

**IN THE ENVIRONMENT COURT
WELLINGTON REGISTRY**

**I TE KŌTI TAIAO O AOTEAROA
TE WHANGANUI-A-TARA ROHE**

UNDER	the Resource Management Act 1991
IN THE MATTER	of appeals under sch 1, cl 14(1) against the decision of Manawatū-Whanganui Regional Council on Plan Change 2 to the One Plan
BETWEEN	TE RUNANGA O RAUKAWA ENV-2021-WLG-20 NGĀTI TURANGA ENV-2021-WLG-21 ANDREW DAY ENV-2021-WLG-22 WELLINGTON FISH AND GAME COUNCIL ENV-2021-WLG-23 Appellants
AND	MANAWATŪ-WHANGANUI REGIONAL COUNCIL Respondent

**STATEMENT OF REPLY EVIDENCE OF DR ANNE-MAREE JOLLY ON BEHALF OF
MANAWATŪ-WHANGANUI REGIONAL COUNCIL**

OVERSEER AND RISK ASSESSMENT TOOL (CVG)

Dated: 13 November 2023



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REPLY EVIDENCE OF ANNE-MAREE JOLLY**A. INTRODUCTION**

- [1] My full name is Anne-Maree Jane Jolly.
- [2] I prepared a statement of evidence dated 6 October 2023 (**Evidence**) on the development of the commercial vegetable growing (**CVG**) nitrogen risk assessment tool for Proposed Plan Change 2 to the One Plan (**PC2**), on behalf of the Manawatū-Whanganui Regional Council (**Horizons**).
- [3] My experience and qualifications are set out in my Evidence.
- [4] I repeat the confirmation given in my Evidence that I have read and will comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2023, and that my evidence has been prepared in compliance with that Code.
- [5] As in my Evidence, in this reply I refer to the Bloomer et al (2020) report, which modelled loss of nutrients from vegetable growing scenarios in Horowhenua. On reflection, the Court may not be familiar with that report, and it is needed to have a full understanding of my evidence. I therefore attach it as **Attachment A**.
- [6] In reply to a number of points raised through the expert evidence for the appellants, and section 274 parties, I have referred to my s 42A reports from the Council level hearing. For completeness, I have also attached the s 42A reports at **Attachment B** to this reply.

B. SCOPE

- [7] My reply evidence responds to points made in evidence by:
- (a) Andrew Barber on behalf of Horticulture New Zealand regarding Farm Environment Plans (**FEP**) and sediment management;
 - (b) Stuart Ford on behalf of Horticulture New Zealand regarding the Overseer modelling I undertook to assess potential nitrogen leaching reductions from CVG;

- (c) Alison Dewes on behalf of Fish and Game regarding the use of Overseer for CVG consenting; and
- (d) Gregory Carlyon on behalf of Ngāti Turanga and Fish and Game, and Michael Scott on behalf of Andrew Day, regarding the stringency of the alternative consenting pathways.

[8] My reply evidence does not respond to points raised by Dr Parlato as her evidence does not address the proposed risk assessment tool for CVG.

C. RESPONSE TO ANDREW BARBER

[9] I agree with Mr Barber's comments in paragraph 39 on the fundamental practices for reducing nitrogen losses from vegetable production.

[10] I partially support Mr Barber's proposal at paragraph 41 of his evidence to modify the definition of crop rotation. In my opinion, a crop rotation occurs over established site-specific commercial vegetable growing land and has a fixed location and area. If the crop rotation shifts beyond that established identifiable location and area onto land that has not previously been used for commercial vegetable growing, it cannot be considered genuine 'crop rotation'. Rather, for the purposes of PC2, it would be considered to be a 'new' commercial vegetable growing operation and require consent under the relevant rule for new intensive farming land use activities.

[11] Paragraph 73 of Mr Barber's evidence discusses the adoption and roll-out of NZGAP as of part the implementation of PC2 for CVG. Since the Council level hearing, further discussions with Mr Barber have led me to now support the use of the NZGAP vegetable FEP template (**NZGAP FEP**) with the addition of a Regional Guide as part of PC2, alongside the inclusion of the nitrogen risk assessment tool. However, I am reluctant to make the NZGAP FEP the only nutrient management plan (**NMP**) option for CVG at this time. There should be flexibility around options for the NMP. Another complicating factor is that the One Plan requires a consent for CVG area 4 ha or greater, while growers with 5 ha or more require a Freshwater Farm Plan (**FFP**).¹ Therefore, growers

¹ <https://environment.govt.nz/acts-and-regulations/freshwater-implementation-guidance/freshwater-farm-plans/>

who fall between this 1 ha difference may not wish to adopt NZGAP – rather, they may choose to just meet their One Plan consent requirements.

[12] Although closely timed, the timing of PC2 and the roll-out of the national FFP program for the Horizons region is not the same. The Horizons Waiopēhu freshwater management unit which encompasses most of the vegetable growers requiring consent under PC2 do not need a FFP until August 2024.² Further, the first audits are not required until 12 months after the FFP is certified, which may be up to 18 months after the plan was written potentially pushing auditing out by two and a half years.

[13] I do not wish to complicate or deter growers from applying for resource consent under PC2 because they are waiting for the FFP program to begin. Therefore, I do not support the roll-out of the third-party auditing process as required by the national FFP process before it is currently required. Instead, as proposed in Ms Foster’s evidence,³ growers can either complete:

- (a) a NMP to meet the requirements of PC2 and that can become a chapter of the FFP when required; or
- (b) a FEP such as the NZGAP template, which is reviewed and monitored by Horizons until the audit process is up and running.

D. RESPONSE TO STUART FORD

[14] At paragraphs 59–68 of his evidence, Mr Ford questions the Overseer modelling I have completed to gauge the effectiveness of the nitrogen risk assessment tool. I have reviewed my approach to the Overseer modelling, as described in my Evidence,⁴ and I am satisfied with the approach for the following reasons:

- (a) The methodology used closely aligns with Bloomer et al (2020), which Mr Ford considers to be *“the best possible and most accurate*

² <https://www.horizons.govt.nz/managing-natural-resources/our-freshwater-future/compliance-information-nes-fw/freshwater-farm-plans>

³ Statement of Evidence of Christine Foster (7 October 2023) at [154].

⁴ Statement of Evidence of Stuart Ford (13 October 2023) at 61–69.

representation of Overseer modelling that was available".⁵ For example, a vegetable system approach was used with the crop rotations grouped into the three vegetable systems outlined in Bloomer et al (2020) (potatoes and onions, brassica dominant, and intensive vegetables) and then scaled to a catchment level. I also used modified versions of the Bloomer et al (2020) models for my modelling.

- (b) The approach I have adopted has been used consistently in all the Overseer modelling I have completed as part of PC2.
- (c) The appropriate management practices that were determined by Mr Barber when testing the risk assessment score card with a sample of growers have been modelled in Overseer against the relevant crop rotations. These are typical for the targeted water management sub-zone in the Horizons region (around Lake Horowhenua) in which most of the commercial vegetable growing occurs and are therefore appropriate for the purpose of PC2.
- (d) For the Council level hearing, I modelled the effect of changing cultivation practices, the addition of grass buffer strips and controlled trafficking. However, here, only the management practices present within the score card have been modelled.⁶ Therefore, not all agreed good and best management practices have needed to be modelled in this exercise and Mr Ford's concerns about the ability of Overseer to model such practices do not apply.

[15] I do not agree with Mr Ford's comments in paragraph 51 stating that LUC 1 and 2 land have a low nitrogen leaching vulnerability. Although these soils are highly valuable, they are often free draining increasing their risk of nitrogen loss through leaching. Figure 1 highlights that in the Hoki_1a water management subzone (One Plan priority catchment) CVG operations are

⁵ Statement of Evidence of Stuart Ford (13 October 2023) at 55.

⁶ Being nitrogen fertiliser application rate, the use of nitrogen balances/budgets, nitrogen soil testing, crop establishment fertiliser application method, side fertiliser application method, cover crops/fallow periods, and catch crops.

located on primarily medium risk soils to nitrogen leaching. There are also pockets of high-risk soils to nitrogen leaching.⁷

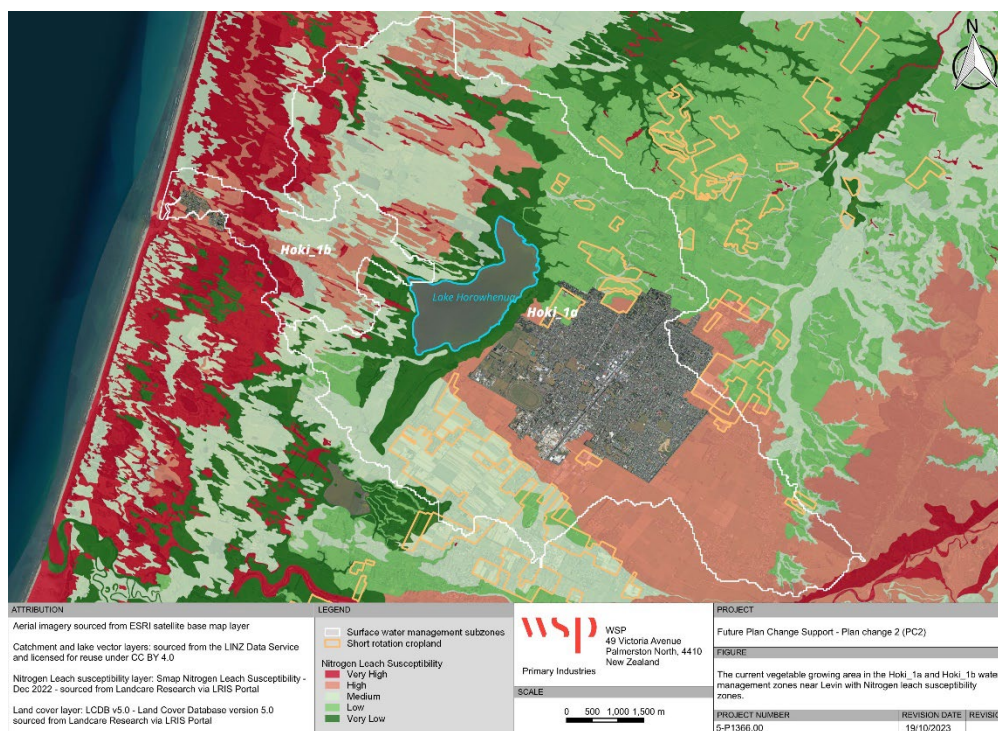


Figure 1: Nitrogen leaching vulnerability map of Hoki_1a water management zone with CVG highlighted.

[16] I note Mr Ford's support for the alternative controlled pathway provided by the nitrogen risk assessment tool, alongside the retention of Table 14.2.⁸

E. RESPONSE TO ALISON DEWES

[17] Although Dr Dewes highlights that Overseer is not ideal for use with CVG, her opinion is that it is better than a risk assessment tool for several reasons.⁹ A key reason Dr Dewes states that Overseer is a better tool than the risk assessment tool is that Overseer can model multi-enterprise farm systems where the risk assessment tool cannot. While this is true, the expectation within PC2 is for farmers and growers to improve on-farm management practices rather than whole farm system changes. Both Overseer and the risk assessment tool are suitable for the assessment of

⁷ <https://smap.landcareresearch.co.nz/maps-and-tools/app/>

⁸ Statement of Evidence of Stuart Ford (13 October 2023) at 89.

⁹ Statement of Evidence of Alison Dewes (6 November 2023) at 12.2–12.4 and 21.8–21.9.

improved management practices. Where a farmer or grower cannot meet the controlled activity consenting pathway requirements the discretionary consenting pathway is available, and it is that pathway where additional tools such as Overseer can be used to inform what on-farm charges (such as a multi-enterprise approach) are required in order to get a consent.

