR SPTS No. 20254.

2. *Deeper-rooted plants.*

Simulation studies on different deeper-rooting plants in FY2021 identified the potential for overestimation of N-leaching for some deeper-rooted crops. This work will therefore confirm and implement the changes required to adjust the current model for decreased leaching as root depth increases, below the 60 cm root zone. It will include running simulations in an alternative model (with multilayer, dynamic time step) to derive a defensible empirical adjustment.

3. *Crop parameters.*

Previous work undertaken in FY2021 has identified ways to adjust the current crop model parameters to improve and facilitate representation of the range of different crops in New Zealand. This work will deliver changes to biomass, cover and harvest index parameters to more accurately profile different crop patterns, decrease data requirements for crop parameterisation, and simplify both the addition of new crops and review of existing crops.

The results of this project will define the model improvements for implementation in the Overseer model'. These changes will improve the accuracy of and confidence in the crop model with respect to N-mineralisation, modelling N-uptake below 60 cm, appropriate crop representation, and facilitating the addition, review and update of crops in Overseer.

Delivers:

- *Model redevelopment to incorporate deeper rooted plants.*
- *Model redevelopment to improve and simplify crop parameterisation.*
- *Model implementation and testing plan to update N-mineralisation.*

Project Team: Overseer Ltd, Plant & Food Research.

Project 3: Model Testing – Sensitivity, uncertainty and sensibility analyses

Goal: *To build confidence in Overseer's N-leaching estimates and comparison of N-leaching estimates for different management scenarios (reliable representation of direction of travel).*

Aim: *To provide more information on model sensitivity, uncertainty and sensibility for the N-leaching estimates for the farm systems modelled in Overseer.*

Project summary:

This project will expand on the targeted sensitivity and uncertainty analysis of the current model structure, completed in FY2021. The approach uses real farms in OverseerFM to investigate overall model sensitivity and output uncertainty at the point of operation, across New Zealand. Previous analyses (local and global sensitivity and climate uncertainty) focused on N-leaching in dairy farm systems in the first instance. Interim results include confirmation of highest model sensitivity to drainage and climate and that average uncertainty due to the input climatic parameters on the estimated N leaching is 25%, across the different farms in the analysis.

The next phase of work will:

1. Expand the sensitivity analysis to cover other farming systems (beef and sheep, cropping). It will extend the uncertainty analyses for the different model parameters and inputs identified as linked to model sensitivity (climate, soil etc) i.e. those most likely to contribute to significant output uncertainty. A challenge will be obtaining uncertainty information where it is not currently available. For example, it will be necessary for Manaaki Whenua Landcare to generate the uncertainty information required for soil parameters (discussions underway).

2. Test model sensibility to ensure that the current model outputs change as expected in response to changes in farm management practices, and other parameters, using the point of operation (real farm systems) approach.

3. Upgrade existing, and add new, analytical and testing functions to Overseer Ltd's research tool, Overseer Sci. This is required to support the delivery of the sensitivity, uncertainty and sensibility analyses, and will also provide the framework to establish an improved business-as-usual Model Testing Platform for ongoing review and assessment of model performance and reliability.

The results of this project will identify and quantify some of the key sensitivities in the model, identify inputs and parameters most likely contributing the greatest uncertainty in N-leaching estimates, and determine output uncertainty relating to those inputs/parameters - for the farm systems in Overseer. These results can then be used, in combination with sensibility testing, to better inform stakeholders of the confidence limits around Overseer's N-leaching estimates and comparative analyses (direction of change).

Delivers:

- *Targeted sensitivity, uncertainty and sensibility analysis reports on the Overseer model for dairy, beef and sheep, and crops.*

Project Team: Overseer Ltd, NIWA, Manaaki Whenua Landcare, Plant & Food Research, AgResearch.

Project 4: Multi-layer hydrology sub model

Goal: *Introduce a multi-layer hydrology sub-model in Overseer.*

Aim: *Develop a 60 cm multi-layer hydrology sub-model in Overseer.*

Project summary:

Overseer currently tracks the amount of water and N in the top 0-60 cm of the soil, but does not account for the vertical distribution down the profile. This project will:

a. Develop a pathway to update the current hydrology model to model the transport of water and nutrients down through different layers (e.g. 10cm) over time. A starting point is to use the same soil data for each depth range within the current 0-60 cm root zone. This approach could then be expanded to use different soil parameter values at lower depths as appropriate data becomes available.

b. Review the soil data availability, and future needs, to expand the multi-layer model for different depths below 60 cm.

The results of this project will deliver the first stage of a multi-layer hydrology sub-model (60 cm) that can be expanded on as more soil data becomes available.

Delivers:

- *Stage one multi-layer hydrology model update (60 cm).*
- *Review on current data availability and future data needs for further hydrology model development.*

Project Team: Overseer Ltd, Manaaki Whenua Landcare, AgResearch, University of Waikato.

Project 5: Model transparency

Following authorisation to publicly release the remaining documented OVERSEER Nutrient Budgets Technical Manual Chapters by the Overseer IP owners (expected in November 2021) the following chapters will be available to download from https://www.overseer.orq.nz/our-science:

- *Animal Intakes*
- *Animal Model*
- *Block Nutrient Budget - Suphur*
- *Characteristics of Crops*
- *Crop based N submode!*
- *Distribution of Farm Data to Block Scale*
- *Effluent Management*

- *Urine Patch Model*

As with the existing published changes, these chapters will be amended should any changes to the model be implemented.

