WORKSHOP ITEM:	SUBJECT MATTER: **What do we know about future nutrient losses in the Waiau catchment from both irrigated and dryland development, and under different assumed amounts of permitted winter grazing of forage crops?**
AUTHOR: Ned Norton	DATE OF MEETING: 29 January 2018

Updated version of this paper: This is an updated version of the paper that was circulated with other workshop material on 24th January 2018.

Purpose of this paper

This paper draws together findings from several pieces of work that are either recently completed or still in progress, to summarise what we know about future increases in nutrients in the Waiau catchment from irrigated development, and from permitted dryland development for both the Waiau and Hurunui catchments.

A subsequent paper will be prepared for the planned 7 February meeting to assess the likely effects of these nutrient increases on the risk of nuisance periphyton growth, that may in turn affect ecological, aesthetic, recreation, and other values. A draft of that assessment has been prepared but does not yet include estimates of nutrient losses from permitted dryland farming as these have been in progress. The present paper suggests that future increases in nutrient losses from permitted dryland farming are likely to be relatively small (see below) and will not significantly change the conclusions on environmental effects.

Two sources of future nutrient increases

We anticipate nutrient increases from two sources:

i) Future irrigated development – including currently consented but not yet implemented development as well as the proposed Emu Plains Irrigation (EPI) scheme for which consent applications were lodged in 2017.

ii) Permitted dryland development

Future irrigated development losses

Work by others has presented predicted increases in nitrogen losses from both the proposed EPI plus currently consented but not yet implemented development combined (Dark 2017; Ellwood 2017; Brown 2017; Ryder 2017). A summary is shown in Table 1.

Table 1: Predicted change in root zone Nitrate-N concentration from baseline to the fully developed scenario (including currently consented by unimplemented potential increases)

	Predicted Increase
Waiau River (below EPI)	7%
Mason River	49%
Pass Stream	17%
Home Stream	6.7%

The EPI assessments also used a nominal assumed upper bound estimate for increased phosphorus loss of 10%.

Future permitted dryland development losses

Predicting increases in nutrient losses from permitted plausible dryland development is particularly challenging for numerous reasons, as laid out in the draft information produced by the Hurunui District Landcare Group's (HDLG) farming survey and related case-study research (e.g., Brown 2017, Brown 2018). We must accept there is unavoidable uncertainty with any prediction made, as is also the case with the predictions above for irrigated development.

A useful and technically valid response when given the task of making predictions involving uncertainty is to consider multiple lines of evidence. If two or more lines of evidence converge to tell a similar story, then we can have greater confidence in our predictions. Several lines of investigation have been pursued as summarised below.

1. The draft HDLG Summary Report (Brown 2018) uses farm survey results and Beef and Lamb NZ data to show there has been a long-term decline in dryland stocking rate and no long-term trend in dryland winter forage area despite year to year fluctuations of around 30%. On this basis the report concludes there is likely to be no significant long-term trend in nutrient losses from dryland farms.

2. The draft HDLG Summary Report (Brown 2018) also offers a prediction for a "worst case" unlikely situation where there is an average increase of winter forage area of 50% across all dryland farms in the catchment (i.e., an increase from the current average 1.9% to 2.9% of property in winter forage) giving rise to approximately 14% increase in nitrogen loss from the group of all dryland farms in the catchment, which is estimated to translate to approximately a 1.3% increase in total in-river N load.

3. The draft HDLG full study results (draft presented at the December 2017 zone committee meeting) also include an estimated average OVERSEER-derived property increase in nitrogen loss of 4.1% over the last 24 years (0.17%/year) across 10 case study dryland development farms. The draft finding is that these 10 development farms may overestimate development in the whole catchment and so work is in progress to attempt to analyse how those 10 case study farms represent the rest of the catchment. This may in due course enable provision of another line of estimate of potential increase in nitrogen losses.

4. An earlier study "*Hurunui River nutrient modelling: impact of dryland intensification*" (Peter Brown 2015) analysed potential dryland development scenarios and reported

that a “*Moderate development scenario*” (involving 25% of the dryland tractor country [slope <15º] increasing N-loss by 30% (i.e., a 7.5% average increase across dryland tractor country) and 10% of the dryland hill country [slope >15º] increasing N-loss by 30%) was identified by a working group at that time as the most likely outcome. The Brown (2015) study also concluded that nitrogen headroom being offered by irrigators at that time (a 5% reduction in N-loss by irrigators) should offset the increase in N-loss under the dryland intensification scenario, so there would be no net increase in nitrogen load in the Hurunui River at SH1.

5. Environment Canterbury staff have been using a GIS-based method to estimate the nitrogen loss increases that could arise under various different amounts of permitted winter grazing of forage crops (see attached Memo; Mojsilovic 2018). These estimates provide another parallel line of evidence and inform discussions around options for permitting amounts of forage cropping. When considering these results it is important to appreciate that the hypothetical scenarios are based on changing the winter forage areas across all dryland farms individually up to the scenario maximum of either 2.5, 5 or 10% of the property in winter forage. In reality there is significant variability in the area of winter forage amongst individual farms as described in the HDLG Summary Report. The draft results (from the attached Memo table) suggest that:

   i) If all dryland farmers took up the opportunity to increase their area in winter forage to 2.5% of the property, this could result in approximately a 3% increase in the total N load lost from the root zone in both the Waiau catchment (at mouth) and the Hurunui catchment (SH1). This prediction is approximately comparable with the unlikely worst case analysis offered in the draft HDLG Summary Report described at bullet 2 above.

   ii) Under a hypothetical scenario where all dryland farmers increase their area in winter forage to 10% of the property (Note this is the theoretical fully utilised PC5 permitted activity case – which the draft HDLG Summary Report analysis suggests is well beyond plausible worst case), then the result is approximately a 10% increase in the total N load lost from the root zone in the Waiau catchment (at mouth) and a 5% increase in the Hurunui catchment (SH1).

   iii) Under a scenario where all dryland farmers increase their area in winter forage to 5% of the property (which is also beyond the HDLG predicted unlikely wort case), then the result is approximately a 6% increase in the total N load lost from the root zone in the Waiau catchment (at mouth) and a 4% increase in the Hurunui catchment (SH1).

