Memo

Date	28 November 2018
To	Lisa Jenkins,
CC	Ian Whitehouse
From	Ned Norton

Nitrogen allocation in the Hurunui catchment and its relevance for dryland farming and a draft plan change to "fix the 10% rule"

Contents

1. Purpose

The purpose of this memo is to set out the current state of nitrogen allocation in the Hurunui catchment, in a manner and level of detail that is relevant for considering the situation for dryland farming under current regional plan rules, and under proposed new plan rules.

A summary of the findings is shown in Figure 1 at the back.

2. Background

The subject of nitrogen allocation in the Hurunui catchment has a contentious history and is complex for several reasons, of which the following are particularly important to be clear about in addressing the purpose of this memo:

i) The Hurunui Waiau River Regional Plan (HWRRP) sets "in-river" catchment nitrogen[1] load limits (e.g., at State Highway 1) in tonnes of nitrogen per year (tN/yr). These are then assessed by monitoring flow and monthly nitrogen concentrations in the river, and from these then annually calculating an estimate of the actual in-river load for comparison with the load limit.

ii) However, the consented allocation of nitrogen to the irrigation schemes also requires administration by what can be referred to as "source" nitrogen loads, i.e., the estimates

[1] Specifically dissolved inorganic nitrogen (DIN) – see HWRRP Schedule 1.

of nitrogen load lost from the root zone or property boundary, or from a collection of properties within a scheme. These are assessed using consent-defined nitrogen loss look up tables that were developed specifically for the Hurunui irrigation schemes' purpose based on OVERSEER modelling. There is a relationship between source loads and in-river loads[2] but they are different, and it is important to be clear which is being referred to when discussing any numbers[3].

iii) The distribution of the load allocated by consents held by the three irrigation schemes in the catchment (Amuri Irrigation Company (AIC), Ngai Tahu Forest Estate (NTFE) and Hurunui Water Project (HWP)) has changed several times, as has the spatial area of the schemes command areas including changing overlaps, during several consent processes, appeals and subsequent agreements over the last few years. This memo only touches on these to the extent necessary to clarify the final (current) situation in relation to the full allocation of the catchment load limit and the situation for dryland farmers and independent irrigators.

iv) While a large proportion of the nitrogen load has been explicitly allocated by consent to each of the three irrigation schemes and a few independent irrigators, there is also an implicit allocation available for dryland farms as a consequence of the HWRRP permitted activity rules (e.g., the "10% rule"). In this memo the word "allocation" is used in a general sense to include both explicit and implicit allocations, and to set out the overall state of that allocation compared to the load limit in the HWRRP.

v) There is more than one way to calculate estimates for source loads (and indeed in-river loads). What is most important is that the same or directly comparable method is used across all allocated users, whether their load is explicitly or implicitly allocated, when setting out the overall status of catchment allocation compared to the load limit. This has been adhered to in this memo by using methods of estimating source and in-river loads associated with dryland farming that are directly comparable with the system of load accounting consented and used by all three irrigation schemes in the catchment.

---

[2] In simple theoretical terms the in-river load at any given point in the river is the source load from all land in the catchment upstream from that point minus the amount of attenuation occurring between the source and the point in-river. Generally, in the Hurunui case the source load is significantly higher (often in the order of double) than the in-river load because of attenuation, although this will in reality vary in time and spatially: a notable exception is the much lower attenuation rate of 0.1 (meaning the source load is only attenuated by 10% giving an in-river load that is only 10% smaller) as assessed for Balmoral Forest land next to the Hurunui River for reasons given in the hearing decision for Ngai Tahu Forest Estates Limited (CRC144606 and then CRC172842).

[3] My working assumption, which is the same as that which underpins the calculations of source load limits described in annexures to the irrigation schemes' consents, is that any percentage increase or decrease in source nitrogen load will ultimately, after allowance for time lag, correspond to the same percentage increase or decrease respectively in the in-river load, regardless of the absolute size of the attenuation rate at any given place and time. Underlying this is the assumption that the *rate* of attenuation remains constant under increases and decreases of source load nitrogen notwithstanding that rate varies spatially and in time.