- [18] As set out in my primary evidence, the risk assessment tool for CVG has been designed to drive practice change by requiring the adoption of the most effective management practices for reducing nitrogen loss. It was these same practices that were modelled by Bloomer et al (2020) and the same practices used to inform the 35% nitrogen reduction in the DV-PC2 alternative pathway. Therefore, irrespective of the tool used, growers will be required to implement the same mitigation practices on farm in order to achieve the reductions in nitrogen leaching loss (or loss risk).
- [19] The risk assessment tool has some other advantages to either the specified nitrogen reduction pathways or solely relying on Table 14.2.
- (a) It addresses the direction from the MfE that in a regulatory context Overseer should be used in combination with other tools. This is why the risk assessment tool was developed in the first place. Despite the improvements to Overseer shown in recent redevelopment project reports, to my knowledge this MfE guidance remains the same.¹⁰
 - (b) It has taken into account the complexity of CVG systems, while developing a pragmatic tool for PC2. This includes different intensities of vegetable system, the complex nature of crop rotations continuously changing, and the fact that nitrogen leaching for CVG is not simply influenced by a single crop.
 - (c) It avoids the negativity that has become associated with the use of Overseer for modelling nitrogen leaching loss from CVG. While I am of the view that Overseer can model vegetable systems, ‘workarounds’ are required.¹¹ It is evident also that the CVG industry

¹⁰ See the Statement of Evidence of Elizabeth Daly (6 October 2023) at Attachment C.

¹¹ Section 42A Technical Report of Anne-Maree Jolly (4 September 2020) at 32–37.

are concerned with the use of Overseer as a regulatory tool for CVG.¹² In contrast, as I noted in my Evidence, the CVG risk scorecard received positive feedback when engagement occurred and when trialled with industry. To my knowledge, this level of engagement has not been known to exist with the One Plan by growers since it was notified in 2007. Given this, I consider that growers will engage with the amended DV-PC2 once operative and will apply for consent and make the necessary practice changes within the timeframes set out in PC2. This would be an important step forward for managing nitrogen loss from CVG within the Manawatū-Whanganui region.

[20] I support Dr Dewes' view that Overseer is not ideal for use with CVG. I also support her view that Overseer can model CVG. This was my position at the Council level hearing, on the basis that suitable 'work arounds' were identified and recorded in a user guide for CVG in the Horizons region. However, since then the Ministry for the Environment (**MfE**) guidance has been that use of Overseer to impose absolute limit values should be avoided, with its use instead supported by other tools and available information. I note Dr Dewes echoes that advice.¹³ Further, as I discuss below, the Overseer redevelopment programme also appears to have had limited scope/validation for vegetable crops.

[21] Finally, Dr Dewes highlights at paragraph 14.3 of her evidence that the risk assessment tool does not incorporate phosphorus. PC2 has the role of reducing nitrogen loss to water through nitrogen leaching and therefore the inclusion of a phosphorus risk assessment tool would be out of scope. However, I would observe that:

- (a) Table 14.2 also does not incorporate phosphorous, so it is no better than the nitrogen risk assessment tool in this regard; and
- (b) Applicants seeking a controlled activity consent under the nitrogen risk assessment tool pathway will still need to submit a NMP, which

¹² See, for example, Statement of Michelle Sands (13 October 2023) at 108 and Appendix B (Statement of Evidence of John Joseph Clarke) at 73–79.

¹³ Statement of Evidence of Alison Dewes (6 November 2023) at section 16.

will record and take into account all sources of nutrients, including phosphorous.

- [22] Having said that, as highlighted in my Evidence,¹⁴ it is my opinion that the risk assessment tool can be modified in the future as necessary. This includes the addition of other contaminants, such as phosphorus.

Overseer Redevelopment

- [23] I have considered the Overseer August 2023 report highlighted in Ms Dewes' evidence at paragraph 16.5, along with the AgResearch Overseer report.¹⁵ This report states that the pastoral data has been deemed 'very good' for estimating nitrogen leaching, while the cropping data as being 'satisfactory' and 'good' for estimating nitrogen losses. I will not comment on the pastoral findings, however, the validation work for the crop comparison looked at a very narrow range of crops across two rotations. The first rotation was potatoes-fallow-peas-potatoes, and the second was potatoes-wheat-potatoes. In my opinion this level of data is not sufficient for validation modelling of the crop model. This is because there is of the vast range of crops within Overseer from grains to vegetable to fruit and seed crops. Therefore, in my opinion further validation should be completed for vegetable crops to support the statements relied on by Dr Dewes.
- [24] The Overseer redevelopment program included soil nitrogen mineralisation and immobilisation and crop model developments. This work was composed to three parts: soil nitrogen mineralisation, deep rooting plants and crop parameters.¹⁶ However, while significant improvements have been made to the crop model in general, I note that most of the issues for Overseer modelling of vegetable systems highlighted in Bloomer et al (2020) are still present at this point in time and the 'work arounds' and assumptions identified by Bloomer et al (2020) and within my original Council reporting are still required. The key issue with Overseer remains the limited number

¹⁴ Statement of Evidence of Anne-Maree Jolly (6 October 2023) at [80].

¹⁵ Jean Paul Tavernet *Assessment of Overseer model performance with experimental data from grazed pastures* (Overseer Ltd, August 2023).

¹⁶ Ministry for Primary Industries *Overseer Redevelopment Programme Report* (Technical Paper 2023/12, August 2023).

of vegetables crop types within the model, along with the monthly time step for data entry, and minimum cropping area.

- [25] In my opinion, the Overseer redevelopment is not the complete answer to the suitability of Overseer within a CVG regulatory framework. Therefore, noting the MfE guidance, the need for an alternative tool that has been specifically designed to manage the risk of nitrogen loss from CVG remains.
- [26] My opinion, supported by Mr Barber, is that the proposed PC2 CVG risk assessment tool is a sound model for managing nitrogen loss from CVG within the Manawatū-Whanganui region, and is fit for purpose.

F. RESPONSE TO GREGORY CARLYON AND MICHAEL SCOTT

- [27] Mr Carlyon raises concerns at paragraph 10.2 of his evidence that the alternative pathways (both the specified nitrogen reduction pathway and the risk assessment tool) are “*easier*” consenting pathways than meeting Table 14.2. Mr Scott echoes this view, suggesting that the alternative pathways are more “*lenient*” in paragraph 8.33 of his evidence.
- [28] In my opinion, both the specified nitrogen reduction and risk assessment tool pathways require growers to adopt meaningful management practice to reduce nitrogen loss to meet the stated threshold to qualify for controlled activity consent. In this sense, neither of the consent pathways are ‘easy’. Neither does this approach seek to secure consents for all intensive farming land uses, as has been suggested by Mr Carlyon and Mr Scott.¹⁷
- [29] To meet the thresholds under either pathway, substantial and specified reductions in nitrogen loss/risk still need to be achieved through the adoption of farm practices that target nitrogen.¹⁸ The alternative pathways are more practical (in that they are more workable for CVG in practice), but I would not say they were ‘easier’. Where the thresholds are not met (which in some cases is likely) a discretionary activity consent is required.

¹⁷ Statement of Evidence of Gregory Carlyon (6 November 2023) at 16.9; and Statement of Evidence of Michael Scott (6 November 2023) at 8.22.

¹⁸ As described in the score card at Schedule [X], in the Council’s proposed provisions.

- [30] At the Council level hearing I supported a proposed controlled activity pathway utilising best management practice for CVG but on the basis that nitrogen reductions needed to be significant.¹⁹ Based on the modelling I had undertaken and other best available information, a reduction of 35% was ultimately supported before the Hearing Panel, with a baseline (or ‘starting year’) of 2013 and considering a range of good management practices.²⁰ This specified nitrogen reduction was ultimately reflected in DV-PC2.
- [31] As I have indicated, similar practice changes will be required under the risk assessment tool. By way of example, Mr Barber highlights the degree of change required by each of the growers.²¹

Modelled reductions

- [32] Mr Carlyon also raises concern on the modelled CVG 70% reduction.²² I do not agree with his concerns. As highlighted above, I have reviewed my modelling approach and I remain comfortable with it. It reflects the score card data collected by Mr Barber. There are several reasons why this reduction is so great, including:
- (a) Primarily, unlike the dairy industry where the adoption of nitrogen focused GMP has occurred slowly over time since the introduction of the One Plan, prior to 2018 little to no nitrogen practice change occurred on-farm by vegetable growers. Therefore, the baseline year of prior to 2018 creates more opportunity for improving nitrogen use efficiency. This has resulted in greater gains when good management practice (GMP) and/or best management practice (BMP) have been adopted and modelled in Overseer.
 - (b) The way management practices associated with nitrogen fertiliser are modelled in Overseer will also influence the amount of nitrogen leached. The modelling approach I undertook follows Bloomer et al (2020). The key GMPs required for adoption are the use of frequent

¹⁹ Section 42A Technical Report of Anne-Maree Jolly (4 September 2020) at 43–48.

²⁰ Section 42A Technical Report of Anne-Maree Jolly (4 September 2020) at 45.

²¹ Statement of Evidence of Andrew Barber (13 October 2023) at 60–66.

²² Statement of Evidence of Gregory Carlyon (6 November 2023) at 14.2–14.8.

nitrogen soil testing alongside a nitrogen budget. These tools will inform the amount of nitrogen fertiliser required by the crop. If the fertiliser quantity is greater or less than what has modelled in Overseer, the nitrogen leaching loss to water value will be impacted. Bloomer et al (2020) relied on Reid and Morton (2019)²³ to inform suitable nitrogen fertiliser quantities for each vegetable crop.

- (c) A modelled reduction in nitrogen loss to water of 70% may seem large but as Table 1 illustrates my original Overseer modelling for the Council-level hearing had a range of reductions in nitrogen loss for the selected crop rotations. This modelling exercise modelled similar practice change such as those associated with nitrogen fertiliser and the use of catch and cover crops. These practices are also key within the nitrogen risk assessment tool.

Table 1: The effect of GMP and BMP on different crop rotations:²⁴

Crop rotation	kg N/ha				
	Original	GMP	%Reduction	BMP	% Reduction
potatoes	22	14	36	10	55
onions	95	46	52	42	56
cauliflower broccoli broccoli	220	100	55	61	72
cauliflower potato cauliflower	134	27	80	23	83
pumpkin cauliflower broccoli	226	137	39	101	55
spring onion spinach lettuce maize	103	32	69	18	83
cabbage					
oats lettuce cabbage spinach oats	160	91	43	54	66
oats lettuce cabbage maize	160	11	94	10	94
maize spinach lettuce spring onion	116	26	78	10	91
oats					
maize spinach lettuce spring onion	116	35	70	11	91
cabbage					

- (d) As discussed above (under Dr Dewes evidence) during the Overseer redevelopment in December 2022 and April 2023 updates to the crop model occurred. Within the December 2022 update modifications to the rooting depth for deep rooting crops occurred.

²³ Jeff Reid and Jeff Morton *Nutrient management for vegetable crops in New Zealand, Horticulture New Zealand* (Horticulture New Zealand, 2019).

²⁴ Section 42A Technical Report of Anne-Maree Jolly (4 September 2020) at 28.

This included maize which is one of the catch crops used within my Overseer modelling. This update resulted in maize capturing more nitrogen than previously in the model as its deep roots, and therefore ability to uptake nitrogen from further down the soil profile, were more accurately represented. This meant less nitrogen would be available for leaching within the model.

- [33] It needs to be noted that the modelling exercise has been undertaken to predict possible nitrogen reductions from CVG at the catchment level with the best intention of reflecting the risk assessment tool accurately. However, on-farm adoption of these GMP and BMP may present different challenges, which may in turn impact the potential reduction of nitrogen leaching.
- [34] Even accounting for some uncertainties (with the use of Overseer, and the fact that on-farm adoption of these GMP and BMP may present differently impacting the potential reduction of nitrogen leaching), I remain confident that the adoption of a range of GMP and BMP will significantly reduce the nitrogen loss from CVG whether the tool is the risk tool or Overseer.
- [35] Looking at the 70% reduction from a different point of view, all parties should have confidence that there are management practices currently available that can reduce grower nitrogen footprint substantially when adopted. Dr Snelder addresses the water quality implications in his reply.

13 November 2023

Dr Anne-Maree Jane Jolly

G. ATTACHMENTS



PAGEBLOOMER

MODELLED LOSS OF NUTRIENTS FROM VEGETABLE GROWING SCENARIOS IN HOROWHENUA

OverseerFM 6.3.2 Modelling of Representative Rotations
within Hokio_1a, Hokio_1b, and Ohau_1b WMSZ

Report for Pattle Delamore Partners

January 2020

Dan Bloomer, Georgia O'Brien, Luke Posthuma
Page Bloomer Associates

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1. Executive Summary

As part of the project, “Environmental Effects of Horticultural Practices in the Manawatu-Whanganui Region”, OverseerFM modelling of vegetable production scenarios was completed. The results apply only to the study area of known vegetable production in the Hokio 1a and 1b, and northern edge of Ohau_1b Water Management Sub-Zones (WMSZ) (see Figure 1, page 3).

