BEFORE INDEPENDENT HEARING COMMISSIONERS APPOINTED BY THE CANTERBURY REGIONAL COUNCIL

IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	Submissions and further submissions by Rangitata South Irrigation Limited on Proposed Plan Change 7 to the Canterbury Land and Water Regional Plan

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SUPPLEMENTARY STATEMENT OF DR GLEN TREWEEK

26 NOVEMBER 2020

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SUPPLEMENTARY STATEMENT OF DR GLEN TREWEEK

Introduction

1 My name is Glen Andrew Treweek. I have previously provided evidence in relation to RSIL's case on Plan Change 7 to the Canterbury Land and Water Regional Plan, dated 17 July 2020.

2 At paragraph 19 of that evidence I set out that the Matrix was formally approved by ECan's Chief Executive as being equivalent to Overseer for setting nitrogen loads limits and determining compliance within catchment groups located between the Rangitata and Rakaia Rivers. Regrettably I did not attach that approval to my original evidence.

3 I now attach that approval memorandum from ECan dated 24 April 2020.

Dr Glen Treweek

26 November 2020

Appendix – Recommendation to Approve the Matrix Method as Equivalent Model to Overseer

Memo

Date	24 April 2020
To	Bill Bayfield, Chief Executive
CC	
From	Andrew Parrish, Tania Harris

Recommendation to Approve the Matrix Method as Equivalent Model to Overseer

Introduction

Irrigo Centre Limited (ICL) has developed a model called the Matrix method (also referred to as the Irrigo model) to estimate diffuse nitrogen losses from agricultural activities within Canterbury. ICL requests that the Chief Executive of Environment Canterbury approves the Matrix method as equivalent to Overseer to estimate nitrogen leaching for properties with an aggregated area of greater than 2,500 hectares within the Mid-Canterbury plains.

Other models, such as NCheck, have previously been approved as equivalent models to Overseer and it has been determined that:

- The Chief Executive can approve an alternative model;
- The Chief Executive can limit or restrict this approval; and
- The Chief Executive has the authority to approve an alternative model if equivalent and may consider relevant factors in making the approval.

The power to the Chief Executive is provided for in the definitions of 'nitrogen loss calculation' and 'nitrogen baseline' in the Canterbury Land and Water Regional Plan (LWRP).

We have carefully considered the equivalent model proposed and have worked closely with the applicant to understand the model, and address issues raised about the equivalency of the model to Overseer. After an evaluation of the model by Environment Canterbury staff, we are confident that we can recommend to you that the Matrix method is equivalent to Overseer for the purpose of calculating total nitrogen loads for irrigation schemes and other groups of properties in Mid-Canterbury.

We recommend that the model is only approved for use in limited circumstances, recognising that the model is not considered equivalent for other purposes, such as assessing localised environmental effects. This will be addressed through the associated resource consent process.

We further recommend that the model is recalibrated once every 4 years, and if the model does not calibrate against the most recent version of Overseer, additional farms are able to

be added to the model. This gives us confidence that over time the model will remain equivalent to Overseer.

We have included the proposed approval text in Attachment 1, which sets out the limited circumstances recommended for the approval.

An assessment of the equivalence of the Matrix method is contained in Attachment 2. In summary, for the circumstances proposed for the use of the Matrix method, it is considered to be an equivalent model because:

- Both Overseer and the Matrix method provide an estimate of nitrogen loss below the root zone, and the key inputs and drivers of nitrogen losses are the same.
- The Matrix method uses the Overseer model.
- The Matrix Method will result in an equivalent outcome in terms of determining a total scheme load.
- The Matrix method can be updated to incorporate new land uses or practices if they change over time (in accordance with an agreed process as outlined in Appendix 2 of the application for approval of an equivalent model[1]).

Recommendation:

That the Chief Executive of Environment Canterbury approves 'the Matrix method' as an equivalent model to Overseer for use in limited circumstances within the Mid-Canterbury plains as follows:

1. The Matrix method is only used to estimate the nitrogen baseline and nitrogen loss calculation to determine aggregated nitrogen loads for groups of properties with a minimum area of 2,500 hectares within the Mid-Canterbury plains.
2. The Matrix method is only used in the context of a resource consent and Environmental Management Strategy.
3. The Matrix method is recalibrated against Overseer files every four years.

29 April 2020

Andrew Parrish, Regional Planning Manager

Tania Harris, Senior Manager Operational Support

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[1] Letter to Chief Executive of Environment Canterbury, 'Summary of the Matrix Methodology for Calculating Nitrogen Losses (v4)', 22 April, 2020.

Attachment 1: Approval of Equivalent Model

1. The definitions of nitrogen baseline and nitrogen loss calculation in the Canterbury Land and Water Regional Plan require the discharge of nitrogen below the root zone to be modelled with Overseer or an equivalent model approved by the Chief Executive of Environment Canterbury.