3. Method

The current state of nitrogen allocation set out in the next section of this memo draws on:

- The HWRRP and the background and documented intent of decisions in setting the particular load limit numbers in Schedule 1 of that plan.
- Several consent decisions that allocated unused portions (at that time) of the nitrogen load limit to the then proposed NTFE and HWP irrigation schemes, including in particular consents CRC120675 (HWP-1), CRC153349 (HWP-2), CRC172780 (HWP-3), CRC172842 (NTF-1), CRC172781 (NTF-2), and their attachments and annexes, which I understand reflect the process from initial allocation through to the final (current) allocation situation following agreements reached between HWP, NTFE and AIC on the nitrogen load split between schemes and areas.
- Planning and legal interpretations by ECan staff and advisors to ECan that I have communicated with on the meaning of conditions on the irrigation scheme consents.
- Estimates of potential increases to the amount of nitrogen lost from dryland farms (collectively) in the catchment under the existing HWRRP permitted activity "10% rule", and those that could potentially occur under the draft new provisions of a targeted plan change to the HWRRP (which will be Plan Change 1 to the HWRRP and is anticipated to be notified later in 2018), using the methods summarised in Norton 2018 (16 March & 12 April) that draw on the work of several others including Brown (J) 2018, Brown (P) 2017 & 2015, and Mojsilovic 2017 & 2018.

As a technical advisor to ECan in the role of Technical Lead during the Zone Committee-led collaborative process to "fix the 10% rule", I have listened to learnings arising from the two-year process, including the knowledge and perspectives of a wide variety of stakeholders and their technical advisors who participated in the Hurunui Science Stakeholder Group (SSG) process[4]. I have drawn on the above sources to set out the situation in a manner that I see as logical and objective. I have stated my assumptions where there is uncertainty around interpretation of consent and decision documents.

Earlier drafts of this memo were shared with key stakeholders to invite review and feedback, including circulation of a revised final draft on 21 September 2018 to all participants on the SSG email list and Zone Committee members. The intention has been to produce a robust, pragmatic, and ultimately widely agreed statement of the Hurunui nitrogen allocation situation to inform the HWRRP Plan Change 1 process. No further technical comments have been received on the 21 September draft and the memo has been finalised on 28 November 2018.

[4] See Norton (April 2018) for description of the SSG process.

4. Allocation situation

4.1 HWRRP catchment nitrogen load limit, background and intent

- The HWRRP decision in 2013 set out that the nitrogen load limit for the Hurunui River at SH1 would be 963 t/year in-river load. That 963 tonnes was comprised of the baseline load for the catchment at that time above SH1 (770 t/year; calculated as the 2005-2011 average annual load) plus an allowance for an increase of 25% which amounts to 193 t/year (770 + 193 = 963) (see Figure 1; row A). It was considered, based on information at that time, that the river could assimilate the additional 193 t/year and still achieve the periphyton objectives and policies of the HWRRP, provided that in-river phosphorus did not increase[5]; a phosphorus[6] load limit of 10.7 t/year was accordingly also set at SH1, this being the calculated 2005-2011 average annual in-river load at the time.
- The HWRRP decisions stated that the 25% additional load headroom allowed for was intended to provide for additional proposed irrigation that would occur at Balmoral (under the NTFE) and under the HWP scheme.
- Implicit in this, and other provisions in the HWRRP (e.g., Rules 10.1, 10.2 and the definition of "change in land use") is that all existing irrigated and dryland farming activities at the time the HWRRP became operative had an implicit ability to continue operating with at least their then current nitrogen losses, provided they met various provisions in the HWRRP around operating at good management practice amongst other things. This is a concept that has become known in subsequent Canterbury plans as operating at their nitrogen baseline loss rate and is a form of what is often referred to as "grandparenting" of users existing (at 2013 in this case) nitrogen discharge. The matter of whether and how those existing activities could increase their loss rates is addressed below.