By the end of March 2022, Overseer Limited will have in place the systems to implement the Overseer Managed Transparency Policy.

Access to farm analysis information/data.

Overseer agrees to provide MPI and MfE continued access to aggregated and anonymised farm analysis information from the OverseerFM system for the sole purpose of freshwater and greenhouse gas policy and programme development including N, P and GHG loss information at a national and regional scale and per enterprise type, subject to data quality analysis.

Overseer contracted milestones and timing of delivery outlined on following page.

Q1 immediately	Q2 end 24 December	Q3 end 30 March	Q4 end 30 June
• Science Redevelopment Plan agreed and signed off.	Third party science contracts signed and underway. All farm systems sensitivity analysis and climate uncertainty analysis complete. OverseerSci update scoped. Comms strategy agreed.	• *Uncertainty analysis for soils complete and analyses for other priority parameters/inputs underway.* • *Sensibility analysis framework confirmed and analyses in progress.* • *Climate data analyses complete and feasibility analyses for redevelopment options in progress.* • *Recommended model redevelopment confirmed for deeper- rooted plants, crop parameterization and multi-layer hydrology model (phase one)* • *OverseerSci upgrade.* • *Communication plan in place confirming communication channels and format (messaging) for different audiences#.* • *Interim progress communicated as appropriate*	• *Sensitivity, Uncertainty and Sensibility analyses complete.* • *Feasibility analyses for climate redevelopment complete.* • *Implementation and testing of agreed model redevelopment changes (climate*, crop, phase one multi-layer hydrology model).* • *N-mineralisation recommendations confirmed – implementation & testing plan in place for Q1 FY2023.* • *Review of multi-layer hydrology modelling below 60 cm complete.* • *Validated model redevelopment changes released.* *Communication of programme delivery to stakeholders and users including:* • *Model changes* • *Impact of model changes - Overseer N-loss estimates* • *Confidence – Model improvements, direction of travel, confidence limits e.g uncertainty* • *OverseerSci user guidance*
		#informed by stakeholder feedback	*Hydrology model daily timestep and climate averaging – informed by feasibility analyses
	Publication of confidential TMC's on Overseer Website	Implementation of the Managed Transparency Policy	
Product hosting	Product hosting	Product hosting	Product hosting
Product maintenance	Product maintenance	Product maintenance	Product maintenance
Helpdesk services	Helpdesk services	Helpdesk services	Helpdesk services

Appendix 2: Notes from Overseer Technical Advisory Group review meeting 28 September 2021

Overseer Technical Workshop

Rydges Wellington, 28 September 2021. 10.00am – 4.00pm

Attendees

Ken Taylor, John Roche, Ed Butler, David Burger, Hamish Brown, Jacquie Harper, Andrew Tait, Donna Giltrap, Damian Diack, Martin Workman, Richard Muirhead, Dave Clark, Mike Scarsbrook, Brent Clothier, Emily O'Connell, Tim Davie

Introductory comments from co-chairs Ken Taylor and John Roche

The chairs noted that the meeting was not to relitigate the Overseer SAP report, but to provide input into a redevelopment programme for Overseer.

Having contextualised the report, from a freshwater regulatory use perspective, it was decided that Overseer's use case should be for nitrate leaching; one of the points of discussion today is whether the use-case definition should be narrowed to just pastoral agriculture.

The discussion should focus around what is needed to provide the evidence base for meeting water quality objectives and delivering tools that help users deliver to freshwater goals.

The review noted several key areas in which Overseer could improve including:

- *climate*
- *soil physics and drainage*
- *soil heterogeneity*
- *soils immobilisation/mineralisation.*

1. Climate data

There was general agreement from the council representatives that the development programme needed to improve confidence in the Overseer model from both councils and farmers. The model also needs to be able to drive tangible change through farmer action. The representatives made it clear that they were interested in long-term averages for their work and were not interested in daily model runs.

It was noted that climate data are modelled for Overseer using recorded data from approximately 250 automatic weather stations. The model resolution provides simulations down to 500m (for long-term average monthly values) and 5km (for daily values) grid squares for climate data across the country. This provides a simulation of climate data for each property. These are interpolated data and may differ slightly from observed data, but there is relatively high confidence in them for the agricultural landscape. NIWA has updated the long-term 30-year average dataset that Overseer uses from 1981-2010 to 1991-2020, as per international best-practice. Overseer noted that they have incorporated the new data from NIWA into the model.

Conclusion

Overseer is using a 30-year average profile of farm-level simulated model data; there was general agreement that this represents a significant improvement on the regionally specific rainfall profiles that were used when the Science Advisory Panel assessed Overseer.

Overseer is currently undertaking an analysis that examines how the output from the model changes with different temporal datasets. An initial estimate is that there is a 10% difference in the model output when 30 annual simulations are performed relative to a single simulation using 30-year average data. Additional work involves using daily rainfall data (at every 5km) compared with regionally representative daily rainfall profiles. Overseer will share the analysis with the wider group once it has been completed. This will provide a greater understanding of the model sensitivity to climate inputs, facilitate the inclusion of variability in output prediction, and give greater confidence to users on the materiality of farm management changes on long-term freshwater quality.

