Joint Witness Statement (JWS) Expert Conferencing Table 3.11-1

Nutrient Attribute: Attachment 2

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Issues considered in JWS nutrient attribute

1. Waikato mainstem nutrients
   - Revision of existing 'trophic-state' TN & TP targets
   - two approaches:
     - *NPS-FM-based* (Approach 1c);
     - *phytoplankton-nutrient relations* (Approaches 2a and 2c)

2. Tributaries and subcatchments
   - New nutrient *thresholds* to address concerns that PC1 only considers nitrogen toxicity
   - three approaches:
     - PC1 mitigations as short-term targets (Approach 3);
     - ecosystem health (Approach 4);
     - Periphyton (slime) (Approach 5)

3. Nitrate and ammonia toxicity - (Waikato mainstem and tributaries)
   - new classification proposed to address inconsistent outcomes of current PC1 targets

Quick note: ‘sub-toxic’ effects of nutrients

- lake ‘trophic state’ → growth of phytoplankton
  (Waikato mainstem)

- river ‘trophic state’ → growth of periphyton
  (hard-bottom tributaries)

- River ‘ecosystem health ’ → macroinvertebrate community
  (all – measured in wadeable tributaries)

1. Waikato mainstem nutrients

- IMPORTANT: Revised nutrient targets based on the same bands/outcomes as PC1
- Approach 1 – *'tidy up' of how NPS-FM lake attribute was applied in PC1*
  - Relationship between TN and lake trophic state depends on *stratification regime*
  - 1c = all Waikato mainstem sites corrected from 'seasonally stratified' to 'polymictic'

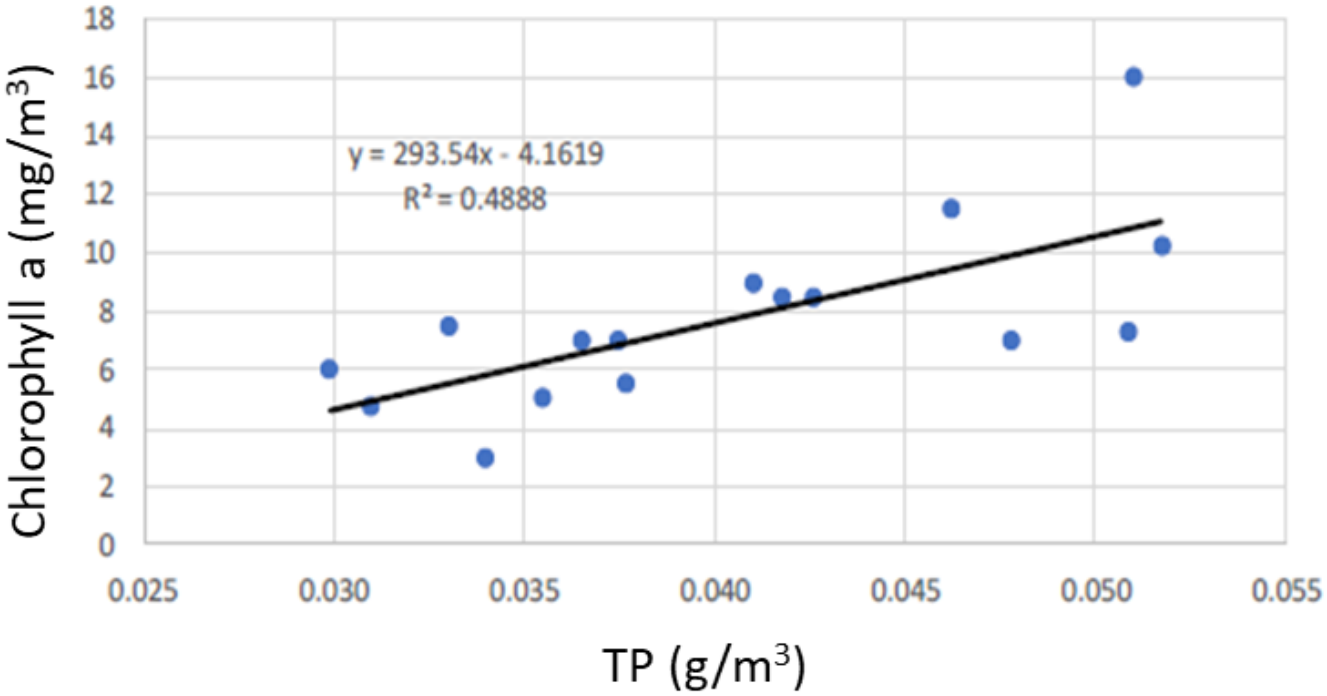
	NPS-FM Total Nitrogen (TN) mg/m^3	
Band	*Seasonally stratified*	*Polymictic*
	PC1	Approach 1c
A	<160 →	**<300**
B	<350 →	**<500**