4.2 Explicit allocation, by consent to irrigation schemes, up to the limit

- HWP had lodged their consent application at the time of the HWRRP hearing and the consent was initially granted in August 2013, a few months before the HWRRP became operative in December 2013. The original consent decision granted 18.5% (of the available 25% new headroom) of the total in-river baseline load (770 t/year) to HWP – this was equal to 142 t/year in-river load. The consent conditions (CRC120675) allocated HWP a total in-river load of 514 t/year, this being the sum of their estimated command area in-river nitrogen baseline load (372 t/year) plus the additional 142 t/year, meaning that 18.5% of the available 25% headroom was allocated to HWP (see Figure 1; row B). The allocation was expressed in HWP's consent (CRC153349) as the equivalent source

[5] Briefly, the technical assumption forming the basis for this decision at the time was that nuisance periphyton growth in the Hurunui River was predominantly, but not universally, phosphorus limited. Allowing unconstrained nitrogen increase would pose risks of reaching nitrate toxicity levels in-river and would also increase the risk of nuisance periphyton, particularly if phosphorus also increased but even if it did not.

[6] Specifically, as the form dissolved reactive phosphorus (DRP).

load of 1,370 t/year[7] (comprising 1,009 t/year current (2013) baseline source load and 360 t/year being 18.5% of the source load at SH1).

- The balance of HWRRP-defined headroom remaining (25% - 18.5% of in-river baseline = 6.5% of 770 t/year = 50 t/year) was allocated by consent to NTFE. Their original consent (CRC172842) was for only part of the Balmoral forest area (3,758ha) and was granted a total of 52 t/year in-river load, this being made up of 2 t/year baseline in-river load plus the additional 50 t/year. The result was that the full HWRRP-defined 25% headroom was allocated between HWP and NTFE at a ratio of 18.5:6.5 (see Figure 1; row B).
- Following appeals and then subsequent agreements, HWP changed their consent conditions so by 2016 their portion of the 25% headroom had decreased from 18.5% to 16% (123 t/year in river) and NTFE's portion increased correspondingly by 2.5%, from 6.5% to 9% (69 t/year in-river) (see Figure 1; row C). HWP's new consented (CRC172780) source load allocation became 1,270 t/year (comprising 959 t/year current (2013) baseline source load and 311 t/year being 16% of the source load at SH1). NTFE now holds its allocation in two consents, one for each of two neighbouring command area blocks. One consent includes the original 6.5% of the 25% HWRRP-defined headroom (CRC172842, for 3758ha) and the other includes the additional 2.5% of the 25% HWRRP-defined headroom (CRC172781, for 4,838ha). The load allocations made in both these consents are expressed as source loads of 57.2 and 100 t/yr respectively. The method used to calculate these source load allocations is consistent with the method used for HWP and AIC consents (i.e., the method uses the same nitrogen loss look-up tables) and is clearly described in annexures on each consent. The allocations in each case comprise the sum of i) the baseline (2013) source load for the relevant command area, plus ii) a proportion of the HWRRP-defined 25% headroom. The final result is the 25% headroom is now fully allocated at a ratio of 16:9 to HWP and NTFE.
- Amuri Irrigation Company (AIC) have a consented allocation of their baseline (2013) nitrogen source load of 956 t/year (CRC153154) which, by calculation[8], corresponds to a 448 t/year in-river load.
- Importantly, it is also clear to my reading of the consent decision documents (e.g., the report and decision on the original HWP consent CRC120675; paragraphs 11.74 and 11.75) that allocation of the full 25% HWRRP-defined nitrogen headroom to the irrigation schemes was made with the assumption in mind at that time that there would be no increase in losses from dryland farms in the Hurunui catchment outside of identified (mapped) irrigation scheme command areas, and that within the defined scheme command areas there would be either no increase in losses from farms remaining as dryland, or any increases (up to the implicitly allowed 10% of those farms 2013 nitrogen

[7] Noting that the equivalent allocated source load is greater than the allocated in-river load on the basis of predicted attenuation occurring between the root zone in the command area and the river at SH1, as already described in footnote 2.

[8] See according to P. Brown (2017)

baselines) would be accounted for by the schemes within their command area allocations, thus constituting no net increase that would take the catchment beyond the HWRRP load limit. I can't think of any other interpretation of the consent decision-makers assumptions about dryland that could fit within the HWRRP load limit.