In combination, all these lines of evidence to date suggest that future increases in nitrogen loss from dryland farming properties as a whole catchment group are likely to be small (i.e. in the order of 0-3%) relative to the total nitrogen load in the Waiau (and Hurunui) catchments and relative to predicted increases from irrigated development.

Memo

Date	25 January 2018
To	Ned Norton, Ian Whitehouse
CC	
From	Ognjen Mojsilovic

Modelling changes in Hurunui and Waiau catchment root zone nitrogen losses from hypothetical scenarios of permitted winter forage development

Method

The current land use and nutrient loss GIS model was updated in January 2018, taking on board feedback from by the Hurunui District Landcare Group. Specifically, the local data gave us an opportunity to more accurately reflect the farm inputs for the extensively grazed easy hill and steep land.

To estimate the effect of winter forage development, we assumed that the Landcare 2016 winter forage crop layer represents the current conditions on the modelled farms. The average area of winter forage cover on modelled dryland farms was 1.8%, although the distribution is highly skewed[1].

For each winter forage development scenario, I modelled the effect of increasing the current area of winter forage activity to 2.5 %, 5.0 % or 10 % of the total farm area. All scenarios restricted the increase to 100 ha of winter forage activity per farm. There was no minimum area assumed, unless the existing area was greater than the scenario maximum. No subdivision of large properties was modelled. Winter forage areas were not increased on irrigated farms.

If an increase in the winter forage activity was possible for a modelled farm, all effective land less than 15 degrees in slope was considered equally likely to be used for the hypothetical increase. I sourced the nutrient loss rates from the MGM dataset.

For reporting, the modelled farms and the modelled root zone nitrogen losses from the farms were grouped:

- according to the sub-catchment making up the largest proportion of the farm, and
- according to the spatial relation to irrigation zones and existing irrigation status. Here, dryland farms were classified into those with 50 ha+ land within the irrigation user/scheme areas (AIC, HWP, NTP, EPI, and Cheviot Irrigators), and all other dryland farms. This was to deal with the uncertainty of future development scenarios associated with some of the identified irrigation zones.

[1] The proportion of farm area classified as winter forage crop is very small on many farms and large on a few farms.

Results

Table 1 summarises the results of how the tested hypothetical scenarios alter the modelled root zone / source nitrogen losses across the main sub-catchments.

Attachments:

File reference:

				Winter Forage development scenarios (% of farm area)								
Farm Catchment	Farm Sub-catchment[1]	Farm irrigation class[2]	Current N load (t N yr^{-1})	Scenario N load (t N yr^{-1})			Absolute Change in N Load (t N yr^{-1})			Increase to the Sub-Catchment load (%)		
				2.5%	5.0%	10.0%	2.5%	5.0%	10.0%	2.5%	5.0%	10.0%
Hurunui	Mandamus	Dryland	395	420	420	425	25	25	30	5%	5%	6%
		Dryland farms (within irrigation user areas)	50	55	60	60	5	10	10	1%	2%	2%
		Irrigated farms (>50 ha irrigation)	40	40	40	40	0	0	0	0%	0%	0%
		All	485	515	520	530	30	35	45	6%	7%	9%
	SH1	Dryland	745	815	845	880	70	100	135	3%	4%	5%
		Dryland farms (within irrigation user areas)	695	750	805	880	55	110	185	2%	4%	7%
		Irrigated farms (>50 ha irrigation)	1,125	1,125	1,125	1,125	0	0	0	0%	0%	0%
		All	2,570	2,695	2,775	2,885	125	210	320	5%	8%	12%
	Mouth	Dryland	840	915	950	1,000	75	115	165	3%	4%	6%
		Dryland farms (within irrigation user areas)	790	850	910	1,005	60	120	215	2%	4%	8%
		Irrigated farms (>50 ha irrigation)	1,185	1,185	1,185	1,185	0	0	0	0%	0%	0%
		All	2,815	2,950	3,050	3,190	135	230	375	5%	8%	13%
Waiau	Leslie Hills	Dryland	260	305	325	345	45	65	90	7%	10%	14%
		Dryland farms (within irrigation user areas)	20	25	25	25	5	5	10	1%	1%	1%
		Irrigated farms (>50 ha irrigation)	365	365	365	365	0	0	0	0%	0%	0%
		All	640	695	715	740	50	75	95	8%	11%	15%
	Mouth	Dryland	840	940	1,020	1,110	100	185	275	3%	6%	10%
		Dryland farms (within irrigation user areas)	570	615	675	740	45	105	170	2%	4%	6%
		Irrigated farms (>50 ha irrigation)	1,465	1,465	1,465	1,465	0	0	0	0%	0%	0%
		All	2,875	3,020	3,160	3,315	145	290	440	5%	10%	15%

[1] Farms assigned to catchments based on area.

[2] Column describes the farm irrigation status, and if a farm has 50 ha+ land within the irrigation zones (AIC, NTP, HWP, EPI and Cheviot Irrigators areas)/