The inclusion of climate work in the development programme will be informed by the climate analysis work already underway.

The group discussion was wide ranging and covered:

- *The timestep used (e.g. 30 years, 20 years, etc) is important for councils to set limits and for landowners to be able to manage nitrate loss. These may be different, but Overseer is able to do both depending on the user.*
- *There needs to be a way to reflect the variability in climate. This could be done with error bars, standard deviation, probability distribution etc. The analysis work Overseer is doing with different datasets will help to inform this.*
- *Overseer is working on different ways to best represent uncertainty in model inputs. Using the standard deviation and average etc. The 30-year mean is defined as a typical representation of the current climate (according to the World Meteorological Organisation). There are multiple ways to cut this dataset and output the data.*
- *Although councils are interested in the long-term average data, the dataset is made up of shorter-term information, which could help in predicting "the hot moments" (autumn flush of N for example). This might be useful for the development of the other tools for council to estimate farm-level losses.*

Soils – physics and drainage

Although the council representatives noted that it is important for the soil model to be more realistic, Overseer currently uses the most up to date soils information from S-Map. Availability of accurate soil data will continue to be a limiting factor. The S-MAP data are updated regularly and new data are used by Overseer. There is acknowledgement that there is a high level of variability in soils across catchments and in many cases, within farms. Currently, Overseer uses an average input for soils although users can add additional data.

It was noted that there are two soils models in Overseer, a 60 cm model and a 1.5m model. These two models are a quirk of adding crop models to Overseer. The Nitrogen balance works to 60 cm and the crop model works to 1.5m for moisture. This looks untidy, but it is materially unimportant. Nevertheless, it was agreed the discrepancy should be tidied up.

It was noted that adding layers to the hydrology model will slow the transport of nutrients and may have the effect of a management change on the farm not showing up in leaching estimates until 2-3 years down the track. Understanding and/or accounting for this lag effect will need to be included in any decisions around revisions to the model.

The issue of management changes to soil physics and drainage was briefly discussed but no conclusions reached. This includes managements such as artificial drainage, soil flipping, contouring and animal treading effects such as pugging. These are important factors for nutrient losses but are not inputs that are, or can be, included in soils databases.

Plant & Food Research has recently finished investigating the potential impact of modelling N-leaching below 60 cm in Overseer. This work indicates gains (~10% less leaching) may be made for some deeper-rooted plants if the model is extended below 60 cm.

The scope of the soils work will be partly informed by the review and modelling work that Plant & Food is doing.

Parts of the arable sector have expressed a lack of confidence in the Overseer model for use in cropping industries. It is not clear what it would take to gain this confidence. It was agreed that modelling for crops in Overseer is important as dairy farm systems are increasingly using a range of crops for feed, and arable and drystock industries often co-exist in one enterprise.

2. Soil mineralisation

Soil mineralisation and immobilisation changes temporally and Overseer does not account for this. In addition, Overseer makes assumptions about the current state of soil at the start of a run. Both of these points can impact the final modelled number, particularly for non-pasture uses. Are there ways to improve this?

There were a number of discussion points that relate to accurate data:

- *It is unclear how Overseer currently accounts for mineralisation and immobilisation. Overseer currently uses inputs of years in pasture and months since cultivation to account for soil mineralisation processes. We need to understand how effective this is compared to a more dynamic modelling approach.*
- *Overseer does not model well with incorrect levels of residues from crops. Residues needs some work.*

One option to improve the predictability of Overseer was to ask arable farmers for a measurement of soil mineralisable nitrogen levels as an input into Overseer. This would help estimate N contribution from the soil N pool and improve estimates of losses. This could also be used by farmers and councils to monitor best practice use of fertilisers.

Mineralisation tests can be done relatively easily and cheaply, which would create meaningful accurate data in the system.

Last year Plant & Food Research reviewed mineralisation and immobilisation under crops in Overseer (identified as a concern by the sector and previous model reviews) and a project to improve how these are modelled has already been scoped.

3. Sensitivity and uncertainty

The sensitivity and uncertainty work will provide greater understanding of the effect of variability/accuracy of inputs on Overseer outputs and help to build confidence in the model.

Overseer has already completed some sensitivity analyses to formally identify the inputs/parameters that have the greatest material impact on the nitrate output. Complimentary uncertainty analysis on climate is completed and Overseer is in discussion with Manaaki Whenua to investigate uncertainty in key soil parameters. This has included discussion on data availability relating to soil profiles at depth that may be useful for informing the soils review. Model sensitivity analyses have looked at P and greenhouse gases but mainly focus on nitrate. Analyses are based on real Overseer farms that allow investigations into operational variability including at regional level. Pilot work has focussed on dairy farm systems with the intention to expand analyses to beef and sheep, and crops.

To improve the confidence in Overseer, the sensitivity and uncertainty work must be undertaken comprehensively and should be published and made available in an understandable format for users. It is vital that there is an independent peer review process for the changes in the model to demonstrate a level of independent assessment of the model.