The tonnages of nitrogen and phosphorous entering the hydrological system were calculated for both pre-2019 and post-2019 using grower supplied data for planted areas, crop rotations and nutrient management practices.

- The total amount of nitrate-N lost by leaching from the vegetable growing areas in the study area was calculated to be 29.59 tonnes pre-2019 and 17.57 tonnes post-2019.
- The total amount of phosphate-P lost by leaching from the vegetable growing areas in the study area was calculated to be 0.66 tonnes pre-2019 and 0.43 tonnes post-2019.

To derive these results, many assumptions and compromises were required. We modelled a range of crop rotations in each of three production system scenarios; an onion/potato rotation, brassica dominated fresh vegetables and intensive fresh vegetables. To estimate catchment impacts, we applied the results on a pro rata basis according to cropped areas provided by growers and Horticulture New Zealand.

We have compared new practice with recommendations in the 2019 guidelines, “*Nutrient Management for Vegetable Crops*”. In general, we find growers often using less fertiliser than the new guidelines might suggest as good practice.

We note that many crops grown are not included in OverseerFM and some alternative must be selected. When selecting surrogate crops, a first option was to select a surrogate from the same family, but in some cases the actual crop has very different yield and different plant parts are harvested. In such cases, a closer representative was selected. We also identify that including grass in a rotation appears to generate unrealistically high levels of crop nitrogen accumulation and subsequent leaching.

Levin currently has no S-Map soil map layer. For modelling, onion/potato crops are on Waitohu deep silt loam (Moko_2a.1) and brassica and intensive fresh vegetable production are on Shannon deep silt loam (Paha_29a.1), both with adjustments to S-Map defaults.

Modelling cropping systems in OverseerFM had limitations. The need to enter grower operations by month in Overseer leads to simplification of crop plans. N leaching increased when we modelled best practice fertiliser management recommendations to split fertiliser applications. The model can give variable results when incorrect yields are entered. However, different growers can use quite different definition of yield, and yield values are further compounded when using surrogate crops from the OverseerFM list. For ryegrass as a cover crop, the model predicts excessive N leaching from unrealistic N plant uptake results. We modelled ryegrass Forage Oats (Autumn sown) which gave more realistic N values.

Our observations are that growers in Levin are generally efficient with their fertiliser use and there are few opportunities to further reduce rates of N applied without increasing the risk of crop failure. In most cases, current applications are near or below those recommended in the latest science based best practice guidelines.

2. Introduction

As part of the project, “Environmental Effects of Horticultural Practices in the Manawatu-Whanganui Region”, OverseerFM modelling of vegetable production scenarios was completed. The OverseerFM results used in this report were generated on 30 January 2020.

We have used data provided by the growers wherever possible in the belief that this project will be best achieved via use of actual information that is pertinent to, and derived from, horticulture in the region. We also considered theoretical data to cross-validate the modelling and considered outputs against results from our own research and consultancy.

We recognise that land use for commercial vegetable production can be extremely variable, with different areas of land used in different ways at different times. This occurs within paddocks, from paddock to paddock and in and out of sub-catchments and changes seasonally and annually.

We modelled a range of crop rotations in each of three production system scenarios; an onion/potato rotation, brassica dominated fresh vegetables and intensive fresh vegetables.

To estimate catchment impacts, we applied the results on a pro rata basis according to cropped areas provided by growers and Horticulture New Zealand. The relative contribution of each has changed with a much reduced area in intensive fresh vegetables and relatively little change in area for the other scenarios. We have restricted areas of vegetable crops to those in the study area, covering the Hokio 1a and 1b, and northern edge of Ohau_1b Water Management Sub-Zones (WMSZ) (see Figure 1).

In the last 12 - 24 months there have been significant changes in growing practices, particularly responding to the new nutrient management requirements. Growers are moving from the 1984 fertiliser recommendations to those in the 2019 recommendations and are adopting the Nitrate Quick Test strip approach. Some are testing very regularly, generally before any fertiliser application, and adjusting fertiliser prescriptions accordingly.

The land area to which no fertiliser is applied has increased significantly. About 40% of cropped area has greatly increased areas of headland and half now has crop-free tramlines for irrigation, spraying and harvest lanes. Growers have retired land and shifted crops out of the catchment.

To understand the likely load entering ground water before present we have modelled scenarios using typical crop rotations, fertiliser practices and areas as they were in years prior to 2019 (“old practice”). To compare this with the likely load in the future we repeated this using the practices growers report they use now and will use in the future (“new” or good management practice”).

We have compared new practice with recommendations in the 2019 guidelines, “*Nutrient Management for Vegetable Crops*”. In general, we find growers often using less fertiliser than the new guidelines might suggest as good practice. In about half of cases, OverseerFM shows a crop nitrogen deficit. Where we identified potential to further reduce nutrient inputs, we have modelled accordingly and reported future results reflect this.

We have been forced to make many assumptions and to substitute actual planted crops with surrogate crops and to assume soils because the area is unmapped. All assumptions and their rationale are described in the following sections.

Importantly we note that many crops grown are not included in OverseerFM and some alternative must be selected. We also identify that including grass in a rotation appears to generate unrealistically high levels of crop nitrogen accumulation and subsequent leaching. Therefore, as described we have replaced grass with forage oats which tends to generate numbers that seem more plausible.

3. Vegetable Growing Areas Used in Modelling

The area selected for this study is restricted to the flatter parts of the Arawhata Catchment south-east of Levin. The area includes Hoki 1a and 1b, and northern edge of Ohau_1b and extends from the Ohau River to Lake Horowhenua with vegetable growing sited on the deeper silt loam soils.

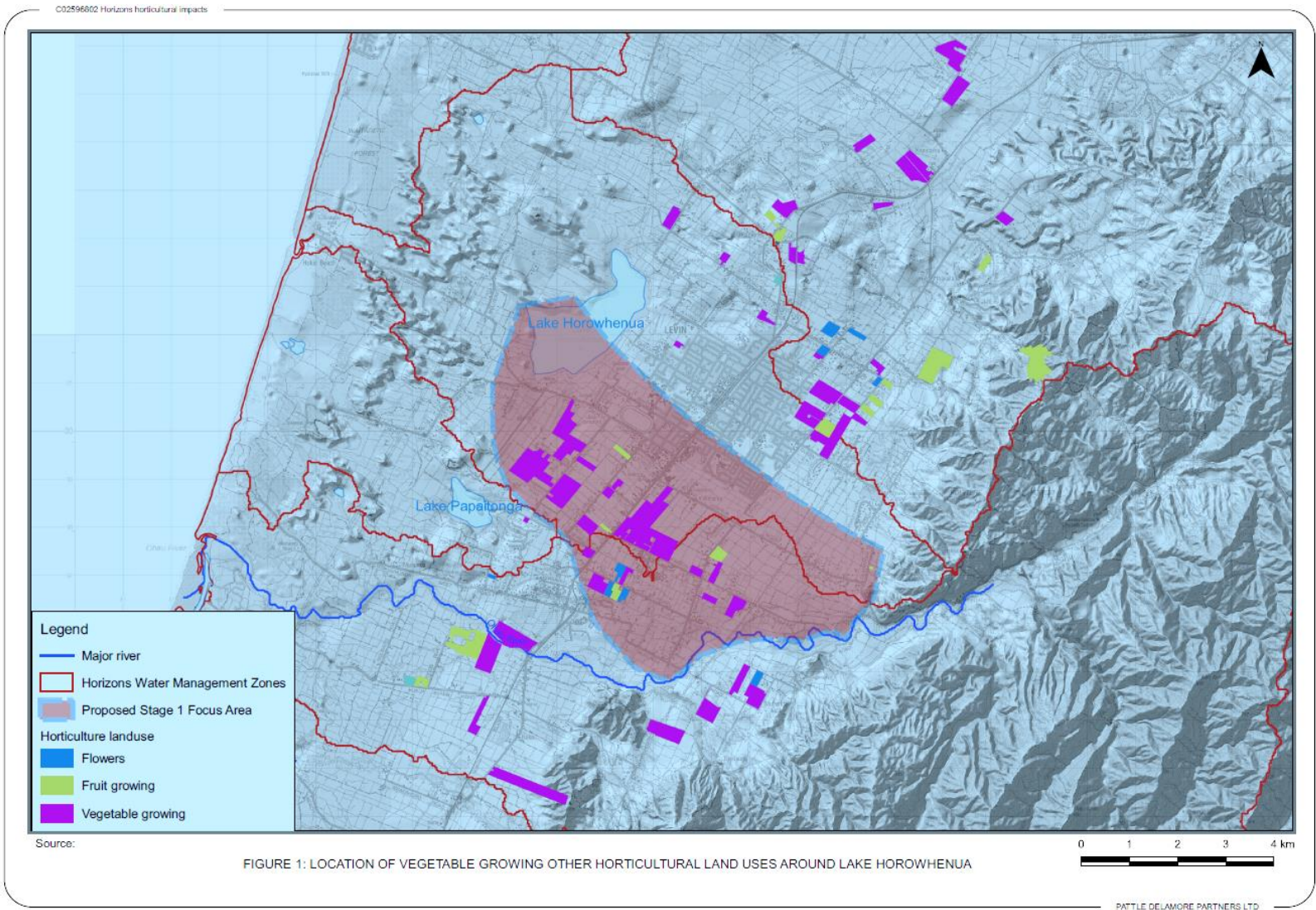


Figure 1 Location of Vegetable Growing within Water Management Sub-Zones around Lake Horowhenua

4. Details of Assumptions

Throughout data procurement and analysis, compromises and assumptions had to be made in order to enter suitable data into OverseerFM and complete the work within the specified timeframe.

4.1 Cropped Area

These results apply only to the area of known vegetable production in the study area. We were supplied with details from the main eight growers who believe they represent 95% of all production in the area covered.

A vast array of potential crops, planting times and rotations are possible and realistically not all can be modelled.

Since 2019, the area in intensive fresh vegetables has reduced much more than brassicas or onion/potato rotations because some land is no longer used for cropping, headlands are much wider, and areas used for unplanted tramlines have increased. Therefore, the relative areas of each farm system scenario changed between pre- and post-2019.

We believe that pre-2019 there were 419 title hectares of which 90% or 377 hectares were cropped. Post-2019 the title area reduced by 9.5% to 379 ha, but the area with crops reduced by 20% to 302 ha or about 80% of title area cropped (Table 1).

Table 1 The extent and relative contributions of different vegetable farm system types pre- and post-2019

Farm System Type	Pre-2019		Post-2019	
	Title Area	Cropped Area	Title Area	Cropped Area
All Vegetable Areas	419 ha	377 ha	379 ha	302 ha
Intensive Fresh Vegetables		62%		52%
Brassica Dominant Rotation		11%		13%
Onion/Potato Rotation		27%		34%

The OverseerFM modelling has been completed assuming blocks have 100% of their area cropped. The catchment load is derived from the modelled losses from each block and each farm system scenario on a pro rata basis according to the actual area in crop once buildings, driveways, headlands and uncropped irrigator/sprayer alleys are deducted.

4.2 Crop Rotations

Onion/Potato Rotation

The onion/potato system typically sees each crop type grown for two years in a paddock before it switches to the other crop type for two more years. Planting and harvest dates, nutrient additions and yields vary according to variety and timing, so a range of scenarios were determined and modelled. The weighted average N and P losses were used to determine the resultant quantity of nutrient loss in total from the full cropped area.

The two year OverseerFM period may have onion-onion and potato-potato or onion-potato and potato-onion or some combination of these. We have compared the results of repeating and switching crops and get very minimal difference across the total modelled area.

We did identify that using the OverseerFM defaults for inter-crop annual ryegrass phases greatly increased the modelled leaching, even more so than if land was left fallow. On the recommendation of Bruce Searle, we substituted the grass with forage oats.

