Waikato Regional Council Revision of Table 3.11-1 (Plan Change 1)

Mike Scarsbrook, Bill Vant, Bevan Jenkins and Bryce Cooper

21 October 2019

Purpose

Provide a revised Table 3.11-1 that incorporates corrections and considers results of technical caucusing as summarised in the PC1: Joint Witness Statement – Expert Conferencing – Table 3.11-1 (17 June 2019).

Style and format

In the current version of the Excel tables we have colour-coded (in yellow) those cells where changes have been made to the notified version.

We also present a more simplified version of the Excel tables that translate numeric values to corresponding A-D bands, where these exist[1]. In these simplified tables, we have highlighted, in blue, those site/attribute combinations where improvements are required, with unshaded site/attribute combinations representing requirements to maintain current state.

We recommend splitting Table 3.11-1 into several panels, with *E. coli* and Clarity merged together, mainstem TN, TP and Chlorophyll a as another panel, and dissolved nutrients (NO3, NH4 and DRP) in a third. The existing lakes table would form a fourth panel.

Addition of new attributes

A wide range of additional attributes were discussed and debated throughout technical caucusing. Of these, only nutrients, *E. coli*, clarity and 'lakes' had unanimous support for inclusion in Table 3.11-1 (see Table 1 of the Joint Witness Statement). All of these attributes are already included in the notified version of Table 3.11-1.

The Joint Witness Statement indicated majority support for two additional numeric attributes. These were Macroinvertebrates (10 for inclusion: 4 against) and Whangamarino (6:5).

The Macroinvertebrate attribute recommended in the Joint Witness Statement is described at the FMU scale (i.e. % of stream length in 'Poor' condition), so does not lend itself to inclusion in Table 3.11-1. Furthermore, the main drivers of macroinvertebrate community health in Waikato streams

[1] Total N at the mainstem Waikato River sites is banded using NPS criteria for stratified lakes in Option 1, and criteria for polymictic lakes in Option 2. No A-D banding is shown for total N in Option 3 because no NOF (or WOF) banding has been developed for this. Similarly, no banding is shown for total P in Options 2 or 3 (although the NOF banding for NZ lakes is used in Option 1). However, as reference to the "numbers" file confirms, in several cases the future states for total N and total P still represent an improvement over the current state, so there are several cells with no banding ("n/a") that have been highlighted pale blue (e.g. both total N and total P for Waikato River at Narrows in Option 3).

are riparian and habitat condition and levels of fine sediment[2], so the match between scope of PC1 (N, P, sediment and *E. coli*) and a Macroinvertebrate attribute remains debatable. Nevertheless, the 2017 amendment to the NPS-FM (2014) added requirements for inclusion of Macroinvertebrates as a monitoring measure. This is consistent with previous advice from the Technical Leaders Group[3].

In relation to Whangamarino, we recognise the split in opinion and have not considered additional numeric attributes any further.

There was also support for addition of several narrative attributes:

- Deposited sediment (unanimous support for inclusion as narrative objective)
- Dissolved oxygen (unanimous support for inclusion as narrative objective)
- Periphyton (unanimous support for inclusion as narrative objective)
- Whangamarino (majority support (6:2) for inclusion as narrative objective)
- Other wetlands (majority support (8:2) for inclusion as narrative objective)

These narrative attributes would necessarily sit outside Table 3.11-1., so we have not considered them further in our revision of the Table.

The exclusion of Periphyton from PC1, despite it being a compulsory Attribute, will need to be addressed, with one option being adoption of a risk-based monitoring requirement and a narrative objective identifying targets for periphyton, particularly in any high-risk sites that might breach the national bottom line of 200 mg/m^2.

Following our review and further discussion, we are not recommending any new attributes be added to Table 3.11-1., with one exception. We propose including current state Dissolved Reactive Phosphorus (DRP; medians) for tributary sites, with short and long-term target states also set at current state (i.e. maintain). This is done for completeness, as the omission of DRP at the tributary scale appears to be an oversight and is not consistent with the scope of PC1.