- **'1c' recommended (12 of 16 experts) for revised mainstem TN targets in Table 3.11-1**
- NPS-FM lake TP thresholds considered problematic for managing phytoplankton in river
- **13 of 16 experts did not select Approach 1 to define TP targets in Table 3.11-1**
  - disagree: Dr. Cooper; Dr. Canning; Ms. McArthur

1. Waikato mainstem nutrients

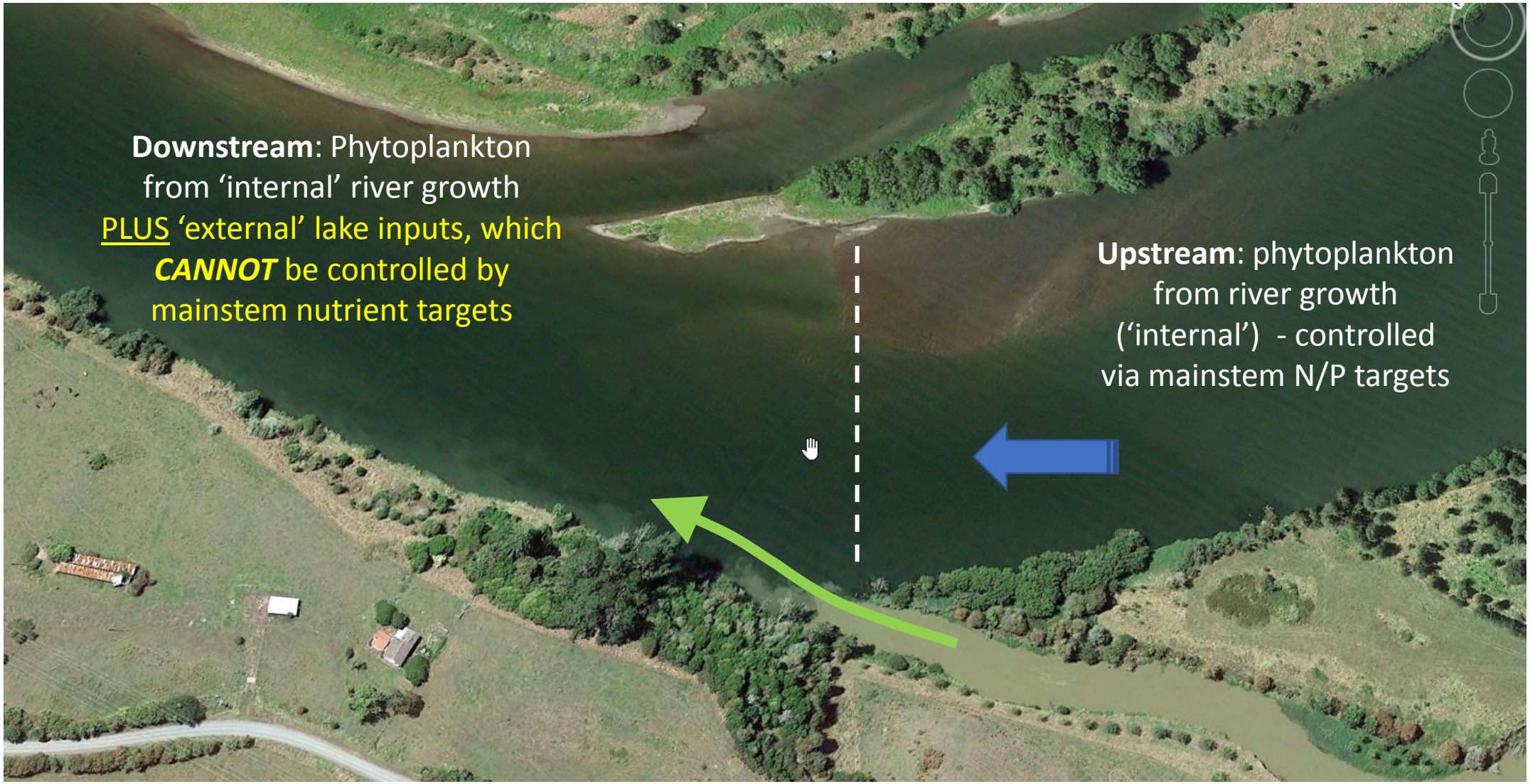
- Approach 2 – *regression models*
- TN/TP thresholds derived via relations between nutrients & phytoplankton
  - NOTE - uses the **same** phytoplankton target ('chlorophyll a' ≤5 mg/m^3) as PC1