	Potato1	Potato1	Potato1	Potato2	Potato3	Potato3	Potato3	Potato4	Onions (Early)	Onions (Mid)	Onion (Main)	Beetroot
Oct	Potato1			Potato2	Potato3	Potato3	Potato3	Potato4				
Nov	Early	Potato1	Potato1		Early	Mid	Potato3					
Dec		Mid	Late				Late					
Jan												
Feb												
Mar									Annual Ryegrass			
Apr	Annual Ryegrass				Annual Ryegrass				Autumn	Annual Ryegrass	Annual Ryegrass	
May	Autumn				Autumn					Autumn	Autumn	
Jun									Early			
Jul										Mid		
Aug												
Sep											Main	Beetroot
Oct	Potato1			Potato2	Potato3	Potato3	Potato3	Potato4				
Nov	Early	Potato1	Potato1		Early	Mid	Potato3					
Dec		Mid	Late				Late					
Jan												
Feb												
Mar									Annual Ryegrass			
Apr	Annual Ryegrass				Annual Ryegrass				Autumn	Annual Ryegrass	Annual Ryegrass	
May	Autumn				Autumn					Autumn	Autumn	
Jun									Early			
Jul										Mid		
Aug												
Sep											Main	Beetroot

Figure 2 The modelled farm system scenario for onion and potato cropping as practised in Arawhata shows crops and dates in a range of representative blocks.

Brassica Dominant Vegetables

A significant part of the WMSZ is used to produce brassicas for year-round sales. To ensure sufficient crop is available every day, multiple smaller plantings are made approximately twice weekly. A degree of crop rotation is needed for disease management and some alternative crops are grown.

To fully represent this system, a rolling rotation with 36 variations was designed and twelve of these selected for OverseerFM modelling. These are weighted by crop area and harvest time to give a fair overall average leaching value for the scenario as a whole.

The same rotation is used for both pre- and post-2019 scenarios, but cropped area and fertiliser applied vary somewhat. We noted that if we split fertiliser into three or more applications, OverseerFM generated increased leaching values. This appears to be due to the OverseerFM algorithm assuming the crop finishes growing and stops taking up nutrients so later fertiliser applications enter the soil nitrogen pool and are subsequently wasted. The experience of growers, published trial results and best practice recommendations suggest otherwise.

Block	3	5	7	11	13	15	19	21	23	27	29	31
Oct		Cauliflower									Pumpkin	
Nov												Cabbage
Dec							Broccoli			Lettuce		
Jan				Cabbage		Lettuce			Cauliflower			
Feb	Broccoli											
Mar			Lettuce		Cabbage			Celery		Cauliflower		
Apr		Broccoli										
May						Cabbage					Cauliflower	
Jun												
Jul			Broccoli				Onion					
Aug												Cauliflower
Sep	Lettuce								Potato			
Oct				Cauliflower						Pumpkin		
Nov												
Dec		Lettuce			Cauliflower	Broccoli		Cabbage				
Jan	Cabbage										Broccoli	
Feb			Lettuce									
Mar		Broccoli										Leek
Apr				Lettuce								
May												
Jun					Lettuce				Cauliflower	Cabbage		
Jul			Onion								Lettuce	
Aug						Cauliflower		Broccoli				
Sep	Potato			Cabbage								

Figure 3 The modelled farm system scenario for Brassica dominant cropping as practised in Arawhata shows crops and dates in a range of representative blocks.

Intensive Fresh Vegetables

The Intensive Fresh Vegetables scenario is the most complex with numerous crops and multiple sowings and plantings to meet daily market demands. This scenario has also seen more significant change since pre-2019.

The introduction of tramlines has increased average planted-area yields, the amount of fertiliser used is much reduced, there has been a reduction or removal of some crop types, and catch-crops (maize, grass and oats) have been introduced. Because of these changes, two related but significantly different scenarios were modelled, one pre-2019 and one post-2019.

The post-2019 scenario is based on actual grower planting plans for the 2019-2022 period, block by block and planting by planting. To model this in detail in OverseerFM we would need to create hundreds of blocks of 0.1 – 1.0 ha each. Once plantings were clumped into months and some other rationalisation was done, 38 different blocks representing different crops and rotations were identified and modelled.

These 38 blocks were adjusted for the pre-2019 scenario, replacing catch-crops with fresh vegetables or fallow. Replacement crops were selected from the other fresh vegetables grown according to grower advice of historic practice. Yields and fertiliser applications were adjusted to reflect changes between pre- and post-2019.



Figure 4 PRE-2019 Intensive Fresh Vegetable Rotations



Figure 5 POST-2019 Intensive Fresh Vegetable Rotations

4.3 Crop Assumptions

Many vegetable crops grown are not included in the OverseerFM options so surrogates must be chosen. When selecting surrogate crops, we considered information from other sources including “*Nutrient Management for Vegetable Crops in NZ*”¹ and the UK Agriculture and Horticulture Development Board “*Nutrient Management Guide (RB209)*”². A first option was to select a surrogate from the same family, but in some cases the actual crop has very different growth form and yield and different plant parts are harvested. In such cases, a closer representative was selected.

Between-crop pasture phases are a particular issue. The defaults from OverseerFM can produce crop nitrogen accumulations of 300 - 400 kg N/ha which is much higher than our other experience shows. The excess accumulation and grower applied nutrients together predict higher leaching than should be expected. We therefore substituted grass with forage oats which generates nitrogen values of 60 - 100 kg N/ha and results from subsequent-crop balances that are more plausible. (See also section 5.1)

Table 2 Actual crops grown, the surrogate crops selected in OverseerFM and rationale for the selection

Actual Crop	Overseer Crop	Reason for crop choice	Notes
Annual Ryegrass	Forage Oats (Autumn)	Plant type - grasses	Representative N Uptake
Celery	Spinach	Petiole/leaf	Similar harvest index
Coriander	Spinach	Petiole/leaf	Significantly lower yield
Fennel	Parsnips	Plant family	Similar harvest index
Kale	Kale (Forage)	Plant family	Default yield
Leek	Onion	Plant family	Lower harvest index
Parsley	Spinach	Petiole/leaf	Similar harvest index
Pumpkin	Squash	Plant family	
Radish	Beet	Swollen stem	Similar harvest index
Red Cabbage	Cabbage	Plant type	
Rockmelon	Squash	Plant Family	
Shanghai	Cabbage	Plant family	Default yield
Spring Onion	Onion	Plant family	Similar harvest index (RB209 Guide)
Watermelon	Squash	Plant Family	
White Pak Choi	Cabbage	Plant family	Default yield
Wong Bok	Cabbage	Plant family	Default yield

4.4 Yield Assumptions

We have used the higher of grower reported yield and the OverseerFM defaults in line with advice received from Horticulture New Zealand. We understand Overseer technical advice states yield should be entered as the crop default yield or higher because the model has simple assumptions that can be wrong when yield is lower than the crop default yield.

We used typical or average crop yields provided by growers. We generalised these and used the same yields throughout the year. However, we selected summer (planted October – January) or winter/spring crop (planted February – September) where this is a relevant OverseerFM option.

¹ JB Reid and JD Morton 2019

² <https://ahdb.org.uk/nutrient-management-guide-rb209>

4.5 Soil Assumptions:

Levin currently has no S-Map soil map layer. There are various indicated soil distributions, so advice was sought. The S-Map soil definitions used follow recommendations from Prof. A. Palmer who has made several local surveys including transects across the Pescini property on Kimberley Road and on the Woodhaven Gardens properties along CD Farm Road. He reports that soils do vary but are predominantly Waitohu at Pescini's and Shannon or Levin at Woodhaven Gardens. For modelling, we therefore deemed a soil change at the State Highway.

Prof. Palmer also recommended some amendments to the details in the S-Map soil catalogue. The onion/potato rotation was modelled using Waitohu deep silt loam – (Moko_2a.1) with the drainage class changed from imperfect to moderately well drained and ASC to 60.

The intensive vegetable and brassica rotations were modelled on a Shannon deep silt loam (Paha_29a.1) with the ASC changed to 25. ASC modifications were made based on past detailed soil tests indicating higher ASC content that suggested by the S-Map factsheets.

Alternative soil options are Levin deep silt loam or Levin deep silt loam on sand (Levi_1b.1 and Levi_4a.2). The proportion of cropping that might fall on this soil is unknown. Its leaching potential is lower than the two soils used for modelling for this report, so our results may over-estimate losses by some margin on some of the area.

5. Modelling Issues

Modelling cropping systems in Overseer had some technical difficulties due to limitations of the model. Some technical difficulties came with crop types and yield definitions. Overseer has a limited range of crops with unclear definitions of yield: total biomass grown, harvested plant part, exported plant part. Similarly, the portion of plant biomass returned as residues to the soil is not clear. For crop types, changing a Summer Cauliflower to a Winter Cauliflower at a critical period can change predicted N loss by 40% for that block.

5.1 Annual Ryegrass:

Good grower practice is to plant cover-crops on ground that will be bare in winter. Current practice for some growers is to plant an annual ryegrass and overwinter graze with lambs.

To avoid excessive N leaching from unrealistic N plant uptake results, in our analysis the actual planted ryegrass was modelled as Forage Oats (Autumn sown) which gives much more realistic N uptake by the growing crop.

When we enter annual ryegrass in OverseerFM, the model estimates very high plant uptake (300-400kg N/ha) when either default grazing or estimated grazing concentration is used. When the annual ryegrass crop is terminated and the subsequent crop is grown, only a small portion of the resulting soil mineral N pool is used. During the following winter period, modelled leaching rates are high – caused by the elevated soil mineral N pool.

The modelled plant uptake is shown to be incorrect based on field-trials completed by Plant and Food Research (Dr Bruce Searle pers.com.). Following discussions with Dr Searle we substituted grass with Forage Oats. If the crop was in the ground for 3 months or less, yield is entered as 4 t/ha. If crop was in the ground for 4 months or more yield is entered as 6 t/ha. The crop was terminated with cultivation. This generates nitrogen uptake values of 60 to 100 kg N/ha, which is in line with Plant and Food Research's estimates for uptake of winter grown ryegrass cover crops. We

understand Overseer technical advice also recommends using forage oats instead of ryegrass in this situation.

5.2 Yield/Weight Definition

The Overseer model can give variable results when incorrect yields are entered. However, definition of yield by growers can change greatly between growers. Yield errors are further compounded when trying to fit actual crops to similar OverseerFM recognised crop types e.g. Asian brassicas to a cabbage or cauliflower crop based on a similar harvest index, but substantially lower yields.

Yield is typically defined as typical harvest portion of the crop. OverseerFM only has models for a few generic crops for which it has default yields. When substitute crops are used, yields entered can be meaningless. To give repeatable results, there needs to be further information for interpreting definitions of yield for each crop to allow correct entry of the correct plant parts. One example is Chinese-cut broccoli, for which the normal cut yield rather than actual yield should be entered into OverseerFM. When the Chinese-cut check box is ticked, OverseerFM models doubled crop removal. To give repeatable results, yield needs to be entered consistently by all users: when there is disagreement on how yield is to be entered, there is a lower level of certainty around the accuracy of the modelled scenarios.

5.3 Nutrient Uptake

The need to enter grower operations by month in Overseer leads to simplification of crop plans. This can result in a crop that grows for 14 weeks appearing to be in the ground for 5 months (20 weeks).

Nitrogen leaching increased when we modelled best practice fertiliser management recommendations to split fertiliser applications to no more than 50kgN/ha/application spread at one application per month. This appears due to the limited monthly time-step in the OverseerFM model predicting that N uptake is complete when additional fertiliser is applied. In reality, the plants are still actively growing and taking up nutrients. This OverseerFM modelling apparently assumes excess fertiliser goes into the soil mineral-N pool and increases leaching risk over the winter period.

6. Results of Modelling

In accordance with the Memorandum of Understanding agreed between project parties, no individual grower data is to be disclosed. As the farm system scenarios modelled do effectively describe individuals, only gross results are presented here. Full details are available for peer reviewers as required.

Nitrogen Loss

The total amount of nitrate-N lost by leaching from the vegetable growing areas in the study area was calculated to be 29.59 tonnes pre-2019 and 17.57 tonnes post-2019. This is a reduction of 41%.

There is considerable variation across all blocks modelled depending on crop selections, rotations and the actual percentage of title cropped. The highest modelled loss from a cropped area was 221 kg N/ha pre-2019, dropping to 163 kg N/ha post-2019. The lowest loss from a cropped area was 11 kg N/ha pre-2019, dropping to 9 kg N/ha post-2019.

Over all blocks, leaching of nitrogen dropped from 71 to 46 kg N/ title hectare.