Inclusion of current state information in the Table

We have added current state data (2010-2014[4]) to Table 3.11-1. This current state data differs from the 2014-2018 information contained within a revised Table 3.11-1 presented to the Hearing Panel in the statement of evidence of Scarsbrook (11 March 2019; Table 3B), but it is consistent, and largely unchanged from, a corrected 2010-14 current state dataset presented in Attachment 1 of that same Statement of Evidence. We have gone with the 2010-14 period for the current state, rather than the 2014-2018 current state as previously requested by the Panel, as the earlier period is consistent with the period used to calculate short-term target values and long-term 'maintain' values in the notified version of Plan Change 1.

Waikato Regional Council is currently working to complete a full current state report. This will outline the methods used to generate the current state information and will set out procedures for

[2] Pingram, M.A., Collier, K.J., Hamer, M.P., David, B.O., Catlin, A.K. and Smith, J.P., (2019). Improving region-wide ecological condition of wadeable streams: Risk analyses highlight key stressors for policy and management. *Environmental Science & Policy*, 92, pp.170-181.
[3] Scarsbrook, M. (2016). Water quality attributes for Healthy Rivers: Wai Ora Plan Change. Waikato Regional Council Technical Report 2018/66.
[4] With the exception of *E. coli* that uses data from 2009-2014.

any future 'current' state assessments. This will ensure that water quality state can be tracked through time in a consistent manner.

Human health (*E. coli*)

We have aligned the values in Table 3.11-1 with the *E. coli* attribute table in NPS-FM (2014, amended 2017).

We present 95th percentiles as notified (but corrected where necessary) and have derived targets for the other three 2017 measures as necessary to achieve the lowest level of average infection risk. The net effect of this is that targets attribute state for all PC1 locations equates to Band A from the NPS-FM (2014; amended 2017).

Note that many of the values in the spreadsheet for *E. coli* attributes are italicised. This reflects low sample size as described in Attachment 1 of the evidence of Scarsbrook (11 March 2019).

Clarity

We present two options for clarity. The first is based on median values (as per notified version, but with corrections where required), whereas the second option uses an alternative method proposed during the technical caucusing process. This alternative approach has the same Minimum Acceptable State for swimming (i.e. 1m), but uses the 10th percentile as the reporting statistic versus medians (50th percentile). The rationale for this more stringent statistic is that meeting the Minimum Acceptable State (i.e. 1m) for only 50% of the time does not reflect the swimming value.

The consequences of adopting Option 2 (10th percentile) would be to grade more sites as failing to achieve the Minimum Acceptable State (53 sites would fail under Option 2 versus 33 sites under Option 1; see pages 60-68 of Joint Witness Statement).

Waikato River Trophic State (Chlorophyll a, TP and TN)

The notified version of Table 3.11-1 included three lake trophic state attributes (Chlorophyll a, TN and TP) from the NPS-FM (2014) that were applied to mainstem Waikato River sites. In addition, the TN attribute, which is split into Seasonally Stratified and Polymictic values, was applied using the lower Seasonally Stratified values.

Over the course of the Technical Caucusing on Table 3.11-1 and in our more recent discussions, the derivation of TN and TP values along the Waikato River mainstem was hotly-debated.

In contrast, there is a level of comfort with notified targets for Chlorophyll a along the river. We consider this was also the majority view during Technical Caucusing. As a result, we do not recommend any changes to the Chlorophyll a attribute values at mainstem sites, although some corrections have been made in the revised Table.

Given our collective knowledge and experience of the Waikato River we consider there to be several important points to raise in relation to managing nitrogen and phosphorus along the mainstem of the river for the purpose of achieving defined phytoplankton biomass outcomes:

1. The Waikato River is comprised of riverine reaches, interspersed with hydroelectric reservoirs that function to varying extents as lacustrine habitats
2. It is more appropriate to describe the Waikato River as polymictic, rather than seasonally stratified