4. Final thoughts from attendees

The co-chairs thanked the group for a good and constructive discussion. It was noted that there could have been a bit more detail around the work programme. The record of the meeting will be distributed to everyone soon. It was also noted that the soils discussion didn't yield as much as expected, but on reflection probably wasn't going to yield much more. The co-chairs were happy with where the group got to and appreciated that everyone turned up and was positive. There was an apology that Māori representation was not strong in the meeting and it was noted that there will be a stronger te ao Māori perspective represented at the Governance and Working Group levels and the development of this work.

Comments from the group included:

- *got enough to build a development programme.*
- *the sensitivity and uncertainty work is really important. We also need to understand the specific requirement for Overseer in policy, and what constitutes good enough for the regional councils and farmer confidence, when considering the specific use of the model and its outputs. Would like to see MfE lead a piece on the additional uncertainties of lag time and attenuation in load between where Overseer modelling stops and water quality monitoring starts. There is no point having a highly refined farm nutrient loss model if there is still considerable uncertainty in load dynamics at other scales, if the actions famers need to undertake are clear and will deliver on the trajectory of change towards the end point.*
- *discussions were easier than he expected. The review was concerned that Overseer was a steady-state model and that this wasn't appropriate. The discussion did not cover this.*
- *big thing on the confidence and the direction of travel. The sensitivity and uncertainty analysis will feed into this. Climate and soils are key to this.*
- *still need to consider if we are talking about the need for dynamic climate data or are we looking at a long-term scenario tool (subsequent discussion confirmed the latter). Noted that climate information is available in real-time to measure recent trends and if this is important for councils.*
- *if a big aim is confidence, then some level of independent peer review is needed here. Not just internal peer review.*
- *good discovery day. In terms of having something that we can work with – relatively confident.*

- *good discussion. Don't think we've nailed the scope for how we want to use Overseer. There is a needs analysis to come from the councils. Over what timeframe are we modelling for? What is Overseer being used for?*
- *encouraged by the climate work that Overseer is doing. Would like to see the climate work tidied away.*
- *lots of public money has been spent on removing nitrogen out of catchments. There is still not confidence in the model to take the nitrogen out of the system. Need to determine what difference we will be able to drive at the catchment level. If we want to measure land-use intensity, how do we measure this and how do we monitor this? If we want to remove nitrogen from a catchment, how do we measure it and monitor it?*
- *great start with the climate data work. It would be nice to know if we're there yet. For wider confidence it would be great to have this published so people know what's been done. How complex do we need the model to be? A summary of this need to be fed back to the SAP. Engagement with Māori was not done well today.*
- *there has been positivity around what can be done and what has been done.*
- *encouraging that some of these things can be done simply. Sensitivity analysis being done is good. If we can get the climate work nailed, then that will go a long way to giving confidence. From a policy setting – the councils don't need this information, but the farmers need this information if they want to effect change.*

5. Next steps

MPI will work with Overseer to draft a high-level work programme. This will be circulated to participants for comment. We expect this to be within the next 1-2 weeks.

Appendix 3: Notes from Overseer Technical Advisory Group review meeting 7 September 2022

Attendees
Alistair Smail, Andrew Tait, Brent Clothier, Damian Diack, David Burger, Donna Giltrap, Ed Butler, Gabby Storey, Gerard Willis, Hamish Brown, Jacquie Harper, Jane Chrystal, Jean-Paul Tavernet, John Roche, Ken Taylor, Martin Workman, Michelle Sands, Mike Scarsbrook, Nic Peet, Reina Tamepo, Richard McDowell, Richard Muirhead, Robyn Dynes, Selai Letica, Tanya Cornwall, Tim Davie, Turi McFarlane, Victoria Bloomer, Wiremu McMillan
Apologies
Christina Robb, Chris Daughney

Notes from meeting

Scene setting – Jacquie Harper

Jacquie noted that Overseer had some work in the general areas identified by the Science Advisory Panel underway prior to release of the SAP report including:

- *scoping work for deeper rooted plants.*
- *scoping work for sensitivity analyses and uncertainty.*
- *updates for the climate data set and examining long-term annual to long-term monthly work.*

The development programme used some of this early work to frame up the redevelopment programme.

Climate – Jean-Paul Tavernet

Jean-Paul Tavernet, Jacquie Harper, Warren Cheetham, Steve Gellatly and Kahu Kirikiri from Overseer and Andrew Tait from NIWA completed the climate work and the peer review was done by Dr Edmar Teixeira.

The model uses monthly data. Daily data is used by one component of the model. Longer-term N-loss is developed from long-term and short-term climate data.

Monthly climate data uses 500m grid squares (virtual climate network) and daily climate data uses 5km grid squares.

Jean-Paul presented data from the report.

See key points from work in attached presentations

Questions/comments

- *The climate report notes that inputs for individual management practices will be required for a daily climate step. What's the feasibility of this? Moving to a daily time step will require a significantly increased level of user data, which would be unrealistic.*
- *When Overseer moved from using a long-term annual to a long-term monthly climate average, what happened to the N-loss output? The Overseer release notes for the climate work included information on how this affected model output. [Link to Overseer V6.4.0 release notes]*
- *There doesn't appear to be any significant skew for rainfall amount. Does the model predict rainfall consistently? The bias in the Overseer rainfall prediction reduces for higher rainfall areas.*

Model sensitivity analysis and uncertainty – Jean-Paul Tavernet

Jean-Paul Tavernet and Jacquie Harper from Overseer, Andrew Tait from NIWA and Linda Lilburne from Manaaki Whenua Landcare Research completed the sensitivity and uncertainty work and the peer-review was done by Donal Krouse from Callaghan Innovation.