Phosphorous Loss

The total amount of phosphate-P lost by leaching from the vegetable growing areas in the study area was calculated to be 0.66 tonnes pre-2019 and 0.43 tonnes post-2019. This is a reduction of 35.2%.

Our confidence in phosphate-P results is reduced, as OverseerFM default values were used for soil fertility rather than actual soil test values for each block. Also, the ASC of these soils may be higher than our amended value used.

The highest modelled loss from a cropped area was 7.0 kg P/ha pre-2019 and 7.1 kg P/ha post-2019. The lowest loss from a cropped area was 0.3 kg P/ha in both cases.

Over all blocks, leaching of phosphate-P dropped from 1.6 to 1.1 kg P/ title hectare.

7. Discussion

Our observations are that growers in Levin are generally efficient with their fertiliser use and there are few opportunities to further reduce rates of N applied without increasing the risk of crop failure. In most cases, current applications are near or below those recommended in the latest science based best practice guidelines.

Many vegetable crops grow large amounts of biomass and do take up significant quantities of nitrogen (>200kg N/ha). A primary issue when growing vegetable crops is crop residue management. Crop residue breaks down and releases significant quantities of mineral N into the soil profile, but the timing is dependent on soil temperature and moisture and there is little certainty when that nitrogen might be in a plant-available form (soil mineral N pool).

Some growers are using winter cover crops to remove excess N from the soil, and other growers are planning to introduce cover crops where their crop rotations allow. OverseerFM modelling does not appear to adequately represent nutrient balances in this case.

Levin's climate and soils provide good winter growing conditions for many vegetable crops. If soil mineral N levels can be minimised coming into winter through good crop residue management and catch crops, winter crops will leach significantly less nitrogen. Winter/Spring crops could require increased fertiliser inputs as the soil supply of nutrients will be reduced, but the timing of these applications can be targeted to match plant requirements and minimise leaching risk.

8. References

Publications

Anon. 2019. “OverseerFM User Guide”. via <https://docs.overseer.org.nz/fm/OverseerUserGuide.pdf>

Reid, JB and Morton, JD. 2019. “Nutrient Management for Vegetable Crops in NZ” Horticulture New Zealand

Agriculture and Horticulture Development Board, 2020. Nutrient Management Guide (RB209) via <https://ahdb.org.uk/nutrient-management-guide-rb209>

Personal Communications

Crop areas planted, rotations, yields, dates and fertiliser practices

- Jay Clarke, Woodhaven Gardens, Levin
- Chris Pescini, Pescini Bros, Levin
- Travis and Nigel Sue, B S Young, Levin
- John Young, Levin
- Jeffery Wong, Levin
- Chung Sue, Garden of York, Levin
- Harry Su, Levin
- Harry Li, Levin

Recommendations for OverseerFM input values

- Dr David Horne, Massey University
- Prof. Alan Palmer, Massey University
- Dr Bruce Searle, Plant and Food Research

Appropriateness of Scenarios and OverseerFM assumptions

- Stuart Ford, Agribusiness Group
- Charlotte Irving, Agribusiness Group

ATTACHMENT B

BEFORE THE HEARINGS PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of proposed Plan Change 2 to the One Plan

AND

IN THE MATTER of the submissions and further submissions
set out in the s 42A Officer Report

**SECTION 42A TECHNICAL REPORT OF ANNE-MAREE JOLLY
ON BEHALF OF MANAWATŪ-WHANGANUI REGIONAL COUNCIL**

TECHNICAL – GMP AND OVERSEER MODELLING FOR COMMERCIAL VEGETABLE GROWERS

4 SEPTEMBER 2020

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A. EXECUTIVE SUMMARY

1. The key conclusions of my section 42A technical report are:

- (a) There are a range of Good Management Practices (“**GMP**”) and Best Management Practices (“**BMP**”) available for Commercial Vegetable Growing (“**CVG**”). These practices play an important role in reducing contaminant loss from intensive farming operations.
- (b) Not all GMP or BMP will be suitable for adoption by all properties. Therefore, GMP and BMP lists need to be used as a toolbox approach, with farming practices and mitigation able to reflect the particular farm context.
- (c) Overseer® is a suitable tool to model nitrogen loss from CVG; however, I recommend that a specific User Guide for CVG is developed to enable consistent application in the Manawatu-Whanganui Region.
- (d) 35%-45% is a reasonably feasible expected reduction of nitrogen leaching from CVG if a combination of GMPs and BMPs, tailored to the property, are implemented by growers under the alternative controlled activity consent pathway.
- (e) The baseline year used for the purpose of assessment of consent application for CVG needs to be a year prior to the One Plan becoming operative. I recommend either 2012/13 or 2013/14.
- (f) Most GMP and BMP can be adopted by CVG farmers within a three-year timeframe. All GMP can be adopted within 5 years. BMP that involve greater interference with the growing system may take longer to fully implement therefore adoption of all BMP may not occur until 10 years.

B. INTRODUCTION

2. My full name is Anne-Maree Jane Jolly (nee Hill). I am currently employed as a Rural Environmental Consultant at WSP. I have been in that position since April 2017. Prior to that I was employed by Ballance Agri-Nutrients.
3. My role at WSP involves providing technical advice on soil and nutrient management across the primary industries. I work across New Zealand with farmers, food processors, district councils, and policy analysts, and regularly provide advice on the use of use of Overseer®. In doing so, I am also involved with the preparation of farm nutrient management plans.
4. I hold a Doctorate in Soil Science from Lincoln University and a Bachelor's Degree in Agricultural Science with Honours in Soil Science from Massey University. I am a Certified Nutrient Management Advisor.
5. I have been involved with Plan Change 2 to the Manawatū-Whanganui One Plan ("PC2") since December 2019, with a focus on providing advice and data analysis on GMP and BMP and the use of Overseer® for modelling the nitrogen leaching from CVG in the context of PC2. As part of my role, I co-authored the WSP Report, *Proposed Plan Change 2 Farm Scale Financial Impact Model*, dated 27 August 2020 ("WSP Report").

C. CODE OF CONDUCT

6. I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise.

D. SCOPE

7. My section 42A report covers the identification GMP and BMP for CVG farmers. It is based upon the technical work I completed for Horizons with respect to CVG, as described within the WSP Report, which involved defining, tabulating and modelling GMP and BMP with Overseer® to determine the effectiveness of possible changes in reducing nitrogen leaching in CVG activities.

8. The use of Overseer® and its suitability for CVG is also addressed in this report.
9. In addition to my own observations I rely on the technical section 42A reports of my colleague Mr Stephen McNally, Associate Professor David Horne and Mr Terry Parminter, as well as the technical report of Bloomer et al 2020.
10. I attended expert witness conferencing held on 21 and 22 July 2020 and 12 August 2020 in relation to Farming and Growing Management Practices and Farm Systems Modelling. I am a party to the outcomes of those conferences recorded in the joint witness statements (“JWS”) dated those same dates.
11. I have also reviewed the submissions and further submissions on PC2. Of particular note when considering my field of expertise are the following:
 - (a) The acceptance of the use of GMP and BMP;
 - (b) The requests for clarification on what are a GMP,
 - (c) The reductions in nitrogen loss that can be expected to result from the implementation of GMP and BMP in CVG; and
 - (d) The role of Overseer®, including the selection of the appropriate base year for assessment of adoption of GMP and BMP.

E. BACKGROUND

12. PC2 was proposed by Manawatū-Whanganui Regional Council (“**Horizons**”) to address issues that had arisen in implementation of the nutrient management framework within the One Plan (Chapter 14). In particular, there were challenges arising from continuous updates to Overseer® and a policy framework which saw competing policies (looping back to the need for compliance with Table 14.2) effectively rendering the restricted discretionary pathway unusable.
13. Implementation of the One Plan rules as written has become challenging because updates to Overseer® mean that nitrogen modelling undertaken today, using the current version of Overseer®, are not comparable with the nitrogen leaching limits specified in Table 14.2 (which is associated with a much earlier version of Overseer®). Therefore, the cumulative nitrogen leaching maximum (“**CNLM**”) values in Table 14.2

no longer reflect the modelling assumptions contained in the current version of Overseer®. Typically, nitrogen leaching rates estimated using the current version of Overseer® are significantly higher than the rates that would have been estimated using the original (Table 14.2) version, even for an unchanged farm system with the same fertiliser and management practices. This means it is, generally, more difficult to demonstrate compliance with the Table 14.2 CNLM limits. Additionally, the operative provision include a policy (14-5) that requires that all existing and new intensive farming land use activities (“IFLU”) activities must not exceed the Table 14.2 CNLM limits. Although the One Plan framework provides for applications to be made to exceed these limits, Policy 14-5(d) means they can never be granted and creates a conflict within the Plan.

14. PC2 seeks to resolve both these issues. It was designed to be a short-term solution to recalibrate Table 14.2 in line with an updated version of Overseer® and to provide a workable consenting pathway for IFLU which do not meet Table 14.2 (i.e. to address the issues with the policy framework), pending development of a revised plan to give effect to the NPS Freshwater Management 2020).

F. ASSUMPTIONS AND METHODOLOGY

15. To be able to confidently model the cost impact of practice changes on IFLU activities, both GMP and BMP needed to be defined, tabulated, and modelled with Overseer® to determine the effectiveness of each possible change in reducing nitrogen leaching.
16. In defining GMPs and BMPs the approach was to create an extensive list of options rather than keeping it narrow. This allows commercial vegetable growers to have a complete understanding of what Horizons considers to be a GMP or BMP and, therefore, what is required when growing vegetables within a priority catchment¹.
17. In differentiating between good or best management practices, GMP has been agreed through expert conferencing as a practice that a grower or farmer is already doing, or if not what they should be doing, if deemed suitable for their farming or growing system.² On the other hand, BMP has been agreed by the experts as practice changes that have a greater system impact, a greater financial cost to implement or maintain,

¹ Priority catchments within the Horizons region are Water Management Sub-zones where management of existing intensive farming land activities is controlled. These catchments are identified in Table 14.1 of the One Plan.

² Joint Witness Statement – Farming and Growing Management Practices dated 21 and 22 July 2020.

such as newer technologies, or which are similar to a GMP but more involved (such as different levels of soil testing for CVG).³

18. The majority of GMPs and BMPs defined are already included in the Horticulture New Zealand Code of Practice for Nutrient Management 2014. Inputs have been provided by Bloomer et al (2020), in addition to being verified/added to by a local grower. Several GMPs and BMPs outlined in the NZGAP Farm Environment Plan template (2019) have been ear-marked as being suitable for Horowhenua CVG. The defined values of the required width of a grass buffer strip were identified in the Erosion and Sediment Control Guidelines for Vegetable Production (Barber, 2014).
19. I carried out the Overseer® crop rotation models to feed into the farm financial modelling my colleague Mr McNally discussed in his technical report. The Overseer® models developed by WSP are not enterprise models across a catchment and do not represent the actual range or location of growing systems in the catchment. Rather, they have been useful in exploring the range of nutrient reduction that might be achievable. Others have, separately, explored what impact that could have on water quality in the CVG catchments in the region, based on available land use data (in particular Dr Snelder and Mr Cox in their reporting).
20. The WSP models I have developed looked at eight different crop rotations adopting GMP and BMP, covering: potatoes, onions, leafy greens, pumpkin and brassicas typical of the Horowhenua production area. The eight rotations were selected from Bloomer et al (2020). For the purpose of this report, I note the following key features of the modelling approach I have used in looking at the eight rotations:
 - (a) Eight baseline Overseer® models were developed using 2014 data (one model for each crop rotation). These models were built from the best publicly available information (Bloomer et al 2020, Clark 2019, O'Brien 2019, Reid and Morton 2019, and The Agribusiness Group 2014). These models determined how the crop rotation aligns with the current and recalibrated Table 14.2;
 - (b) Using the eight baseline models, single practice changes (e.g. fertiliser modifications) at GMP were fed into the baseline model to determine how a single change element affected the crop rotation and the alignment with the current Table 14.2 and recalibrated Table 14.2 after farm practice refinement.

³ Joint Witness Statement – Farming and Growing Management Practices dated 21 and 22 July 2020.