3. Hydraulic retention time is an important factor controlling phytoplankton growth patterns along the river
4. In comparison to New Zealand lakes, and more specifically the lakes dataset used to identify the attribute thresholds in the NPSFM (2014), the Waikato River mainstem is likely to accumulate lower levels of phytoplankton biomass for given levels of nutrients due to reduced retention times through the hydrolakes, greatly reduced retention times below Karapiro and the incremental input of nutrients down the river's length.
5. There is clear evidence of significant phytoplankton inputs to the lower Waikato River associated with connected hypertrophic, shallow lakes (e.g. Waikare). These inputs mask the phytoplankton growth patterns within the lower river
6. Available scientific evidence indicates that phosphorus currently tends to play a stronger role in controlling phytoplankton biomass along the river than nitrogen, although there are likely to be times when nitrogen is the main limiting factor

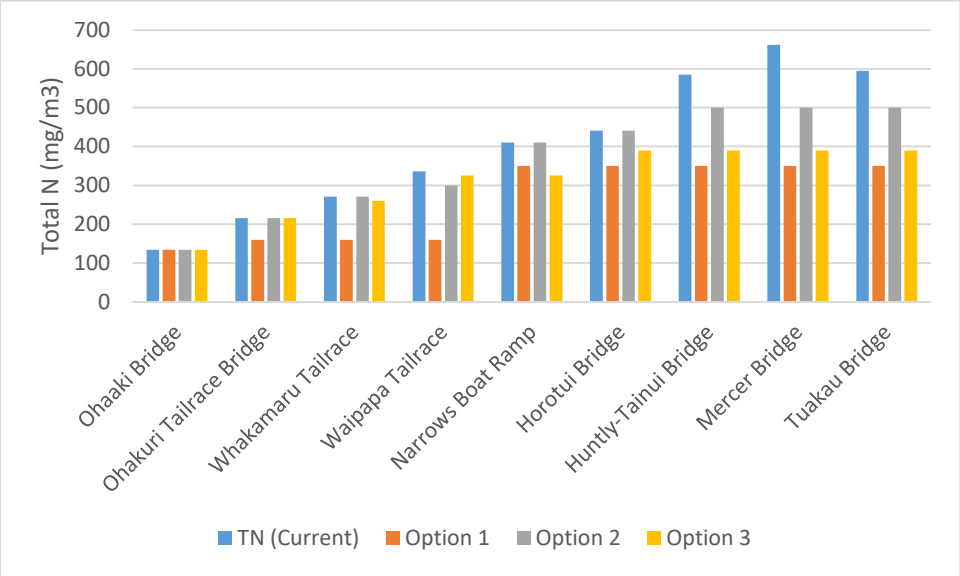
Based on these observations we conclude that application of TN and TP target values as per the NPS-FM attribute tables are very likely to be overly-conservative in achieving chlorophyll a outcomes when applied to Waikato River mainstem sites and it is likely that defining TP target values will be of greater importance than TN.

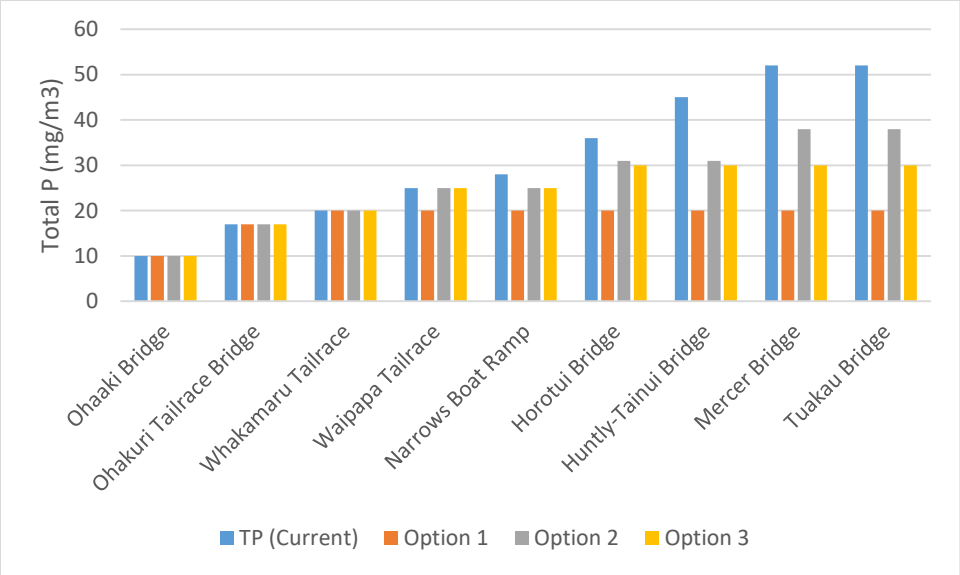
During Technical Caucusing, a lot of work went into developing a range of approaches to deriving TN and TP target values. Included in this was an assessment of locally-appropriate TN and TP values to achieve desired Chlorophyll a objectives. We were linked into this work and have taken it into account in our further discussions.