- two models used:
  - NIWA 'model' – TN and TP (2a)
  - new 'models' (Dr. Cox) – TP only (2c)



- 2a and 2c accounted for external inputs from lowland lakes (Mr. Vant; Dr. Depree)

External inputs from lowland eutrophic lakes



- 13 of 16 experts agreed that nutrient thresholds for Waikato River at Mercer & Tuakau should account for external lake inputs. disagree: Dr. Cooper; Dr. Canning; Ms. McArthur

1. Waikato mainstem nutrients (Approach 2)

- 2a vs 2c: different equations – but comparable threshold concentrations ✓

	2a (NIWA)		2c (Dr. Cox)	PC1
FMU	TN (mg/m^3)	TP (mg/m^3)	TP (mg/m^3)	TP (mg/m^3)
Upper	360	**25**	**25**	**20**
Mid	360	**29**	**31**	**20**
Lower	470	**35**	**38**	**20**

- 2a & 2c yield TP targets considered more directly related to phytoplankton (cf. PC1)
- **'2c' recommended (13 of 16 experts) for revised mainstem TP targets in Table 3.11-1**
  - disagree: Ms. McArthur; Dr. Cooper; Dr. Canning
- **13 of 16 experts did not select Approach 2 to define TN targets in Table 3.11-1**
  - 2c only modelled TP; lower predictive power of NIWA models yielding TN (Dr. Cox)
  - disagree: Mr. Kirk; Mr. Kessels; Dr. Mueller

2. Tributaries and subcatchments

- New nutrient *thresholds* to address that Table 3.11-1 only considers N-toxicity

- Approach 3 – based on modelling of mitigations anticipated in first 10-years of PC1
  - modelled outputs expressed as:
    - concentrations; total loads; anthropogenic loads (Dr. Cox; Mr. Conland)
  - confirmed findings of policy mix modelling report (Doole et al., 2016) ✓
  - outputs provided for 'panels consideration' – one option to use as 'short-term' targets
  - nutrient targets do not relate to managing an instream effect/response (i.e. attribute)

- most experts (12/16) supported use as 'short-term' targets for tributary (and Waikato mainstem) subcatchments
  - disagree: Mr. Vant; Dr. Scarsbrook; Dr. Cooper; Dr. Depree