During this process two crop options became four due to two options for practice change;

- (c) Point 'b' was repeated to all BMPs;
- (d) All GMPs were fed into the baseline model simultaneously to determine how the crop rotation aligns with the current and recalibrated Table 14.2 after farm practice refinement; and
- (e) All BMPs were fed into the GMP models simultaneously to determine how the crop rotation aligns with the current and recalibrated Table 14.2 after additional farm practice refinement.

21. Further details are provided in Section 4 of the WSP Report.

G. REPORT FINDINGS

22. There are a range of GMPs and BMPs suitable for adoption by CVG that will reduce nitrogen loss from the farm systems.

23. The majority of nitrogen-focused GMPs and BMPs for CVG can be modelled using Overseer®, however there are some questions around accuracy. I discuss the use of Overseer® later in this report (Section H).

24. The GMPs and BMPs that have been modelled in Overseer® are highlighted below. All of these GMPs and BMPs were agreed by the relevant experts in conferencing on PC2⁴.

1. GMP soil

- 1.1. *Minimise soil tillage as much as practicable*
- 1.2. *Minimise fallow periods between crops*
- 1.3. *Incorporate crop residual where possible*
- 1.4. *Planting of buffer strips at the bottom of each paddock (3 m)*
- 1.5. *Planting of buffer strips at the sides of each paddock (1.5 m)*
- 1.6. *Planting catch crops in between vegetable rotations*

2. GMP nutrients

- 2.1. *Soil testing for base fertiliser every two years*
- 2.2. *Soil testing for nitrogen at the beginning of each crop planting using quick N test*
- 2.3. *Yearly deep N tests (600 mm) to determine the level of residual nitrogen remaining in the soil*
- 2.4. *Matching soil testing results to plant requirements*
- 2.5. *Split fertiliser application*
- 2.6. *Using most suitable types of fertiliser for crops*

⁴ Joint Witness Statement – Farming and Growing Management Practices dated 21 and 22 July 2020.

2.7. *Applying fertiliser only where it is required, follow instructions for application, avoid waterways*

3. GMP water and irrigation

3.1. *On-site soil moisture monitoring is conducted on crops that require 'wet' soils*

3.2. *Irrigation scheduling is tied in the soil moisture monitoring*

3.3. *Irrigation is applied to maintain soil moisture between wilting point and field capacity where possible*

3.4. *Irrigation applied allows achievement of the yield target for fertiliser applied*

4. BMP soil

4.1. *Planting of buffer strips at the bottom of each paddock (6 m)*

4.2. *Planting of buffer strips at the sides of each paddock (1.5 m)*

4.3. *Use control trafficking where appropriate*

5. BMP nutrients

5.1. *Soil testing for base fertiliser every year*

5.2. *Soil testing for nitrogen before each side dressing for fertiliser using quick N test*

5.3. *GPS monitoring all fertiliser applications: proof of placement*

5.4. *Nutrient levels are managed and informed by soil tests to match rainfall/irrigation and yields*

25. For CVG there are a wide range of GMPs and BMPs available, many of which are not nitrogen focused but rather phosphorus and/or sediment. Due to individual systems and the makeup of each enterprise, every GMP or BMP may not be suitable for adoption on every farm. Therefore, it is recommended that a toolbox approach is used with the intention that each individual enterprise adopts the suitable GMPs and BMPs for their individual system, the nitrogen leaching sought and the consent they are applying for.
26. The predicted cumulative nitrogen leaching values for the baseline models completed by WSP ranged between 22 kg N/ha to 226 kg N/ha for a range of brassica, intensive vegetable, and potato crop rotations. This is from a 2014 starting point/baseline.
27. Most of these values are well above the Table 14.2 CNLM values required for a controlled activity consent under the operative One Plan. Currently, Table 14.2 has a maximum allowable nitrogen loss of 25 kg N/ha on LUC class 1 land at year 20. The adoption of the recalibrated Table 14.2 would lead to the maximum allowable nitrogen loss being set at 43 kg N/ha on LUC class 1 land.

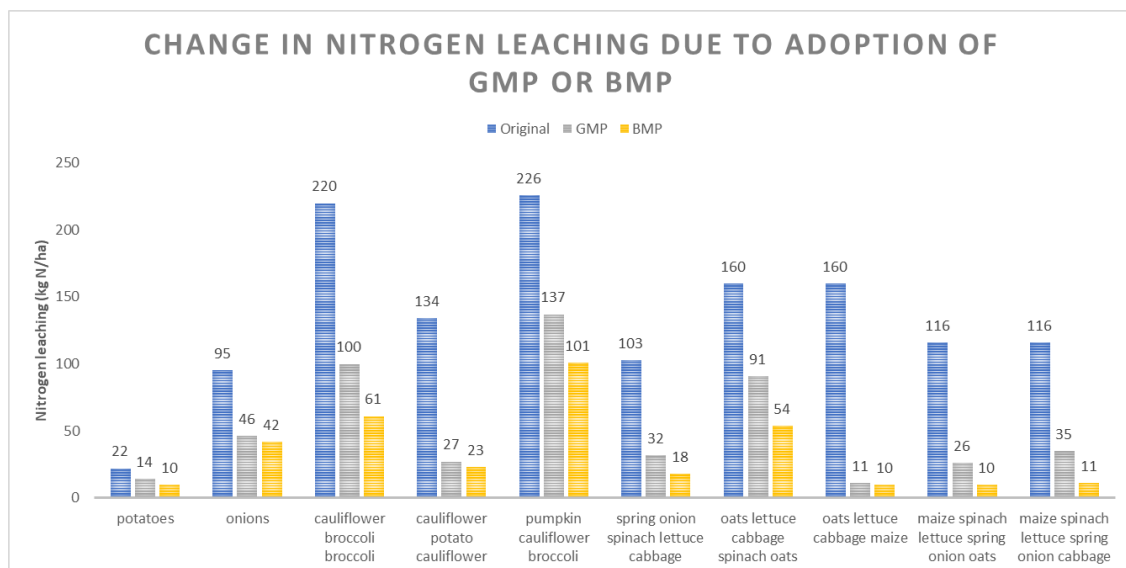


Figure 1 A comparison in nitrogen leaching losses value expected to result from the adoption of GMP or BMP

28. Through the adoption of GMP or BMP as part of CVG, I would expect reductions from individual crop rotations ranging between 36-94% for GMP and 55-94% for BMP, using a starting year/baseline of 2014 (Figure 1 and Table 1).

Table 1 The effect of GMP and BMP on different crop rotations

Crop rotation	kg N/ha			LUC 1 GMP	
	Original	GMP	% Reduction	Table 14.2	Table 14.2 R
<i>potatoes</i>	22	14	36	Y	Y
<i>onions</i>	95	46	52	N	N
<i>cauliflower broccoli broccoli</i>	220	100	55	N	N
<i>cauliflower potato cauliflower</i>	134	27	80	N	Y
<i>pumpkin cauliflower broccoli</i>	226	137	39	N	N
<i>spring onion spinach lettuce maize cabbage</i>	103	32	69	N	Y
<i>oats lettuce cabbage spinach oats</i>	160	91	43	N	N
<i>oats lettuce cabbage maize</i>	160	11	94	Y	Y
<i>maize spinach lettuce spring onion oats</i>	116	26	78	N	Y
<i>maize spinach lettuce spring onion cabbage</i>	116	35	70	N	Y

<i>Crop rotation</i>	<i>kg N/ha</i>			<i>LUC 1 BMP</i>	
	Original	BMP	% Reduction	Table 14.2	Table 14.2 R
<i>potatoes</i>	22	10	55	Y	Y
<i>onions</i>	95	42	56	N	Y
<i>cauliflower broccoli broccoli</i>	220	61	72	N	N
<i>cauliflower potato cauliflower</i>	134	23	83	Y	Y
<i>pumpkin cauliflower broccoli</i>	226	101	55	N	N
<i>spring onion spinach lettuce maize cabbage</i>	103	18	83	Y	Y
<i>oats lettuce cabbage spinach oats</i>	160	54	66	N	N
<i>oats lettuce cabbage maize</i>	160	10	94	Y	Y
<i>maize spinach lettuce spring onion oats</i>	116	10	91	Y	Y
<i>maize spinach lettuce spring onion cabbage</i>	116	11	91	Y	Y

29. Through the adoption of all the GMP or BMP considered by WSP (not a mix of both), a number of crop rotations are able to meet the recalibrated Table 14.2 limits for LUC 1, 2 and 3. However, there is no LUC class where all rotations can meet the recalibrated Table 14.2 (Table 2).
30. As LUC decreases (i.e. higher LUC number) the CNLM allowance decreases according to Table 14.2 of the One Plan, therefore the number of rotations able to meet the recalibrated Table 14.2 also decreases. This is evident from Table 2 below.
31. If a 20% margin of error is adopted (the accepted margin of error of Overseer® (Parliamentary Commissioner for the Environment, 2018)) additional crop rotations are able to meet the recalibrated Table 14.2 for some LUC classes (Table 2 below).

Table 2 The number of crop rotations after the adoption of GMP or BMP under different LUC classes out of a total of 10 rotations

	<i>LUC 1</i>	<i>LUC 2</i>	<i>LUC 3</i>
<i>GMP</i>	6	6	4
<i>Addition with 20% margin</i>	2	0	2
<i>BMP</i>	7	6	6
<i>Addition with 20% margin</i>	0	1	0

H. USE OF OVERSEER

32. The nutrient modelling tool Overseer® was created in the 1980s. Since then, significant resources have been used to further develop Overseer® into a world-class farming decision support tool. Although not originally developed as a regulatory tool, Overseer® has become a well-known tool used extensively by Regional Councils across New Zealand for regulatory purposes.
33. Overseer® is a decision support tool that needs to be used by suitably-qualified person. In my opinion, when using it for regulatory purposes the modelling should be undertaken by a suitably-qualified person (being one who holds a current Certified Nutrient Management Advisor certificate). This opinion was shared/confirmed at expert conferencing, as recorded in the JWS dated 20 and 21 July 2020.⁵
34. Within the consent application process, a range of different models are used. For IFLU applications, when taking an output-based approach (as in the One Plan), nitrogen loss must be determined somehow. Due to the diffuse nature of the movement of nitrogen through a farming landscape, on-farm measurements are near impossible. Therefore, a model is required. It is my opinion that Overseer®, when applied appropriately, can be a suitable model for this purpose.
35. Like any model, Overseer® has a standard of error. The standard margin of error for Overseer has been stated to be 20% (Parliamentary Commissioner for the Environment 2018). However, I accept that for systems other than pastoral systems this error margin is likely to be higher due to the limited data available. It is therefore advisable to consider setting relative percentage nitrogen leaching reductions alongside absolute targets. As research is completed and the models within Overseer® are updated the margins of error will decrease. As margins of error decrease it is likely that absolute values for estimated nutrient losses will change, sometimes substantially, as has happened previously. Providing an option for a relative reduction pathway for consent reduces exposure to these changes when Overseer® updates via two mechanisms. Firstly, the percentage reduction should be calculated by comparing 'before' and 'after' models of the farming system using the same version of Overseer®, with any changes to outputs as a result of the update impacting both models relatively evenly. Secondly,

⁵ Joint Witness Statement – Farming and Growing Management Practices dated 21 and 22 July 2020.

as the target is a percentage reduction, Overseer® improvements that do not directly affect mitigation practices should have less impact on the percentage reduction, and thus farm compliance, than absolute nutrient loss estimates.

36. In addition to standard error, limitations of the model also need to be considered. There are known limitations for all land uses, however the accuracy of Overseer® is the most questionable for CVG. In saying all the above, I do not agree with some submitters who suggest that the limitations and margin of error deem Overseer® ‘unusable’ for CVG.
37. There are a range of suitable ‘work arounds’ that can be used when modelling CVG. In my view, the methodology developed by Bloomer et al (2020) shows it is possible to model nitrogen losses using Overseer® for CVG. However, to achieve consistency in modelling approaches and agreement on suitable ‘work arounds’ it is recommended that an Overseer® User Guide for CVG in the Horizons region be considered. The development of any User Guide would be prepared by Horizons or the technical experts with technical input from CVG Overseer modellers and any industry group who wishes to be involved (such as Potatoes NZ). The basis of the Guide would be methodology developed by Bloomer et al 2020 and WSP.
38. Due to continuous improvements around the available data on nutrient loss from New Zealand farming systems, as well as constant development of mitigation options, Overseer® is updated every year. Each development ultimately makes Overseer® a more robust tool and the nitrogen loss estimates become more accurate. As history has proven, significant version upgrades, as happened in 2015, can have a profound impact on model outputs. As explained by Associate Prof. Horne, there are always ways that values adopted in regulatory settings can be recalibrated to remain meaningful.
39. There are other models that can model nitrogen loss from CVG, however I have no experience in using any of the available alternates so cannot comment on their advantages or disadvantages over Overseer®. Associate Prof. Horne provides a useful summary of their relative merits and disadvantages.