2. Irrigo Centre Limited have developed an alternative model called 'the Matrix method' for the purposes of determining the aggregated nitrogen baseline and nitrogen loss calculation in particular circumstances.

3. Technical information about the Matrix method, including the process for amendments to the model, is outlined in the application to the Chief Executive for approval of the equivalent model, titled 'Summary of the Matrix Methodology for Calculating Nitrogen Losses (v4)', 22 April, 2020.

4. The particular circumstances where 'the Matrix Method' is approved for use as a model equivalent to Overseer under the Canterbury Land and Water Regional Plan, are as follows:

    a. Within the Mid-Canterbury plains, between the Rangitata and Rakaia Rivers, up to the foothills of the mountains, for groups of properties with a minimum combined area of 2,500 hectares.

    b. To be used only in the context of a resource consent to:

        i. generate an aggregated nitrogen baseline or nitrogen discharge allowance for the groups of properties; and

        ii. generate an aggregated nitrogen loss calculation to determine compliance with consented nitrogen loss limits.

    c. Where the Matrix method is recalibrated against Overseer files every four years.

    d. The approval is in effect until 30 April 2035.

5. Any proposed amendments to the Matrix method shall be submitted to Environment Canterbury for consideration before being implemented:

    a. The amendments shall be considered by a panel made up of representatives of the Consents, Planning, Science and Compliance Monitoring sections of Environment Canterbury.

    b. Within 30 working days of receiving the proposed amendments the panel shall make a recommendation to the Chief Executive for consideration.

c. Upon receiving the recommendation, the Chief Executive shall make a decision on the proposed amendments within 14 working days and notify all parties within 5 working days of making the decision.

6. In giving this approval I have considered the information set out in the attached information and I am satisfied that 'the Matrix Method' is an equivalent model to Overseer in the particular circumstances outlined in this approval.

Bill Bayfield, Chief Executive **29 April 2020**

Attachment 2: Equivalence Assessment

Introduction

Irrigo Centre Limited (ICL) has developed a model called the Matrix method (also referred to as the Irrigo model) to estimate diffuse nitrogen losses from agricultural activities within Canterbury. ICL requests that the Chief Executive of Environment Canterbury approves the Matrix method as equivalent to Overseer to estimate nitrogen leaching for properties with an aggregated area of greater than 2,500 hectares within the Mid-Canterbury plains.

The Application and context

The applicant has described the Matrix method as a catchment model used to calculate nitrogen losses for groups of properties within Canterbury. ICL acknowledges that the Matrix method is not a suitable replacement of Overseer nutrient budgets on an individual farm basis[2]. ICL consider that the minimum catchment size that the model is suitable for is 2,500 hectares based on their calibration of the model.

The Land and Water Regional Plan (LWRP) definitions for nitrogen baseline and nitrogen loss calculation require that they are set using Overseer or an equivalent model approved by the Chief Executive of Environment Canterbury. If approved as an equivalent model, the Matrix method would be used to set nitrogen loss limits on future resource consents and to assess compliance with those limits.

The LWRP does not define the word “equivalent”. In making this recommendation the meaning of equivalent is based on the Online Merriam-Webster dictionary which defines equivalent as: 1. equal in force, amount, or value; 2. like in signification or import; 3. corresponding or virtually identical especially in effect or function.

This recommendation assesses whether the proposed Matrix method is equivalent to Overseer for the purpose of the nitrogen baseline and nitrogen loss calculation definitions in the LWRP.

Assessment

Legal advice has recommended five criteria to consider when making the decision on whether the model is equivalent to Overseer:

1. Consideration of what the model actually does.
2. A comparison between the input parameters used for Overseer and those used for the Matrix method.
3. The proposed use of the Matrix method, including the planning context within which the Matrix method will be used and any limitations of that use.
4. An assessment between the two models in the context of the proposed use.

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[2] This is because there is significant variation in nitrogen loss calculations at a property scale due to individual properties undertaking activities which are different to that described in representative files.

5. Any environmental consequences (and whether they are neutral in light of the proposed use).

The Matrix method is assessed against the five criteria below.