Jean-Paul presented data from the report.

The work set out to quantify the relationship between model inputs and the model output.

See key points from work in attached presentations

Questions/comments

- *It was clarified that the uncertainty work focused on the input parameters with drainage and rainfall being the focus of the work as key parameters.*
- *It was clarified that cropping was included in the sheep and beef farm systems uncertainty work.*
- *There does not appear to be any response in Nitrogen-loss when changes are made to the number of animals (i.e., stocking rate). The interactions between feed supply and animal numbers are complex and the sensitivity analysis of Overseer cannot account for interacting management factors, like lactation length, when stocking rate is adjusted.*
- *If rainfall and soil information are major drivers of uncertainty, was there any uncertainty analysis work done in areas that have no S-MAP coverage (use the Fundamental Soil Layer instead) and no virtual climate station network data (coastal areas)? It was noted that this analysis was not done.*

Deeper rooted plants – Hamish Brown

Hamish Brown and Rob Zyskowski from Plant & Food Research completed the deeper-rooted plants work and the peer-review was done by Jeff Reid. Hamish Brown noted that the comments from Jeff Reid were constructive and some aspects of the report were changed as a result of the feedback.

Hamish Brown presented results from the work.

The work used the APSIM model for simulations of root depth. This included application of a number of root-depth treatments down to 1.5m and a number of scenarios with respect to other inputs.

See key points from work in attached presentations

Questions/comments

- *There was a discussion about the lack of knowledge about how parameters interact deeper in the soil profile. It was acknowledged that the deeper the soil profile is modelled, the less we know.*
- *There was a discussion about the convergence of the deeper-rooted plants work and the multi-layer hydrology sub model. Hamish noted that this was something that could be examined in the future, but it would take time to bring these models together.*

Crop parameterisation – Hamish Brown

Hamish Brown and Edith Khaembah from Plant & Food Research completed the crop parametrisation work and the peer-review was done by Jeff Reid.

Hamish Brown presented the data from the report.

There has been lots of work in the past on adding crops to Overseer. The Overseer crop model has been simplified to add new crops into Overseer more easily. Some of the crop parameters are calculated internally.

See key points from work in attached presentations

Questions/comments

- *The presentation noted that users can input predicted yield rather than use the default modelled yield from Overseer. This is seen as an improvement as growers usually have a good understanding of yield so the modelled data should improve as a result.*
- *From a vegetable grower's perspective, what are the uncertainties with certain types of vegetable rotations? Currently, there are still a lot of unknowns with vegetable crops and uncertainties will remain until new vegetable crops are added. Some work is underway to improve the number of crops included in the model, which will reduce the uncertainties.*
- *How much modelling of tree crops has been done in Overseer? While there are some tree crops in Overseer, having a deeper-rooted component in Overseer will improve the modelling associated with this. It was noted that there is a lot of information around tree crops that could be used for bringing new crops into Overseer if the demand is there.*

Multilayer hydrology sub model – Donna Giltrap

Donna Giltrap, Joseph Pollacco, Scott Graham, Sam Carrick and Linda Lilburne from Manaaki Whenua Landcare Research and Jean-Paul Tavernet from Overseer completed the multi-layer hydrology sub model work and the peer-review was done by Brent Clothier.

Donna Giltrap presented the data from the report.

See key points from work in attached presentations

Questions/comments

- *There was a discussion about k_{sat} values of soils. It was acknowledged that k_{sat} values are set on drainage class of the soil. The k_{sat} values seem quite high and some work was done to examine these, and it was clear that this probably needs more testing. This included comments around the need to examine the water balance models as it seems that these don't predict the saturated soil models well.*
- *There was a discussion about whether testing of the model was done on flat runs. The focus of this discussion was around whether the model accounted for slope and for run-off saturation excess and rather than run-off excess. Donna noted that the model testing was done on flat runs and did not account for slope. Donna noted that this may need some more work.*
- *It was acknowledged that testing the model is very difficult. While there are some data for deeper lysimeters that measure leaching at different levels, there will always be limitations on this type of work.*
- *There was a discussion about the water balance models and acknowledgement that there needs to be more work about the benefits of adopting the new water balance model – particularly based on the early testing work.*
- *Was there any consideration of adding nutrients to the water in the hydrology model? While there is a very close relationship between Nitrates and water, modelling this would require a lot more work and would need to account for difficult to measure variation in reaction rates, mobility components etc.*

Updates and model developments – Jacquie Harper

Jacquie Harper from Overseer described the general deployment process. It was noted that this is a complex and time-consuming process.