4.3 Implicit allocation, to dryland farms, by HWRRP permitted activity rules

- While the decision-makers on the original HWP and NTFE irrigation consents assumed that dryland farms and other existing (at 2013) land uses would not increase their nitrogen losses, the HWRRP does provide the opportunity for this to occur, by up to a 10% increase on 2013 baseline loss rates under permitted activity Rules 10.1 and 10.2. There is a question around whether the full 10% increase would be likely to occur across all dryland farms but nevertheless the HWRRP provides this potential opportunity. I refer to this as a form of 'implicit' allocation for the purposes of this memo (see Figure 1; row D).
- As part of informing the collaborative process to "fix the 10% rule" I helped coordinate and ultimately pulled together several pieces of work that were used, after first seeking review input from the Hurunui Science Stakeholder Group, to provide the Zone Committee with estimates of:
    i) the theoretical increase in nitrogen loss that could occur under the existing HWRRP Rules 10.1 and 10.2; and
    ii) the "plausible worst case" increase in nitrogen loss that might arise under the draft new Plan Change 1 rules for permitting dryland farming.
- For the existing permitted activity HWRRP rules I estimated that if all dryland farmers above and below Mandamus, but upstream of SH1 and outside irrigation scheme command areas increased their baseline (2013) nitrogen losses by 10% this would lead to an in-river nitrogen load increase of 14 t/year, which corresponds to a source nitrogen load increase of 30 t/year[9]. If it is accepted that such an increase constitutes an 'implicit' allocation, then a form of over-allocation appears to exist currently as a result of consent decisions allocating the full HWRRP-defined 25% nitrogen increase headroom to irrigation schemes (see Figure 1; row D).

4.4 Implications of draft Plan Change 1 and nitrogen load offset considerations

- Under the draft new Plan Change 1 rules the "plausible worst case" increase in in-river nitrogen load arising from dryland farmers above and below Mandamus, but upstream of SH1 and outside irrigation scheme command areas, is estimated at 18 t/year, which corresponds to a source nitrogen load increase of 38 t/year[8] (see Figure 1; row E).

[9] Norton (16 March 2018) and further described in Norton (12 April 2018), incorporating the work of J. Brown (February 2018), P. Brown (6 November 2017) and Mojsilovic (25 January 2018).

- Thus, the draft new Plan Change 1 rules could at worst result in an extra 4 t/year in-river nitrogen load (corresponding to an extra 8 t/year source load) compared to the existing HWRRP permitted activity rules for dryland farming activities.
- The implications of this include the need to find an offset for the estimated load increase from dryland farms, in order to achieve a "zero sum game" as sought by the Zone Committee (i.e., to ensure both explicit and implicit forms of nitrogen allocation fit within the HWRRP in-river load limit of 963 t/year). Potential sources of this offset are relinquishment of some allocated load by irrigation schemes and/or other load reduction mitigations such as abstracting and re-using nitrogen-rich water from some Amuri Plains groundwater-fed tributaries before they discharge to the Hurunui River. Discussions between the irrigation schemes and the Zone Committee on the potential for both types of offset are actively progressing and positive at time of writing this memo.
- An offset of 8 t/year source nitrogen load (4 t/year in-river) would offset the effect of the slightly greater over-allocation that would occur under the draft Plan Change 1 rules, but the apparent existing over-allocation would remain.
- An offset of 38 t/year source nitrogen load (18 t/year in-river) would offset the apparent existing overallocation that occurred as a result of consented allocations not providing headroom for HWRRP-permitted activity increases on dryland farms outside irrigation scheme command areas (see Figure 1; row F).
- I assume that dryland farms that are within the command area of an irrigation scheme and remain as dryland could also increase their nitrogen losses by 10% under the existing HWRRP permitted activity rules, but that this must be accounted for by each of the respective irrigation schemes (HWP, AIC and NTFE) within their respective total consented command area load allocations. Thus, these do not contribute to existing over-allocation (see Figure 1; row F).
- However, building on the bullet point above, a further implication of draft new Plan Change 1 is that dryland farms remaining as dryland within irrigation scheme command areas may increase their nitrogen losses to a slightly greater degree than the existing HWRRP permitted activity 10% rule allowance. From the same work I described in the previous section a "plausible worst case" estimate is that losses could increase by 14% instead of 10%. To explore the implications of that; if we take an estimate of say 4000ha that might remain in dryland inside HWP's command area after full implementation of the HWP scheme[10], and we assume a baseline (2013) nitrogen loss rate for that dryland of 7 kg/ha/year, then an additional 4% increase on top of the 10% currently allowed for in the HWRRP (i.e., 14% -10% = 4%) computes to an additional 1.1 t/year source nitrogen load or 0.5 t/year in-river load.
- Finally, there is the matter of existing (as at 2013) independently irrigated properties who are not part of an irrigation scheme. I understand the majority of these existing