1. Consideration of what the model actually does.

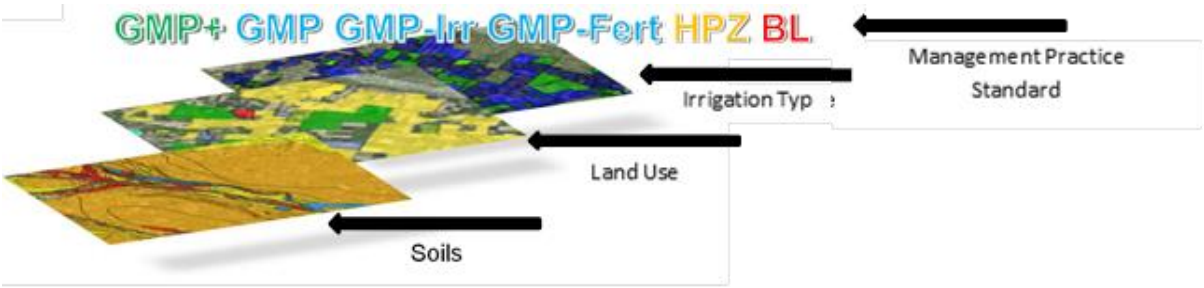
Both models provide an estimate of the amount of nitrogen leached below the root zone using Overseer. Therefore, they are similar in what they do, but use a different method to achieve this. Overseer provides the estimate based on farm-specific information and applying a number of mathematical equations tracing the movement of nutrients within a farm system. It provides an estimate of nitrogen leached on a per property basis expressed in kg per hectare per year. Updates to the Overseer model are provided for in the definitions of nitrogen baseline and nitrogen loss calculation in the LWRP.

While the regional rules within the LWRP require farmers to operate at or below Good Management Practice (GMP) loss rates from specified dates, the Overseer model itself does not estimate good management practice loss rates. This is achieved through the Farm Portal which modifies uploaded Overseer analyses to reflect GMP.

The Matrix method works by overlaying the most representative soil type, land use and irrigation type to determine the appropriate 'representative farm' Overseer analyses. These representative farms have been prepared at six levels of management practice standard[3]. The Matrix method calculates the aggregated nitrogen loss rate by applying the appropriate representative analyses at the appropriate level of management standard.

To determine compliance with nitrogen load limits, the Matrix method includes an additional step to Overseer where the Farm Environment Plan (FEP) audit grade is used to determine the standard of management practice, which is used to calculate the nitrogen loss rate. The Matrix method is illustrated in the diagram below which was provided by ICL.

Summary of Layers Used to Calculate Nitrogen Losses (Figure 2 of the ICL application).



In summary, the models are similar in terms of what they do, given that for both models the purpose is to provide an estimate of the amount of nitrogen leached below the root zone.

[3] Baseline, Hinds Plains Zone good management practice, Irrigation GMP, Fertiliser GMP, Irrigation and Fertiliser GMP and Advanced Mitigation.

Overseer provides this estimate at a farm scale (and then those estimates can then be combined to determine losses at a catchment scale), whereas the Matrix method provides an estimate at a catchment scale, for catchments greater than 2,500 hectares.

2. A comparison between the input parameters used for Overseer and those used for the Matrix method.

The Matrix method uses Overseer as the basis to estimate nitrogen losses and in this regard, it uses the same inputs as Overseer. However, the difference is that Overseer uses input data for each individual farm for the relevant time period (the nitrogen baseline period or past four years). The Matrix method proposes to use base datasets for representative farms where Overseer has been used to estimate nitrogen losses. Given this, Overseer provides for a higher level of specificity with respect to data inputs. The use of representative farms in the Matrix method introduces a level of coarseness and potential inaccuracy.

In addition, the Matrix method uses the FEP audit grade and the level of confidence in certain areas to determine the nitrogen loss calculation for the farm, rather than as one of the matters to be considered in determining the audit grade.

While there are differences in data inputs, the inputs which affect the overall nitrogen loss calculation, such as soil type and land use, are the same for both models, in that for both Overseer and the Matrix method, these will be the key drivers for changes to N loss calculations.

3. The proposed use of the Matrix method, including the planning context within which the Matrix method will be used and any limitations of that use.

The applicant proposes to use the nitrogen leaching limits estimated by the Matrix method to:

a. Set nitrogen loss limits for future resource consents for activities in the Ashburton Plains area; and

b. Assess compliance of irrigation schemes, collectives and farming enterprises with these limits.

For areas subject to the regional rules, the LWRP now requires farmers to operate at nitrogen loss rates that reflect industry-agreed Good Management Practice. This requirement was introduced through Plan Change 5 to the LWRP, which introduced new definitions of ‘Baseline GMP Loss Rate’ and ‘Good Management Practice Loss Rate’ which require reductions in nitrogen loss to rates that reflect GMP. The requirements vary for sub-regions. In the Hinds catchment further reductions are required to achieve the water quality outcomes specified in the LWRP, and therefore any equivalent model to Overseer will need to be able to determine if these reductions have been achieved.

The LWRP provides for the use of equivalent methods to Overseer in limited and specified circumstances to calculate a nitrogen baseline or a nitrogen loss calculation. While the calculation of the Good Management Practice Loss Rate and Baseline GMP Loss Rate do not require approval from the Chief Executive, they are related in that the model used to

calculate the nitrogen baseline and nitrogen loss calculation will determine *how* the GMP loss rates are calculated (using the Farm Portal if Overseer has been used, and by reference to the audit grade if the Matrix method has been used).