I. SUBMISSIONS

40. I have reviewed the submissions relevant to GMPs and Overseer® for CVG. I also attended pre-hearing meetings attended by submitters who are commercial vegetable growers and (as described above) I attended expert conferencing for Farm Systems Modelling, GMP and Overseer®

41. Submitters widely support the use of GMP as part of the consent application process. However, some submitters have asked for GMP to be better defined. Submitters with a CVG focus have also supported the use of BMP on-farm. Defining what practices are GMP or BMP for nitrogen loss have been explained above. GMP and BMP across all four contaminants have been highlighted in the WSP Report.
42. Some submitters have contributed differing opinions on which year to use as the 'starting year' or baseline. For CVG, some submitters proposed a baseline of the 2017/18 season or 2019. In my opinion the base year for CVG consent applications needs to be prior to the One Plan becoming operative. Therefore, I suggest that 2013/14, or 2012/13 (to align with dairy farms) is a more suitable starting year (base year). A later starting year would disadvantage any commercial vegetable growers who began adopting GMP since the One Plan became operative (2014) and prior to applying for consent. With a 2013/14 base year, any changes that have been made on-farm already would be accounted for within the consenting process. However, I note that data is likely to be unavailable across many CVG operations for a 2013/14 base year.
43. Several submissions with a CVG focus proposed an alternative controlled activity consent pathway. Following discussions at pre-hearing meetings, Horizons circulated an alternative controlled activity consent pathway which was considered by the experts during conferencing on a without prejudice basis. That pathway focused on the adoption of BMP for CVG and a percentage reduction of nitrogen.
44. I support a proposed pathway utilising BMP for CVG but equally consider that nitrogen reductions need to be significant. This is because it is a controlled activity pathway. All suitable GMP and any suitable BMP for that individual property would need to be adopted. GMP and BMP would also need to target all suitable contaminants on an individual property, not just nitrogen. Any consent application would require Overseer® nutrient budgets as well as a comprehensive Farm Environment Plan (FEP).
45. The nitrogen reductions expected from a pathway relying on BMP would need to be determined. It is difficult to define a rigid expected nitrogen reduction that could be applied across a catchment based off the modelling I have completed to date. However, based on all best available information, for CVG a minimum reduction of between 35% and 45% could be expected across an enterprise. This is higher than the suggested reduction of Bloomer et al (2020), who suggested a 23% to 35% reduction was achievable. However, there are two key differences between the work I have

completed and the modelling of Bloomer et al (2020). Firstly, I used a different baseline or 'starting year' of 2014 whereas Bloomer et al adopted a 2019 baseline. Secondly, Bloomer et al adopted fewer of the of available GMP practice changes. Bloomer et al focuses on GMP practice changes that were linked to nitrogen fertiliser usage and the adopted on some catch crops. In comparison, I looked at a range of GMPs associated with the use of nitrogen fertiliser, the addition of a catch crop whenever there was a three-month fallow period (apart from between June to August), change in cultivation practices, the addition of grass buffer strips and controlled trafficking (BMP)⁶.

46. Woodhaven Garden's submission (s57) proposes reductions of up to 36% be required across a 20-year period for a controlled activity. Specifically, at year 5 a 15% reduction, year 10 a 25% reduction and by year 20 a 36% reduction. The fact that a major vegetable grower within a priority catchment proposes a 36% reduction, suggests to me that a reduction between 35% and 45% is not infeasible.
47. In my opinion, the nitrogen reductions can be achieved in a much shorter timeframe than highlighted in the Woodhaven Garden submission (S57). Most GMP and BMP practice changes across all IFLU activities can be adopted within three years. The exception being anything to do with animal genetics and breeding programmes (which may take up to 10 years), the building of significant infrastructure (such as herd homes which have a significant cost attached), and the implementation of controlled trafficking (where the machinery upgrades that are required have a significant financial cost) which is likely to be implemented at the time when machinery is due to be upgraded.
48. During expert conferencing, it was discussed that over time new GMPs and BMPs will become available to growers and farmers. Therefore, the current GMP and BMP lists for each IFLU should not become 'locked-in' lists but rather lists that are capable of review over time so that additional practice changes can be added. Having a live GMP and BMP list will also continue to encourage innovation and novel solutions across all intensive land uses, which will lead to continuing improvements in the industry.
49. What is required in a consent application was discussed during expert conferencing. Irrespective of the consent pathway, it was agreed that nutrient modelling showing nitrogen reductions around the meeting of Table 14.2 (or otherwise) are required.

⁶ WSP Report Section 4.

50. Currently, Horizons requires a Nutrient Management Plan (NMP) as part of an IFLU consent application. NMP predominately cover the loss of nutrients from a property. This is despite PC2 highlighting that an NMP is required to cover nitrogen, phosphorus, sediment and E. coli. This may be suitable for a controlled activity consent where Table 14.2 is met. However, in my opinion it is not sufficient for the discretionary activity consent pathways. Therefore, the requirement of a FEP rather than an NMP should be considered as an as a requirement within a consent application.
51. A well put together FEP can provide farmers and growers strong guidance on where contaminants are lost from a property and how changes can be made to reduce or even off-set contaminant loss. In my opinion, key features of a good FEP include:
- (a) Property details;
 - (b) Property goals;
 - (c) Farm maps identifying all significant infrastructure and natural features (e.g., waterways);
 - (d) Highlighting the current farm practices including all GMPs the farm is currently doing which reduce contaminant loss;
 - (e) Farm maps highlighting all critical source areas of all contaminant losses (nitrogen, phosphorus, sediment and E. coli);
 - (f) An assessment of risk from on-farm practices and activities resulting in reduced water quality including nitrogen, phosphorus, sediment and E. coli. Assessment includes, but is not limited to, nutrients, waterways, topography, soil, current farm policies, effluent, water usage and irrigation;
 - (g) Identification of time-bound actions in place to mitigate impacts of farming practice on the environment including the adoption of additional GMPs and other mitigations; and
 - (h) Evidence (such as photographs) of critical source areas or current practices where improvements are to be made.

J. SUMMARY

52. Through the adoption of GMP, six out of the ten CVG growing rotations modelled will be able the meet the recalibrated Table 14.2 on LUC class 1 land. Adopting BMP will result in one additional rotation being able to meet the recalibrated Table 14.2. At an

enterprise level, low crop rotation nitrogen leaching will be able to provide some off-setting to higher leaching crop rotations.

53. The work completed by Bloomer et al (2020) has shown that CVG can be successfully modelled in Overseer®. I have successfully used the Bloomer approach when developing Overseer® models to feed into the financial modelling. There are questions around the accuracy of modelling CVG in Overseer®. However, these questions do not make Overseer® 'unusable' and I recommend that guidance be developed for use compiling and assessing applications for consent, to achieve consistency of Overseer® use in Horizons Region.

K. REFERENCES

Barber, A. 2014. Erosion & Sediment Control Guidelines for Vegetable Production. Report for Horticulture New Zealand.

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Dr Anne-Maree Jolly

4 September 2020

BEFORE THE HEARINGS PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of proposed Plan Change 2 to the One Plan

AND

IN THE MATTER of the submissions and further submissions
set out in the s 42A Officer Report

**SUPPLEMENTARY SECTION 42A TECHNICAL REPORT OF ANNE-MAREE JANE JOLLY
ON BEHALF OF MANAWATŪ-WHANGANUI REGIONAL COUNCIL**

TECHNICAL – GMP AND OVERSEER MODELLING FOR COMMERCIAL VEGETABLE GROWERS

7 OCTOBER 2020

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A. INTRODUCTION

1. My full name is Anne-Maree Jane Jolly I previously provided a section 42A technical report in this matter dated 4 September 2020 on the topic of GMP and Overseer Modelling for Commercial Vegetables.
2. My background, experience and qualifications are set out in my original section 42A technical report, which I confirm but do not repeat in this supplementary report.

B. CODE OF CONDUCT

3. I reconfirm that I agree to comply with the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014, as set out in my original s 42A report.

C. SCOPE

4. This supplementary section 42A technical report responds to the evidence of Stuart John Ford. In particular this supplementary report focuses on:
 - (a) The required reduction of nitrogen leaching by commercial vegetable growers in order to gain the alternative controlled activity consent (Mr Ford, at paragraphs 63, 69, 74, 75, 76, 77, 83, 85 and 117 and 78 and Ms Sands, at paragraphs 296 and 297);
 - (b) The role of an Overseer User Guide (Mr Ford, at paragraph 62);
 - (c) The use of Good Management Practice ("**GMP**") and Best Management Practice ("**BMP**") for Commercial Vegetable Growing ("**CVG**").
5. I note that I do not intend to respond to every point raised in the above evidence and have focused instead on what I consider to be central issues or key matters in dispute. For the avoidance of doubt, where I have not responded on other issues raised within the evidence, it does not necessarily mean that I agree with the evidence.

D. HORTICULTURE NEW ZEALAND – STUART FORD

6. Mr Ford proposes that a 10-20% reduction in nitrogen leaching loss should be required in order to gain resource consent under the newly proposed alternative controlled activity pathway (paragraphs 76-78). I do not agree with this proposed reduction range.

For the reasons set out in my original section 42A technical report I continue to rely on my initial proposed range of 35-45%. I note that Ms Foster has in her section 42A technical report adopted a minimum reduction of 35%, which is at the lower end of the range recommended in my evidence. Specifically, at paragraph 12(c) of the section 42A,¹ Ms Foster records, *“for CVG, implementation of GMP and BMP that will achieve a minimum 35% reduction of N leaching compared to the baseline year (2013/2014) within three years of lodging the application.”* I support this approach. Therefore, from now on, I will refer to a reduction of at least 35% in nitrogen leaching.

7. Mr Ford is of the view that the work of Bloomer et al (2020) gives a more realistic view of the whole property nitrogen leaching result. As I stated in my original section 42A technical report, at paragraph 45, Bloomer et al (2020) suggested a 23% to 35% reduction in nitrogen leaching was achievable. The different conclusions reached in my modelling and that of Bloomer et al (2020) can be explained by two key differences: the baseline year, and the range of GMP and BMP adopted by each of us in our modelling work. I expand on these points below.
8. The key reasons I continue to support my proposed reduction range are:
 - (a) The Bloomer et al (2020) report identified an average property nitrogen loss of 71-78 kg N/ha pre 2019. Through the adoption of GMP and BMP for nitrogen fertiliser and the addition of catch crops, Bloomer et al (2020) reports a reduced average property nitrogen loss of 46-60 kg N/ha post 2019.
 - (b) On reviewing the Bloomer et al (2020) work there are two key differences between their assumptions and mine:
 - (i) Baseline year: The starting year (baseline) relied on by Bloomer et al (2020) was pre 2019. I disagree with this as a ‘starting year’ due to the One Plan becoming operative in 2014. Therefore, the starting year needs to be prior to that date (pre-2014) to avoid inadvertently legitimising unauthorised establishment or expansion of CVG since that time. The later ‘starting year’ of 2019 would also result in fewer achievable reductions because some growers have already made

¹ Section 42A Report, Christine Foster, 4 September 2020, page 174.

environmental improvements between 2014-2018, which would not be observed when using a starting year of 2019. This would penalise CVG who have already adopted BMP and GMP. One example of this is nitrogen fertiliser usage. Management practices associated with nitrogen fertiliser key GMP and BMP for CVG, with significantly different quantities being used between 2014 and 2019. This is highlighted by the field day handout attached at **Appendix A**, which records the Woodhaven nitrogen fertiliser usage between 2014 and 2019. The reduction indicates how the baseline year impacts the percentage nitrogen reductions that can be achieved.

(ii) Range of BMP and GMP adopted: a narrower list of GMP/BMP was adopted by Bloomer et al (2020) when compared to the agreed CVG GMP and BMP list adopted at expert witness conferencing for PC2 on 21 and 22 July 2020.² For example, Bloomer et al (2020) focused on fertiliser application and catch crops, whereas I also consider changing cultivation practices, the addition of grass buffer strips and controlled trafficking. All of which are agreed by the relevant experts, and by the relevant industry codes, to be GMP and BMP.