[10] An estimate that was considered a reasonable mid-range estimate by HWP during discussions with the Hurunui Science Stakeholders Group (Christina Robb pers. comm.)

independent irrigators are situated within HWP's command area and that the baseline (2013) in-river nitrogen load for that group is estimated at 93 t/year[11]. I haven't calculated the equivalent source load but this could be done (using a GIS tool) by identifying the boundaries of those properties and using the same nitrogen loss look-up table that was used to calculate the baseline component of HWP's consented source load. I assume that this must be accounted for by HWP within their total consented command area load allocation. These properties can increase their nitrogen loss by up to 10% on top of their 2013 baseline under the existing HWRRP permitted activity rules and/or the draft new Plan Change 1 provisions. As a technical advisor to ECan I don't know what legal requirement HWP has to account for that 10% increase within their total consented command area load allocation.

- The last small group of independently irrigated properties who are not part of an irrigation scheme and are not situated within HWP's command area (or any other scheme command area) are primarily pieces of irrigated land along the Hurunui and Waitohi mainstems and the estimated baseline (2013) in-river nitrogen load for that group is 11 t/year[12]. These properties can also increase their nitrogen loss by up to 10% on top of their 2013 baseline under the existing HWRRP permitted activity rules and/or the draft new Plan Change 1 provisions. If they did then that potential increase (10% of 11 = approximately 1 t/year in-river load) also constitutes over-allocation (see Figure 1; row F).

References

Brown, J. (February 2018). "Likely trends for dryland farming as a permitted activity in the Hurunui and Waiau Zone: In the context of water quality discussions". On behalf of Hurunui District Landcare Group. Prepared for Environment Canterbury, February 2018; 49p. "

Brown, P. (6 November 2017). "Hurunui and Waiau catchment nutrient calculators". Memorandum dated 6 November 2017. Prepared for Ned Norton and the Hurunui Science Stakeholders Working Group.

Brown, P. (2015). "Hurunui River nutrient modelling: impact of dryland intensification". Memorandum dated 15 March 2015. Prepared for the Hurunui, Waiau and Jed Nutrient Working Group.

[11] P. Brown (6 November 2017).

[12] P. Brown (6 November 2017).

Mojsilovic, O. (6 November 2017). “Estimates of area for winter forage crops in Hurunui and Waiau catchments”. Environment Canterbury Memorandum dated 6 November 2017. 5p.

Mojsilovic, O. (25 January 2018). “Modelling changes in Hurunui and Waiau catchment root zone nitrogen losses from hypothetical scenarios of permitted winter forage development. Memorandum dated 25 January 2018. Prepared for Environment Canterbury. 3p.

Norton, N. (16 March 2018). “Estimating the ‘plausible worst case’ increase in nitrogen load from a new way of permitting ‘normal dryland farming’, that would need to be offset by decreases elsewhere in order to stay within the Hurunui Waiau River Regional Plan (HWRRP) nitrogen load limit” Paper circulated to the Hurunui Waiau Zone Committee and Hurunui Science Stakeholders Group by email on 16 March 2018. 8p.

Norton, N. (12 April 2018). Summary of process to estimate the nitrogen load increase that would need to be offset in the Hurunui catchment as part of fixing the dryland farming “10% rule” issue” Environment Canterbury Memo. 7p.