In relation to the planning context it is noted that the LWRP encourages irrigation scheme initiatives to improve land and water use practices and meet water quality outcomes (Policy 4.36).

4. An assessment between the two models in the context of the proposed use.

This assessment of whether the Matrix method is equivalent to Overseer focusses on the use of the model to estimate the nitrogen baseline and nitrogen loss calculation, given these are the only situations where the LWRP provides for an equivalent method to be used (subject to the approval of the Chief Executive).

Importantly, the approval of an equivalent model for the purposes of the nitrogen baseline and nitrogen loss calculation definitions are different to the rules in the LWRP that provide an alternative pathway where the Farm Portal is unable to generate a Baseline GMP Loss Rate or Good Management Practices Loss Rate.

Nitrogen baseline

The nitrogen baseline is defined in the LWRP. In summary it is the discharge of nitrogen below the root zone, modelled in accordance with Overseer (where the data is inputted into the model in accordance with Overseer Best Practice Data Input Standards) or an equivalent model, averaged over the four-year period from 2009 to 2013, expressed in kg/ha/yr for an identified area of land. The definition provides for the nitrogen baseline to be recalculated with the most recent version when Overseer is updated.

Nitrogen loss calculation

The nitrogen loss calculation is similar to the nitrogen baseline but is averaged over the most recent four-year period. Overseer version changes are also provided for in the nitrogen loss calculation definition.

In the context of these definitions, Overseer and the Matrix method can both estimate the nitrogen baseline and nitrogen loss calculation (i.e. the loss of nitrogen below the root zone for either the 2009-2013 period, or the most recent four-year period). However, there are some key differences as follows:

a. Overseer estimates nitrogen loss rates on a per property basis, whereas the Matrix method estimates losses on a catchment scale and is not suitable for individual farms. Calculating nitrogen losses at a catchment scale for irrigation schemes is consistent with the policy framework of the LWRP.

b. Overseer updates are provided for by the LWRP. For the Matrix Method, Irrigo have proposed a process for updates to the model, which provides for:

i. Comparing Overseer and Matrix nitrogen losses for a sample of farms every four years[4] and recalibrating the model if it deviates from Overseer nutrient budgets by more than 10%;

ii. Updating the Matrix into later versions of Overseer; and

iii. Other updates to incorporate new files and management standards into the Matrix.

c. Given that Overseer inputs are based on actual farm data, any land use changes on the farm within the relevant four-year period are taken into account. Given that the Matrix method uses representative farm systems, it may not capture actual land use changes within this four year period when determining the nitrogen baseline or nitrogen loss calculation, particularly where those changes reflect farm systems that do not easily correlate with the model farm files.

d. The Matrix method estimates losses on a catchment scale and it is not clear how nitrogen loss limits will apply when individual farms leave or join an irrigation scheme given that the Matrix method is not appropriate at an individual farm level. The LWRP requires that farmers generate a property-specific loss rate to obtain a Farming Land Use consent. It is understood that the number of farms leaving the schemes is expected to be low (if any), and therefore this is not considered to be a significant issue. For associated properties joining the scheme (i.e. not irrigated by the scheme but owned by a scheme shareholder), they are required to estimate the nitrogen baseline when joining the scheme, which addresses this issue for associated properties.

e. The LWRP requires reductions in nitrogen loss in the Hinds catchment to achieve water quality outcomes. Overseer estimates can be used to calculate reductions in nitrogen loss at a farm scale whereas the Matrix method can only calculate reductions at a catchment scale. This difference is not considered to be significant, as calculating reductions at a catchment scale will meet the policy requirements for the Hinds catchment.

f. In regard to determining the good management practice loss rate, the planning framework relies on the Farm Portal to modify Overseer files to reflect GMP, whereas the Matrix method uses the audit grade for the irrigation and nitrogen fertiliser targets to determine the appropriate GMP representative file. An internal CRC review of the Matrix method GMP files has confirmed that the files meet the requirements of the LWRP, although they may require regular review and refinement to ensure that they remain consistent with the LWRP requirements.

ICL calibrated the Matrix method by comparing nitrogen loss estimates for 94 farms within the three irrigation scheme areas. Based on the initial analysis, ICL stated that the Matrix overestimates average nitrogen losses compared to Overseer by 3.6%[5]. ICL acknowledge that there is significant variation between Overseer and Matrix method nutrient loss calculations at a farm scale due to individual properties undertaking different activities to

[4] Minimum sample size to give 95% confidence of a result within 10% of the true value.

[5] This is the difference in the average loss rates calculated by Overseer and the Matrix method in kgN/ha/yr.

those described in the representative files. However, they state that variability is managed on a catchment scale through averaging, with 2,500 ha being the minimum catchment size where the Matrix method is appropriate.

To determine if the differences in the models are significant, the calibration data provided by ICl was evaluated further by Environment Canterbury. The initial evaluation found a poor correlation between the two models, and a bias in the model with over prediction of low emitters and under prediction of high emitters. Bias within the model poses a risk to application of the Matrix model to a different dataset, or to predicting the change in losses from changing land uses and practices.