(c) Given these two key differences, I am of the opinion that greater nitrogen reductions can be expected. Although Mr Ford does not support a 2012/13 baseline, I note that most other submitters do support a baseline year of 2012/13, including Michelle Sands in evidence on behalf of Horticulture New Zealand (paragraphs 296 and 297).

9. I disagree with Mr Ford's assertion that the Overseer work I completed was invalid or incomplete (paragraphs 63 and 69). Mr Ford's description of my modelling work is incorrect. I did not take the approach Mr Ford outlined in his statement of evidence. My work consisted of modelling two years of crop rotation, not individual crops in isolation. Further, contrary to another assertion by Mr Ford, my modelling work was closely aligned with approach taken by Bloomer et al (2020). This included the adoption of the same workarounds as Bloomer et al (2020), including the adoption of the same surrogate crops (for those crops which it was not possible to model in Overseer) as the

² Joint Witness Statement – Farming and Growing Management Practices dated 21 and 22 July 2020.

Bloomer et al (2020) modelling work. The exception being an additional step taken by Bloomer et al (2020) where the final nitrogen loss for a property was adjusted down by factoring in additional non-productive land. My modelling did not include this step.

10. I was provided access by Page Bloomer Associates to the Overseer modelling completed by Bloomer et al (2020). Access was provided on the basis that I/WSP would not share any confidential grower information. I have upheld this obligation of confidentiality in my work to date. To ensure alignment between my modelling and the Bloomer et al (2020) modelling, I took the Bloomer et al (2020) models and recreated them in my own Overseer account. Using the Bloomer et al (2020) models as base models I adjusted the current fertiliser inputs to those outlined in **Appendix A** (year 2014) and labelled these models 'original'. Adjustments made to the future models included splitting them into GMP and BMP adoption, and adopting more practice changes. Two of Bloomer et al (2020) future rotations had crop modifications – I kept the original future rotation, but also looked at only adopting one catch crop over a two-year rotation rather than two (**Table 1**).
11. Table 1 below highlights the rotations which I modelled and the comparison rotation within the Bloomer et al (2020) work.

Table 1 Rotations modelled by Anne-Maree Jolly and the comparison rotation within the Bloomer et al (2020) work.

Anne-Maree Jolly crop rotation	Bloomer et al (2020) crop rotation
potatoes	E_PDP Onion & Potato 1b. Nadine Mid
onions	E_PDP Onion & Potato 6.ELK
cauliflower broccoli broccoli	E_PDP Brassica 05
cauliflower potato cauliflower	E_PDP Brassica 23
pumpkin cauliflower broccoli	E_PDP Brassica 29
spring onion spinach lettuce maize cabbage	E_PDP Intensive Vegetables 11
oats lettuce cabbage spinach oats	E_PDP Intensive Vegetables 35
oats lettuce cabbage maize	E_PDP Intensive Vegetables 35
maize spinach lettuce spring onion oats	E_PDP Intensive Vegetables 17
maize spinach lettuce spring onion cabbage	E_PDP Intensive Vegetables 17

12. Mr Ford suggests in his evidence that an Overseer User Guide is unnecessary (paragraphs 62 and 79). I disagree. I continue to support the development of a User Guide. The fact that I have suggested a User Guide does not mean that I consider

Overseer unworkable for CVG or that it is “damned with faint praise” in my evidence.³ My original section 42A technical report says otherwise at paragraph 36.

13. Adapting Overseer to reflect the specific needs of an industry is not unusual. In my experience with Overseer and dairy farms, there are well accepted ‘workarounds’ relied on when preparing budgets in that industry. The use of these accepted practices or protocols does not undermine the usefulness of the model within a regulatory environment. Working with the model to achieve consistency in application is important, particularly in the context of an interim plan change such as PC2 where Horizons is seeking to provide workable pathways for farmers and growers pending future plan reviews. I note that Ms Sands in her evidence for Horticulture New Zealand also recognises that in reality most growers will have to use Overseer as there are limitations in alternative options.
14. The Overseer User Guide I have recommended in my original section 42A report can be more simply described as a Practice Note or Protocols for data input. The purpose of any guide is to simply provide consistency in how data is entered in Overseer. This consistency will give Horizons and growers certainty that the consultants completing Overseer nutrient budgets for CVG are using the same approach when developing nutrient budgets for consenting purposes under PC2. This ensures that no grower is benefited or disadvantaged through any potential variance in Overseer approach.
15. I would be happy to prepare an Overseer Practice Note with support from Horizons Rural Advice team. However, I believe it is best to develop a user group to inform its preparation. Given that any Overseer Practice Note would be implemented and relied on by a wide range of stakeholders for the purpose of consenting under the One Plan, it is important that any user group is representative of the wider community. A user group will ensure that there is a diverse range of experience and practical knowledge contributing to the Overseer Practice Note. Involving users at the design stage will also, in my view, create better industry engagement and eventually adoption/acceptance.
16. At this stage, a user group has not been established, but a high-level list of parties who should be involved has been put together, including representatives from Horizons and

³ Stuart Ford, Statement of Evidence, dated 25 September 2020, paragraph 62.

submitters with Overseer expertise, plus Dan Bloomer. Under the direction of the Panel one possibility is for these parties to meet during the hearing to open discussions.

17. Mr Ford does not support the use of Overseer for CVG and believes that the use of look up tables are a better approach (paragraphs 83, 85 and 117). Irrespective of the limitations that Overseer has in modelling CVG, as I outline in my primary evidence (35 and 36) I continue to support the use of Overseer. I do not support the use of look up tables. There is a distinct absence of detail (methodology) in Mr Ford's evidence as how the look up tables would work in the context of PC2. My understanding of the look up tables suggests that their use would result in a blanket approach being taken across all growers. This is because, for some, the values will overestimate nitrogen loss, whereas for others, the values will underestimate nitrogen loss by arbitrary amounts.
18. A blanket approach would result in nitrogen leaching values being averaged. Growers who have been improving their environmental footprint will therefore be disadvantaged with the creation of look up tables. In comparison growers who have made no attempts to improvement their environmental footprint will be advantaged. I am of the opinion that this would disincentivise the adoption of GMP or BMP as there is no point in doing any more than the bare minimum. Potentially bad practice may therefore also be incentivised. This is the exact opposite of what PC2 is seeking to achieve.

E. OTHER

19. All submitter evidence from the CVG community to date provides a high level of support for the use and adoption of GMP and BMPs.
20. At the Farm and Growing Management Practices expert conference on 21 and 22 July 2020 all experts agreed on a suitable list of both GMP and BMP (as confirmed in the second expert conference on 14 August 2020), with the adoption being a 'toolbox' approach.⁴ The idea of a 'toolbox' was that growers and farmers could choose the practices that would enable them to reach the nitrogen loss reductions they required under the different consenting pathways and to demonstrate the adoption of GMP and BMP on their farms. In reflection of this I understand Ms Foster does not intend for the

⁴ Joint Witness Statement – Farming and Growing Management Practices dated 21 and 22 July 2020.

GMP/BMP lists to be applied as if they were exhaustive or prescriptive within the PC2 policy framework.

21. Although submitter evidence supports the use of GMP and BMP, both Horticulture New Zealand and Woodhaven have provided their own lists of suitable GMP and BMP. Horticulture New Zealand has done so in the form of the NZGAP FEP template and Woodhaven have provided further context in what they achieve on their property.
22. I do not consider the additional documentation on suitable GMP and BMP to be necessary. As I stated in my original section 42A report, these matters are already accounted for. At paragraph 18 I stated: *“The majority of GMPs and BMPs defined are already included in the Horticulture New Zealand Code of Practice for Nutrient Management 2014. Inputs have been provided by Bloomer et al (2020), in addition to being verified/added to by a local grower. Several GMPs and BMPs outlined in the NZGAP Farm Environment Plan template (2019) have been ear-marked as being suitable for Horowhenua CVG. The defined values of the required width of a grass buffer strip were identified in the Erosion and Sediment Control Guidelines for Vegetable Production (Barber, 2014).⁵”* Therefore, lists provided by Horticulture New Zealand and Woodhaven have already been taken into consideration when preparing my evidence.
23. It is also clear from the evidence of Mr Andrew Barber, Mr Damien Farrelly and Ms Sands that there is widespread understanding within the sector of what GMPs and BMPs are, with specific initiatives in place to get them established and implemented on farm. I therefore see no need to alter the purpose of the industry NZGAP and FEPs by inserting them as requirements into the policy or rule framework. I accept that this is a matter ultimately for the planning experts, and I defer to Ms Foster on this point.
24. Finally, I note Ms Sands’ view that Woodhaven’s submission was relied on in determining the required percentage nitrogen reduction (paragraphs 211-214). This is incorrect. The percentage range was determined by the factors highlighted above. My section 42A technical report later drew attention to the fact that Woodhaven also proposed reductions upwards of 35%. This formed part of the supporting analysis but was not a driving factor (or indeed a factor at all) in arriving at the reduction range.

⁵ Anne-Maree Jolly Primary Evidence 4 September 2020.

F. SUMMARY

25. The nitrogen reduction under the alternative controlled activity pathway should remain at least 35%. A 35% is the lower end of my range, and close to the upper range of Bloomer et al (2020) before taking into account the difference in 'starting year' and GMP/BMP.
26. All Overseer modelling, I completed was rotational modelling and closely aligned with Bloomer et al (2020) modelling. There is deliberate alignment in our approaches.
27. I recommend an Overseer Practice Note is required for CVG to provide consistency between modellers using Overseer and provide certainty to Horizons and growers.
28. There is strong support for the use of GMP and BMP for CVG across all parties, with widespread understanding within the CVG sector of what GMPs and BMPs are, and what needs to be done to ensure they are established and implemented on farm.

G. REFERENCES

Barber, A. 2014. Erosion & Sediment Control Guidelines for Vegetable Production. Report for Horticulture New Zealand.

Bloomer, D. O'Brien, G. & Postuma, L. 2020. Modelled loss of nutrients from vegetable growing scenarios in Horowhenua: Report for Pattle Delamore Partners.

Horticulture New Zealand. 2014. Horticulture New Zealand Code of Practice for Nutrient Management.

NZGAP. 2019. Environment Management System add-on: Farm Environment Plan Template.

Dr Anne-Maree Jolly

7 October 2020

APPENDIX A

Crop	average units of N/ha						
	Woodhaven Gardens			Best Practice - Regulated or Guidelines			
	old practices (up to 2014)	old practices (from 2015-2018)	New practices (from 2019)	NZ	America	Europe	Australia
Cabbage	145-220	85-195	60-160	113-169	196-252	180-363	88-144
Red Cabbage	145-220	74-262	60-160		120	70-325	
Lettuce	180-260	130-220	60-141	110-146	67-201	75-200	200
Spinach	155-170	80-170	35-60*	150-350	112-218	120-215	
Silverbeet	90-160	160-215	60-160	100-250	168-224	100-200	58-100
Broccoli		145-280	60-168	200	168-224	181-243	
Kale		120-197	60-114	91-109	67-112	250	
Radish	65-80	60-80	35-72*	100	56-84	100	
Pumpkin	120	120	60	120-180	56-165		160
Leeks	170-220	160-210	80-188	200	200-250	200	
Spring Onion	150-190	110-180	23-90*	120-180	130	280	138-276
Beetroot	65-120	60-120	40-76*	150-250	145-190	>250	
Celery	160-210	160-240	114-228	350	224-336	280	155-232
Celeriac		160-240	189	150-240	100-150	100-200	
Parsley	170-220	100-160	60-114		90-112	175	
Fennel	65-145	65-145	60-144		80-130	120-160	
Zucchini	120	120	110	80	80	180	
Watermelon	250	180	120	100	140-168		
Pak Choi			35-90		90-120		
Shanghai		35-90	35-90				
Wong bok			60-160		90-120		

* bt, sp, r, so 66.6%

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<http://www.hortnet.co.nz/publications/guides/fertmanual/veggie1.htm>

<https://www.freshvegetables.co.nz/assets/Uploads/Nutrient-Management-for-Vegetable-Crops-in-NZ-Manual-Feb-2020.pdf>