In the revised Table 3.11-1 we present three Options for TN and TP values:

1. Option 1 involved corrections to a number of errors in the current state as notified in the s32 report. For main-stem Waikato River sites such errors affected the short and long-term targets in Table 3.11-1, and these have also been corrected (Note: this option equates to Approach 1A in the Joint Witness Statement. It is the option with the least change from the notified version).
2. Option 2 promulgates Option 1C for TN and Option 2C for TP from the Joint Witness Statement. Of the 17 freshwater scientists engaged in technical caucusing, 13 supported changes to the TP values in Table 3.11-1 to reflect our current understanding of nutrient controls on phytoplankton along the river and the effects of phytoplankton inputs from shallow lakes to the lower Waikato (Option 2C). 14 supported a change in TN to reflect a polymictic versus seasonally stratified status (Options 1B or 1C) and 12 supported further changes to TN levels at Ohakuri (Option 1C).
3. Option 3 reflects additional analysis and conversations by the authors of this memo following conclusion of technical caucusing and also subsequent to presentation of the Joint Witness Statement to the Hearings Panel. The approach we took was to recognise the importance of reduced retention time along the Waikato River mainstem and derive TP values that reflected local conditions (see points 1-6 above). This resulted in values of TP similar to those of Option 2C from Technical Caucusing. Values of TN were then calculated to maintain an N:P ratio of 13:1 (average of current state N:P at nine river sites). This option uses local expert knowledge and monitoring data. Should this option be adopted, further work will be needed to document and test this option.

Differences in the numeric values for the three options relative to current state are presented below.





Option 1 ("as notified") requires the greatest nutrient reductions particularly in the lower river, whereas Option 2 ("majority view") sets less stringent TN and TP thresholds. Option 3 ("WRC") has similar or more stringent TP thresholds to Option 2 and is more stringent with regard to TN than Option 2.

It is our view that Option 1 is not supported by our current understanding of phytoplankton dynamics in the Waikato River. In contrast, Options 2 and 3 both reflect derivation of nutrient thresholds that are based on local information and collective (but incomplete) scientific understanding of processes occurring along the Waikato River mainstem.

We recognise that on-going monitoring and further research into phytoplankton and nutrient dynamics along the Waikato River will almost certainly result in further refinements of the nutrient

threshold recommendations for the river. In particular, we endorse the recommendations of the TLG and others that a dynamic river model be developed.

WRC will carry out research over the next twelve months to test and develop Options 2 and 3, with an expectation that any future revision of nutrient thresholds in the river can be informed by improved scientific understanding and evidence.

Nitrate and Ammonia

As notified, Table 3.11-1 contained several "perverse" results for nitrate and ammonia targets. In these instances the 80-year targets for median values were larger than the targets for 95th percentile or maximum. For example, Kawaunui Stream at SH5 bridge had a notified median Nitrate target of 2.4 mg/L, whereas the target for the 95th percentile was 1.5 mg/L. To address these perverse results, we've identified the 80-year targets for the six affected sites as "poorer of the two measures up one band (to B), other measure maintained at current concentration (in Band B)".

We now realize there appears to have been a systematic error in the calculation of the notified values of 95th percentile nitrate (but not medians). As a result, all current state values have been updated.