ICl carried out a review of the bias identified by Environment Canterbury, as outlined in Appendix 2 of their application[6]. Their review found:

- Residual analysis using nitrogen load (kgN/yr) instead of loss rate (kgN/ha/yr) results in greater alignment with Overseer nutrient budgets.
- The Matrix slightly overestimates nitrogen loads for higher emitting properties, but the variance with Overseer estimates is still within 10%.
- Small properties were disproportionately represented in the highest variance between the two models.
- Adding the Dryland Arable nitrogen loss figures to the Matrix improves the underestimation of lower intensity properties.

Based on this review, ICL conclude that by completing a residual analysis using the nitrogen load instead of loss rate, and including the Dryland Arable nitrogen loss rates, the bias is reduced sufficiently to ensure that the Matrix is equivalent to Overseer for calculating catchment loads and identifying higher risk land use activities.

Environment Canterbury evaluated ICL's review of the bias and the updated dataset. As part of this evaluation it is noted that comparing loss rates and property loads provides different information. A comparison of loss rates indicates how well the model can match Overseer for a particular activity, irrespective of area, whereas a comparison of the property load indicates how significant the difference is between the models for this application of the model. Both approaches have been evaluated, and it is concluded that:

- A comparison of loss rates (kgN/ha/yr) still shows a bias in the model with overprediction of low emitters and underprediction of high emitters. This confirms that the Matrix method is unable to match Overseer loss rates on an individual property scale.
- The bias in predicting loss rates may be due to rainfall variation which is not accounted for by the model.
- The variance in loss rates between the two models is greater for smaller properties. However, the total loads predicted by the two models are similar because the sample dataset included a wide range of property sizes.

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[6] Letter to Chief Executive of Environment Canterbury, 'Summary of the Matrix Methodology for Calculating Nitrogen Losses (v4)', 22 April, 2020

- Comparing the property loads (kgN/yr) produced by the two models shows a much better fit and less bias compared to loss rates.
- A residual analysis (of the residual difference between the two models compared to Overseer property load) shows less bias than the loss rate per hectare, because of the small property sizes factoring into the bias. That is, the largest errors are occurring on the smallest properties and their contribution to the total load is smaller (than if the differences were occurring on the larger properties).

In summary, Environment Canterbury's review of the model suggests that the Matrix method is suitable to estimate total scheme loads, but it does not match Overseer well enough for predicting loads or loss rates for individual areas or properties. The distribution of property sizes and locations 'average' out errors when considering the schemes as a whole. Validation with a random selection of properties will be essential to ensure this remains true in the future. If the model validation is maintained, there can be some certainty that the total load from the schemes would be similar to that calculated using Overseer.

5. Any environmental consequences (and whether they are neutral in light of the proposed use).

The Ashburton sub-region (excluding the Hinds catchment) is largely comprised of orange and red nutrient allocation zones (NAZ), indicating water quality outcomes are not being met or at risk of not being met for most of this area. The Hinds catchment is a former 'Red NAZ' under the LWRP indicating water quality outcomes are not being met and significant reductions in nitrogen losses are necessary to achieve freshwater outcomes for this catchment. These irrigation schemes currently irrigate around 20% of the total irrigated area in Canterbury. Therefore, any differences between the Matrix method and Overseer nitrogen loss estimates could be significant given the required reductions necessary to achieve the Plan's objectives for water quality. However, Irrigo consider that there is the potential for the use of the Matrix method to achieve better environmental outcomes as a result of the use of the audit grade to inform the final nitrogen loss number, which incentivises farms to improve farm practices.

In the context of the proposed use to estimate a total nitrogen load for groups of properties greater than 2,500 ha, the environmental consequences are considered to be neutral, if validation of the model is maintained. However, the model is not considered to be equivalent for use in other contexts, such as assessing localised environmental effects, and this will be addressed through the associated resource consent process.

Memo

Date	23/4/2020
To	Jacqui Todd
CC	
From	Dan Clark

Updated comparison of loss rate estimates from the Matrix method proposed by Irrigo and those produced by Overseer

I previously evaluated how closely the outputs from the Matrix Method (proposed by Irrigo on behalf of the Mid-Canterbury Irrigation Schemes) compared to those from Overseer. The previous evaluation, dated 16/3/2020, found that the loss rates from the Matrix Method (in kg N/ha/yr) were generally overpredicted for properties with a low loss rate and under predicted for properties with a high loss rate. Overall, both methods produced very similar total loads for the sum of all properties modelled.