Questions/comments

- *There was a general question about the process for the TAG and whether the group "approves" changes to Overseer from the redevelopment work. It was noted that Overseer will make the final decision on uptake of the redevelopment work. This includes the process that Jacquie outlined.*

General questions

Use of tools by Māori

- *How disadvantaged are Māori as users of this tool? This is particularly important when considering the use of inputs like S-Map and the virtual climate network and their coverage with respect to Māori whenua land. It will be important to understand how this may the disadvantage Māori land users and how this could be addressed.*
- *It was suggested that refining the scope of reviews can often be the demise of Māori input into these types of processes. Where do the Māori TAG members sit in this process?*
- *It was acknowledged that there may be some over-arching matters that will need to be raised as part of the report that may be outside of the original scope of the review, but that these matters cannot supersede the purpose of the review – the confirm that the work undertaken by Overseer has addressed the plan agreed on in September 2021.*

Focus for TAG at meeting on 29 September 2022

- *It needs to be clear whether the redevelopment work focuses on total nitrogen loss OR nitrate loss. It would be useful to understand the difference between modelled total nitrogen loss and nitrate loss in the Overseer model.*
- *It will be important to understand the difference that the redevelopment work has made – application of the model before the redevelopment work and application of the model after the improvements have been made.*
- *What is the primary purpose of the improvements? Are these improvements primarily to improve the usability for farmers or are they to improve the certainty for use by regulators?*
- *The group will need to focus in on verifying that the redevelopment work was done to a high degree.*

What do councils need from a tool like Overseer?

- *What do regional councils want from a model? Should we try to model Nitrate loss or risk of Nitrate loss?*
- *The level of uncertainty is a critical part of understanding how to apply models in regulation. What does 27%±9% mean in real terms? It will be important that this is communicated clearly. This needs to be put into context of other model uncertainty.*
- *Following from the uncertainty comment, what output is required for regulation? What do regional councils need and want for this?*
- *The application of using daily data in using Overseer for regulation needs to be understood. What level of resolution and precision do councils need from tools in terms of requirements for national regulation.*
- *It is well-documented that there are very large uncertainties in attenuation and lag times. Provided farm inputs are consistent then comparisons should be able to be made.*

Appendix 4: Notes from Overseer Technical Advisory Group review meeting 29 September 2022

Attendees
Alistair Smail, Andrew Tait (online), Amanda O'Brien (online), Chris Daughney (online), Christina Robb, Damian Diack, David Burger, Dirk Wallace (online), Donna Giltrap, Ed Butler, Gabby Storey (online), Gerard Willis, Hamish Brown, Jacquie Harper, Jane Chrystal, John Roche (online), Ken Taylor, Martin Workman (online), Michelle Sands, Mike Scarsbrook, Nic Peet, Reina Tamepo (online), Richard McDowell, Robyn Dynes, Selai Letica, Tanya Cornwall, Tim Davie, Victoria Bloomer, Wiremu McMillan
Apologies
Brent Clothier, Richard Muirhead

Summary overview of meeting and recommendations
The TAG agreed, in principle, that the redevelopment work has improved the Overseer model and addressed the key technical concerns raised in the SAP review around Overseer's ability to estimate nitrogen losses through sub-surface drainage. This increases the confidence in the use of Overseer for the proposed limited-use case of nitrate leaching. *1. Validation work for the improved Overseer model components needs to be completed as a matter of urgency, so that guidance can be drafted for a limited use case for regional councils.* *2. There is need for MPI and MfE to work in partnership with Māori experts and groups collectively to:* • *develop a deeper understanding of the size and scale of differences in equitable access to reliable input data for nutrient tool use (e.g., climate and soils) and how this can be overcome;* • *(in the context of spatial coverage and information accuracy), to understand the implications of poor S-map and virtual climate data coverage on the confidence that users and regional councils should have in the use of the Risk Index and Overseer as inputs to regulatory decision making.*

Notes from meeting
Scene setting *John Roche provided a very brief overview of the development of the Overseer redevelopment programme. John noted:* • *the time-bound nature of the work programme, which restricted what could reasonably be achieved.* • *the continued focus on nitrate loss for the work. The redevelopment work was not attempting to work on issues that related to other contaminants or non-nitrate species of nitrogen – the agreed position 12 months ago was to limit the use of Overseer by regional councils in regulations that seek to limit nitrate losses.* *Martin Workman noted that MfE wants to provide more clarity in the guidance material for how councils could apply Overseer in regulation. The questions in the Terms of Reference were included to guide the discussion to generate some clarity. This is in part related to the confidence that the councils require in using the tool.* ***How has the redevelopment programme addressed key technical concerns raised in the SAP report?*** *In principle, the TAG agreed that the redevelopment work has improved the Overseer model and addressed the main technical concerns raised in the SAP review about Overseer's ability to estimate losses of nitrogen through sub-surface drainage. This work (including the transparency work and the uncertainty and sensitivity work) has substantially improved their confidence that the model better represents the biophysical world.*

The TAG noted that there was a need for some validation work. This should be completed with some urgency.

See the table at the end of the report for more information on how the redevelopment programme work addressed the key SAP concerns.

- *uses average climate data and, therefore, cannot model episodic events, or capture responses to climate variation.*

This concern particularly related to overland flow losses, which are at increased risk of occurrence during episodic, high-rainfall events. Limiting the use-case for Overseer in regulations to sub-surface drainage losses (i.e., leaching) overcame a large amount of this concern, as episodic events are not as foundational for sub-surface drainage losses. In addition, Overseer has examined the use of daily climate data and compared different time-step data to produce annual averages. The work determined the N-loss estimates using different climate datasets were statistically comparable.