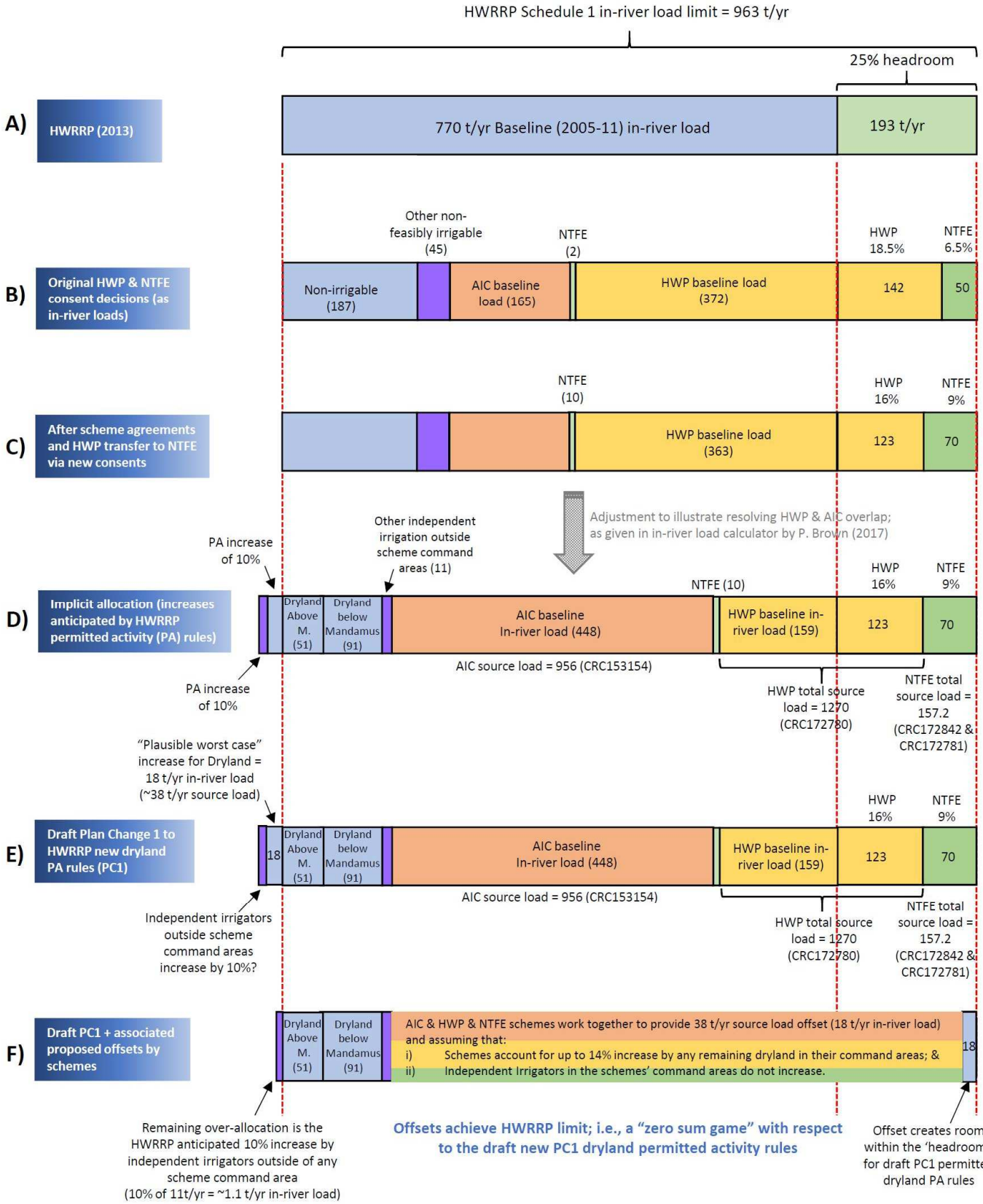

Figure 1: Schematic representation of nitrogen allocation in the Hurunui catchment.