Following discussions between Environment Canterbury, Irrigo and representatives of the Mid Canterbury Schemes, some changes were made to the Matrix Model data. These changes meant that the previous evaluation needed to be updated. The updated dataset provided by Irrigo included loss rates and property loads for 181 farms. This is the same dataset as used by Irrigo in Appendix two of their *Summary of The Matrix Methodology for Calculating Nitrogen Losses (v4).*

Throughout the discussions there has been some disagreement as to whether evaluation should be completed using the loss rates (in kg N/ha/yr) or property loads (in kg N /yr). As these both provide different information. In my previous evaluation I compared loss rates, and in Irrigo's evaluation they compared property loads.

Comparing loss rates indicates how well the model can match Overseer for a particular activity, irrespective of the area covered by that activity. Comparing the property load, indicates how significant the difference is between the models for this application of the model. In this evaluation I provide evaluation of both approaches and describe what the combination of these tell us about the model performance.

The Matrix Method's ability to match Overseers loss rate

Figure 1 shows the loss rates (kg N/ha/yr) produced by the Matrix Method compared to those from Overseer. There is a large amount of scatter in the predictions and generally shows a poor model fit. The R^2 for the trend line in these data is 0.12.

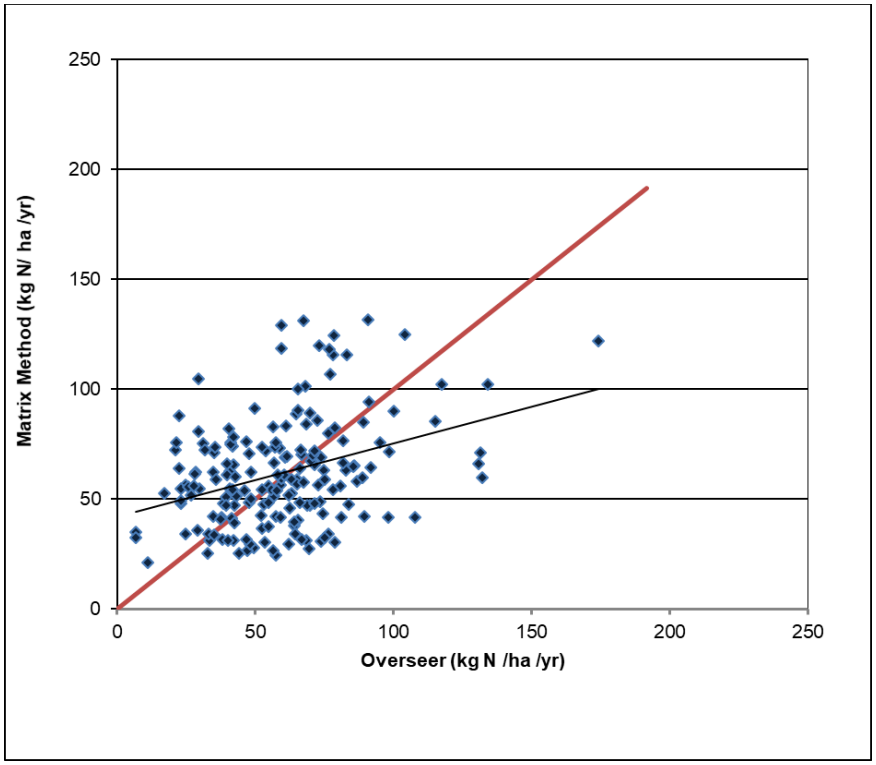

Figure 1 Modelled loss rate in kg N/ha/yr for each model, the trend for these data is shown in black and a one to one line is shown in red

Subtracting the Overseer loss rate from the Matrix Method loss rate provides the residual loss rate for each property, this indicates the how closely the two models are for the property. Figure 2 shows the residual for each property plotted against the Overseer loss rate for that property. This shows the updated model dataset continues to overpredict where the Overseer loss rate is low and underpredict where the Overseer loss rate is high. This confirms the previous evaluations findings, that on an individual property scale the Matrix Model is unable to match Overseer loss rates. Loss rate is important as it is independent of the area and highlights how well the model is performing for different activities. The systematic over and underprediction can be considered as model bias and appears to be related to rainfall. Evaluation of the previous dataset provided by Irrigo indicated that the Matrix Model overpredicted loss rate in the areas with rainfall below 800mm/yr and underpredicted loss rates in areas with rainfall greater than 800 mm/yr.