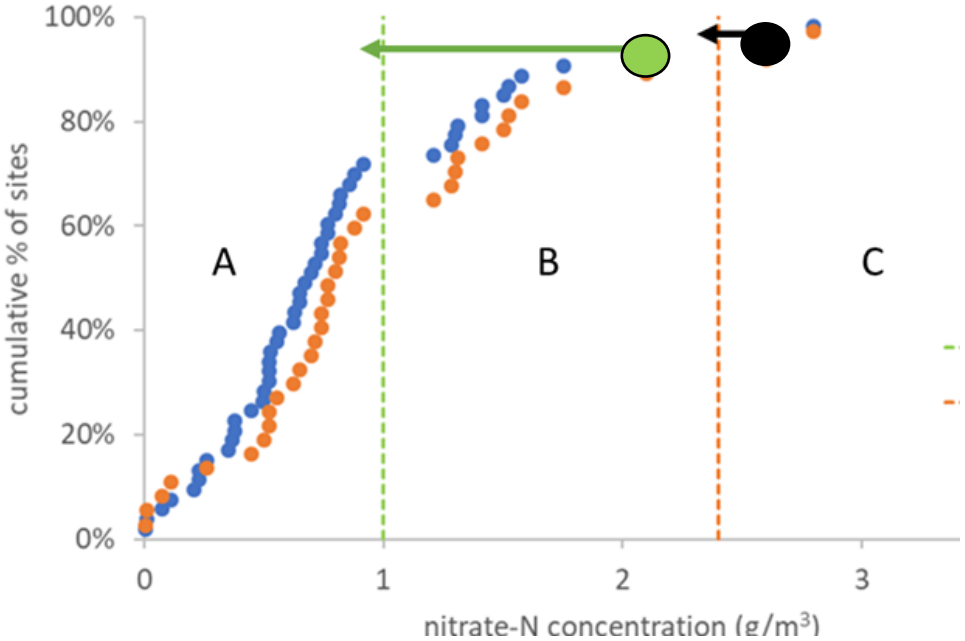
2. Tributaries and subcatchments

- New nutrient *thresholds* to address that Table 3.11-1 only considers N-toxicity
- Approach 4 – based on correlations of nutrients with multiple ecosystem responses
  - based on the technical work presented in evidence of Dr. Canning
- Approach 5 – based on correlations between nutrients & periphyton (slime)
  - 5b based on 2016 NIWA *Instream plant and nutrient guidelines* (Ms. McArthur)

- Only 2-3 experts supported Approach 4 or 5 (Dr. Canning; Ms. McArthur; Mr Kessels)
  - uncertainty of 'global' nutrient thresholds for achieving ecosystem health outcomes
  - 'ecosystem responses' (i.e. periphyton & macroinvertebrates) are strongly supported as new attributes in PC1

3. Nitrate & Ammonia toxicity

- New ‘classification’ proposed to address inconsistent outcomes in PC1 (Mr. Conland; Dr. Depree; evidence Ms. McArthur)
  - i.e. similar sites with one (← 🟢) requiring >50% reduction and the other (← ●) <10% reduction



- alternative approach to use a combination of ‘no degradation’ (i.e. no increase in current state concentrations) and nitrate and ammonia toxicity targets based on NPS-FM upper threshold limits of:
  - **‘A-band’ for Waikato mainstem** (e.g. median nitrate <1.0 g/m^3)
  - **‘B-band’ for tributaries** (e.g. median nitrate <2.4 g/m^3)
- Recommendation of attribute document (not specifically commented on in run sheets)
- **Recommend two additional mainstem sites for inclusion in Table 3.11-1**
  - Tahorakuri – upstream of Ohakuri (Mr. Conland)
  - Karapiro - downstream boundary of upper Waikato FMU (Dr. Depree)

Summary

1. Trophic state: Waikato mainstem

2. Trophic state/ecosystem health: tributaries

3. Toxicity - Waikato mainstem and tributaries catchment

FMU	Chla (mg/m³)		TN (mg/m³)		TP (mg/m³)	
	PC1	JWS	PC1	JWS (1c)	PC1	JWS (2c)
Upper	5	5	160	300	20	25
mid	5	5	350	500	20	31
lower	5	5*	350	500	20	38

	approach
PC1	not currently included
JWS (approach 3)	TN/TP concentrations/loads based on modelling of mitigation anticipated in first 10-years of PC1

	approach
PC1	Current state A-band = at least maintain (no degradation) Current state B-band, improve to A-band Current state C-band, improve to B-band
JWS (workstream 3)	**Waikato mainstem:** A-band (no degradation) **Tributaries:** A- & B-band, at least maintain current state **Tributaries:** C-band, improve to B-band

Appendix

Waikato River lake stratification regime

- Appendix 7 (Verburg 2012)

Polymictic, clear									
Council	Lake	Altitude	Salinity	Water clarity	Stratification	TP	TN	Chl a	Overall
NRC	Lake Rotokawau	lowland	fresh	clear	polymictic	excellent	good	good	good
ECAN	Lake Hawdon	upland	fresh	clear	polymictic	excellent	good	excellent	excellent
ECAN	Lake Ida	upland	fresh	clear	polymictic	excellent	excellent	excellent	excellent
ECAN	Lake Sarah	upland	fresh	clear	polymictic	excellent	excellent	excellent	excellent
ECAN	Maori Lake (front)	upland	fresh	clear	polymictic	excellent	good	excellent	excellent
HBRC	Lake Kaweka	upland	fresh	clear	polymictic	excellent	excellent	excellent	excellent
	Ohakuri	lowland	fresh	clear	polymictic	fair	excellent	good	good
	Waipapa	lowland	fresh	clear	polymictic	fair	good	good	good
ARC	Lake Tomarata	lowland	fresh	clear	polymictic	fair	good	fair	fair
ARC	Lake Kereta	lowland	fresh	clear	polymictic	fair	unacceptable	fair	fair
	Whakamaru	lowland	fresh	clear	polymictic	fair	excellent	fair	fair
	Karapiro	lowland	fresh	clear	polymictic	fair	good	fair	fair
BOP	Lake Rotoehu	lowland	fresh	clear	polymictic	fair	good	fair	fair