- *uses monthly time steps.*

The redevelopment programme did not seek to address this concern as it was recognized that 1) it was a key feature of usability of the model and 2) management changes and inputs in New Zealand's pasture system do not vary substantially within a month. Moving to a daily time-step is unlikely to provide a substantial benefit in model predictions in pastoral systems and would render the model much less usable. There was discussion among the TAG as to whether a more frequent time-step was needed for arable and vegetable systems. It was generally felt, that if Overseer's use was limited to nitrogen loss through sub-surface drainage, more frequent inputs would not greatly improve estimations of loss.

- *does not account for variation in water and nutrient distribution in the soil profile.*

The multi-layer soil hydrology model has provided some additional model components that address this concern and better represent drainage in a biophysical sense. It was noted that the work only considered water transport in the soil profile. As leaching involves the movement of dissolved N, representing water movement through the soil profile will capture some of this. To include nutrient distribution in the model would require more work.

- *does not adequately accommodate deep-rooting plants.*

The crops work was completed well. The work added new crops and provided a model for new crops to be added. The SAG believed that this is extremely useful.

- *lacks consideration of surface water and nutrient transport, as well as critical landscape factors.*

The redevelopment programme did not seek to address this concern, but instead recommend that Overseer's use in farm plan development be limited to subsurface drainage losses of nitrogen (i.e., nitrate leaching, predominantly). The use case does not recommend reliance on Overseer where overland flow is a major source of nitrogen loss, although it should be acknowledged that Overseer is presenting a nitrogen balance picture at a monthly level that could be very useful as an input into risk of Overland flow losses due to episodic rainfall events.

- *focuses on nitrate and omits ammoniacal nitrogen and organic matter dynamics.*

The TAG acknowledge that other nitrogen species from farming operations can be significant in certain topographies and soil types. Their importance depends on a number of factors, including land use, soil type, climate and management practices. There is a need to understand the importance of the other forms of nitrogen in different catchments and this could help inform the usefulness of Overseer in these scenarios.

- *does not balance mass.*

The redevelopment programme did not seek to address this concern. There is additional work needed to understand the scale of this problem and how it adds to the confidence of the model.

- *is a steady state model was attempting to simulate a dynamic, continually varying system.*

The redevelopment programme did not seek to address this concern, noting that in the limited use case around nitrate leaching, management is most likely to be based on long-term management.

Discussion on Māori issues from the SAP and EAG reports and data gaps

There was a wide-ranging discussion about the SAP and EAG report recommendations for engagement with Māori and what had been done with these recommendations. It was noted that Māori were not involved in the development or execution of the redevelopment programme. This was despite the SAP and EAG recommendations. However, MPI and MfE have developed Māori governance and Māori operations-level groups to engage more widely in how Overseer and other available nutrient tools will be used in regulations.

There was a general discussion about differences in the representation of S-MAP and climate data in different parts of the country, which has a greater effect on whenua governed under Te Ture Whenua and may impact regulatory decisions resulting from use of the nutrient tools (including Overseer). There is a need to better understand the scale and scope of the issue as it relates to Overseer and the Risk Index Tool, including uncertainty and sensitivity tests associated with Māori land.

There was also discussion about the complementary benefits of bringing a Te Ao Māori view to the development and use of nutrient management tools strengthening their relevance and usefulness. This is an area for improvement.

There was a discussion about accessibility to tools for Māori landowners and the capability within Māori farmers and advisors to use tools.

Given the reports and potential for changes to Overseer, how could Overseer be used to support regulation?

There was a wide-ranging discussion about MfE's guidance document. It was noted that there is a current document on MfE's website that provides some guidance for regional councils on how to apply Overseer in regulation.

https://environment.govt.nz/publications/responding-to-the-overseer-review-advisory-note/

There was discussion about limiting the use of Overseer in regulation for some land uses. However, it was noted that without additional information this exercise would require unreasonable assumptions.

Understanding how Overseer modelled outputs relate to observed measurements is the "gold standard" for a limited use case for Overseer. The TAG were uncomfortable specifying limits for land use cases without additional validation work.

General comments

- *It is important not to try to develop a model that does everything and winds up doing nothing.*
- *We don't want perfect to get in the way of good/useful.*

Table of SAP concerns* considered by TAG at 29 September 2022 meeting.

SAP concerns	Programme generated additional knowledge?	Achieved what was set out in work programme?	Additional gaps for consideration	Does this constitute a critical issue with the model?
1. *uses average climate data and, therefore, cannot model episodic events, or capture responses to climate variation.*	Yes, no significant difference found between daily averaged and annual averaged data.	Yes.	Requires some validation work. Needs work to understand how to account for episodic events.	No.
2. *does not account for variation in water and nutrient distribution in the soil profile.*	Some additional knowledge through development of multi-layer soil hydrology model.	Yes.	Requires some validation work. Needs work on nutrient transport through soil profile. As leaching involves the movement of dissolved N, representing water movement through the soil profile will capture much of this.	No.
3. *does not adequately accommodate deep-rooting plants.*	Yes – additional crops added and new way of adding crops developed.	Yes.	Requires some validation work. Consider adding tree crops to cover some horticulture and forestry land uses.	May need to limit use in regulation for some crops.
4. *lacks consideration of surface water and nutrient transport, as well as critical landscape factors.*	None generated.	No work for this SAP concern.	Yes, work on overland flow and nutrient transport through the soil profile.	Focus limited use case for regulation on nitrate loss and only use as a risk factor (i.e., N surplus) for situations where overland flow is a concern.
5. *focuses on nitrate and omits ammoniacal nitrogen and organic matter dynamics.*	None generated.	No work for this SAP concern.	Yes, may be important in some situations. Refer SAP concern #2 above – how significant are the other forms of nitrogen?	Focus limited use case for regulation on nitrate loss.
6. *is a steady state model was attempting to simulate a*	None generated.	No work for this SAP concern.	The model is a steady state model.	No.