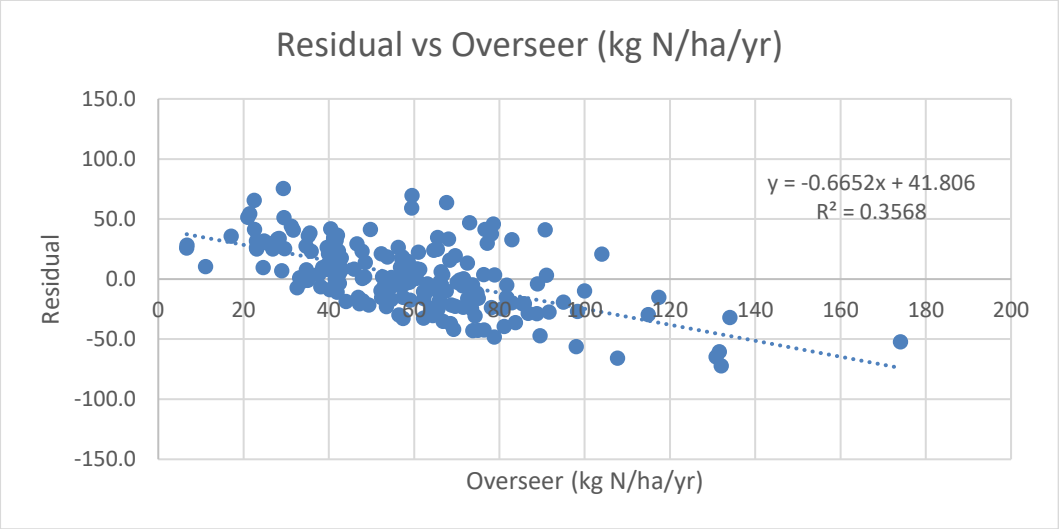

Figure 2 Residual difference between the Matrix Method and Overseer loss rates compared to Overseer loss rate (plot provided by Irrigo)

As the proposed use of the model is to predict total load from the Mid-Canterbury irrigation schemes it is important to know how the inability to predict individual properties impacts on its proposed use. Figure 3 shows the residual loss rate plotted against property size. This shows that the largest errors in the loss rate predictions are occurring with smaller sized properties. This plot also shows that there is not a meaningful trend towards over or underprediction based on property size.

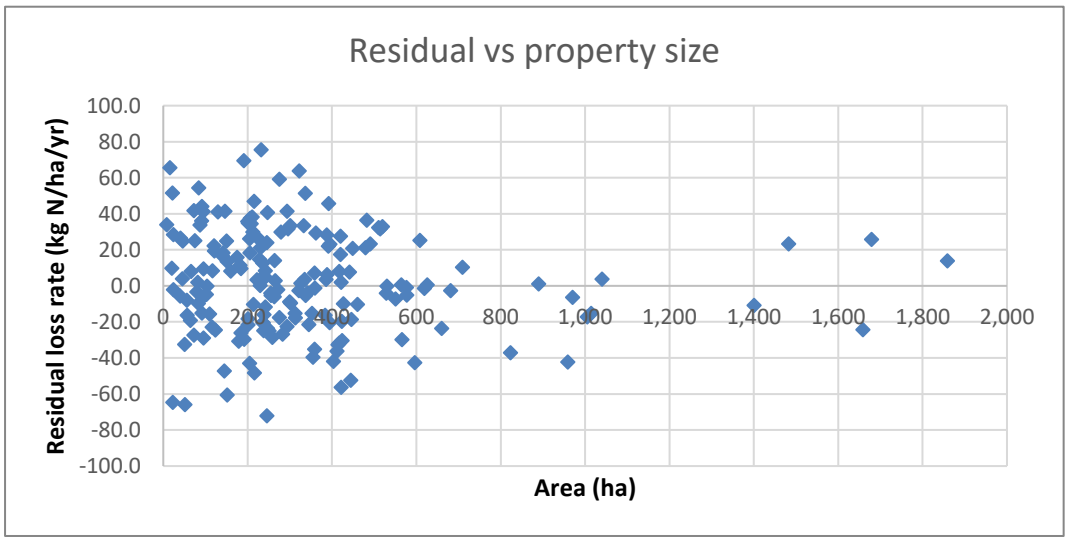

Figure 3 Residual difference between the Matrix Method and Overseer loss rates compared to property size

This analysis indicates that the Matrix Method cannot match the Overseer loss rate for individual properties, and that the error associated with these predictions appears greatest with smaller properties. As the sample dataset used for model validation included a wide range of property sizes these over and under predictions in loss rate resulted in the total loads from both models being very similar.

The Matrix Method's ability to match Overseer property loads

Comparing the property loads produced by the two models combines the impacts of how well the model fits and the impacts of the differing property sizes. As the poorest predictions of loss rate occur on the smallest properties, the fit between the Matrix Method and Overseer property loads is much better. Figure 4 show the comparison between the total N load per property under the two models, this shows a much closer model fit, compared to the loss rate per ha.