dynamic, continually varying system.				
7. uses monthly time-steps.	See SAP concern #1 above.	Yes.	Needs work to understand how to account for episodic events.	No.
8. does not balance mass.	None generated.	No work for this SAP concern.	This is not considered to be a material issue in respect of current or likely future uses of the tool by water resource managers. More work to understand what situations increases the uncertainty would be useful.	No.

*Concerns copied from page 14 of the *Government Response to the findings of the Overseer peer review report*

Appendix 5: Notes from Overseer Technical Advisory Group review meeting 19 June 2023

Notes from Overseer Technical Advisory Group review meeting – 19 June 2023

Attendees
Alexander Hunt-Painter, Alistair Smail, Andrew Tait, Brent Clothier, Bruce Thorrold, Chris Daughney, David Burger, Donna Giltrap, Ed Butler, Gerard Willis, Hamish Brown, Jane Chrystal, Jean-Paul Tavernet, Jon Palmer, John Roche, Julie Everett-Hincks, Kate Simpson, Ken Taylor, Mike Scarsbrook, Nic Peet, Stephen Lamb, Reina Tamepo, Richard McDowell, Richard Muirhead, Robyn Dynes, Rosalyn Anderson-Lederer, Selai Letica, Tim Davie, Tapuwa Marapara, Wiremu McMillan
Apologies
Tanya Cornwall

Summary overview of meeting and recommendations
Ed Butler from the Ministry for Primary Industries gave an overview of the Technical Advisory Group (TAG) meetings to date and outlined the process for closing out the Overseer redevelopment work and the TAG. *Richard Muirhead presented an overview of the Overseer model and some of the challenges comparing modelled nitrate loss results against nitrate loss measurements. This was followed by a presentation from Jean-Paul Tavernet on the validation work comparing Overseer modelled nitrate loss against nitrate loss observations from experiments.* *Julie Everett-Hincks from the Ministry for the Environment (MfE) presented an overview of the nutrient management work that MfE is engaged in.* *Ed Butler and Reina Tamepo provided an overview of the work being done to compare Overseer results using SMAP and FSL layers on Māori land.* *The meeting closed at 10am.*

Notes from meeting
Overview of TAG meetings and next steps *Ed Butler from MPI gave an overview of the TAG meetings to date. This included:* • *the in-person establishment TAG meeting for the Overseer redevelopment programme on the 28 September 2021* • *the online TAG meeting on the 27 July 2022 to discuss the early results from the Overseer redevelopment programme, and* • *the in-person TAG meeting on the 29 September 2022 to discuss the Overseer redevelopment work and provide some advice to MfE on how Overseer could be used.* *Ed noted that the TAG was set up to establish the Overseer redevelopment programme, ensure that the programme was delivered to a high standard and provide advice to MfE on the use of Overseer in regulation. Given that the Overseer redevelopment programme was now complete, the meeting on the 19 June 2023 would be the final TAG meeting.* *MPI will prepare notes from the meeting that will be circulated to the TAG for comment before being finalised. The meeting notes will form part of an MPI report outlining the Overseer redevelopment programme.*

Overseer validation presentations

Richard Muirhead presented an Overview of the Overseer model and some of the challenges comparing modelled nitrate loss results against nitrate loss measurements.

Jean-Paul Tavernet presented validation work comparing Overseer modelled nitrate loss against nitrate loss observations from experiments. Jean-Paul noted that Overseer is planning to undertake additional validation work in the future.

There were a number of questions and comments about the validation work that Jean-Paul presented including:

- *clarification on the treatment of the outlier point that appears in some of the graphs*
- *clarification that the most recent version of Overseer was used for the analysis*
- *some comments and questions regarding the statistical analysis (was the data normally distributed, what were the 95% confidence limits and use case information), and*
- *more information on Overseer's ability to model direction of travel.*

There was some discussion about whether the Overseer validation would be released in its current form or augmented following the TAG discussion.

MfE ongoing nutrient management work

Julie Everett-Hincks from the Ministry for the Environment (MfE) presented an overview of the nutrient management work that MfE is engaged in. This includes:

- *the ongoing development of the Risk Index Tool*
- *work on principles, stewardship and governance of nutrient models, and*
- *establishment of a group to examine use of tools in regulation.*

A question was raised regarding how Te Tiriti principles would be incorporated into the work to examine use of tools in regulation. MfE noted that this will be incorporated into the group makeup.

Ed Butler and Reina Tamepo provided an overview of the work being done to compare Overseer results using SMAP and FSL layers on Māori land. This work is in progress and farms will be identified that can be used for this work.