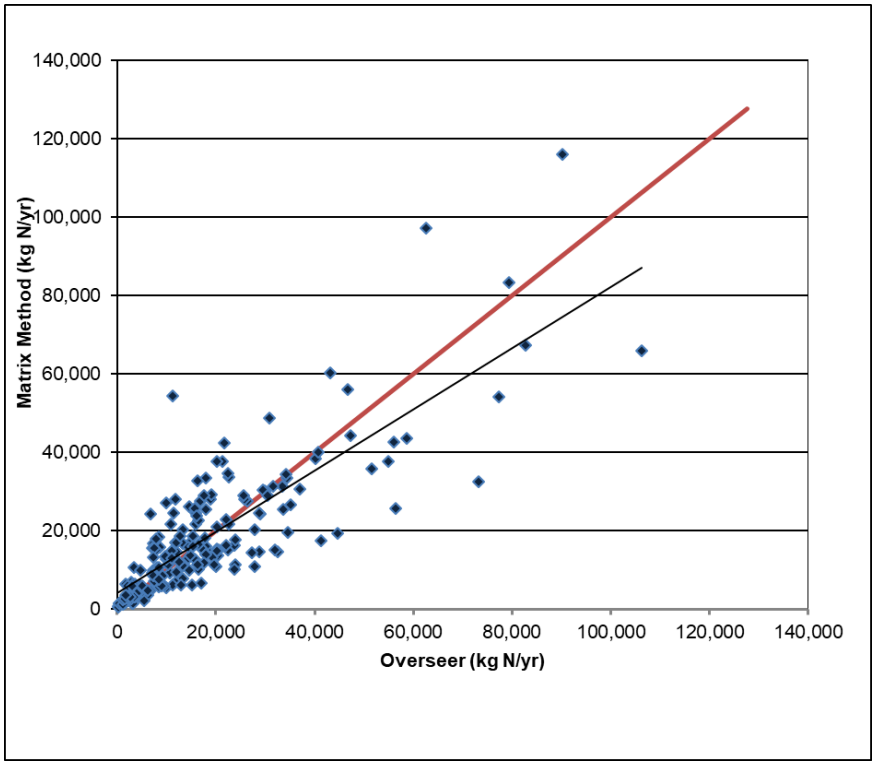

Figure 4 Modelled property load in kg N/yr for each model, the trend for these data is shown in black and a one to one line is shown in red

Repeating the residual analysis using property load results in the plot shown in Figure 5. This shows less bias than the loss rate per ha. This is due to the size of the properties factoring into the analysis. As the largest errors in the model are occurring on the smaller properties their contributions to the total load are smaller than if the largest loss rate errors were occurring over largest areas. As shown in Figure 3 the two models differ most on small properties, but the errors appear evenly distributed. The combination of loss rate and property size result in lower model bias in the predicted property loads and very similar catchment load.

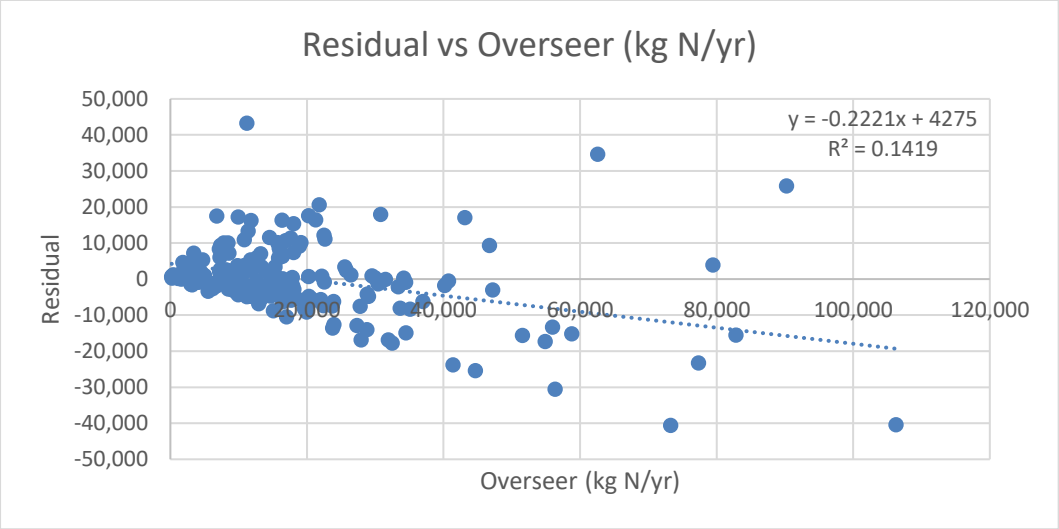

Figure 5 Residual difference between the Matrix Method and Overseer property load compared to Overseer property load (plot provided by Irrigo)

Summary

The overall load from the updated modelled farms is nearly identical between the Matrix Method and Overseer. However, the ability of the Matrix Method to match Overseer loss rates at specific locations remains poor. The distribution of property sizes and locations 'average' out errors when considering the schemes as a whole, but validation with a random selection of properties is essential to ensure this remains true in the future. If the model validation is maintained, there can be some certainty that the total load from the schemes would be similar to that calculated using Overseer.

While the Matrix method may be considered suitable to estimate scheme loads, it is not considered to match Overseer well enough for predicting loss rates or loads for individual areas or properties.