IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of **PROPOSED PLAN CHANGE 1** to the Waikato Regional Plan – hearing of **BLOCK 1** topics
AND	
IN THE MATTER	of the hearing of the further submission by **WAIKATO REGION TERRITORIAL LOCAL AUTHORITIES COMPRISING THE WARTA GROUP** in relation to **BLOCK 1** topics

STATEMENT OF EVIDENCE OF ANTHONY HANS PETER KIRK

1. INTRODUCTION

Qualifications and experience

1.1 My full name is Anthony Hans Peter Kirk. I hold a Bachelor of Science degree in Earth Science and Chemistry from Massey University (1997) and a Master of Science degree in Chemistry from Massey University (2000). I am a member of:

(a) The New Zealand Hydrological Society;

(b) The International Association of Hydrogeologists (New Zealand Chapter); and

(c) The Australasian Land and Groundwater Association.

1.2 I hold the position of Technical Director – Environment and Practice Director – Data and Analytics with GHD Ltd and have worked as an environmental scientist with GHD for 2 years.

1.3 I have 18 years of experience in environmental science, chemistry and hydrogeology. I have co-authored regional guidance on wastewater disposal (Auckland Council) and national guidance on contaminated site assessment, including statistical analysis (Ministry for the Environment). I

have provided technical assessment of discharges to water for a broad range of activities, including wastewater, stormwater, mining, landfill, agricultural, industrial effluent, forestry and petroleum industry discharges.

Involvement in Proposed Plan Change 1

1.4 I was engaged by WARTA to review Plan Change 1 ("PC1"), provide advice on issues that are within my area of expertise and prepare evidence on behalf of the group. I was not involved in the preparation of any of the individual councils' original submissions or the WARTA further submission.

Purpose and scope of evidence

1.5 The purpose of this evidence is to provide an evaluation of the water quality targets of PC1 and the outlined monitoring of attribute achievement.

1.6 My evidence is structured as follows:

(a) Ammonia toxicity limit derivation and units (Section 3).

(b) Monitoring of water quality target achievement (Section 4).

(c) Consistency of targets with National Policy Statement for Freshwater Management ("NPS-FM") (Section 5).

(d) Influence of monitoring locations on consenting of discharges (Section 6).

(e) Conclusions (Section 7).

1.7 A summary of my evidence is contained in Section 2. I have **attached** my recommended changes to PC1 as **Appendix 1**.

Expert Witness Code of Conduct

1.8 I have read and I agree to comply with the Code of Conduct for Expert Witnesses, contained in the Environment Court Consolidated Practice Note (2014). I can confirm that the issues addressed in this statement are within my area of expertise and that in preparing my evidence I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

2. SUMMARY OF EVIDENCE

2.1 The methodology and data used to derive the water quality targets outlined in Table 3.11-1 of PC1 are not readily available for peer review. In my

opinion, a single document which clearly outlines and justifies the adopted approach and data used should be made available and clearly referenced within PC1.

Ammonia toxicity limit derivation and units

2.2 Table 3.11-1 of PC1 provides criteria for ammonia (toxicity) but does not reference the necessary pH and temperature. By not including the adopted pH and temperature for the ammonia (toxicity) targets and limits, the criteria provided do not reflect a single, fixed concentration for ammonia in water and hence are not meaningful as an ammonia (toxicity) criteria.

2.3 I am concerned by the lack of reference in section 42A and section 32 reports as to how the targets and limits were calculated. In my opinion, this lack of supporting information makes the criteria difficult to review, and difficult to understand the basis for how the targets and limits should be applied. I consider that a misunderstanding by the reporting officer of the ammonia (toxicity) targets and limits has further contributed to changes to PC1 not adequately addressing previous deficiencies in the way ammonia (toxicity) targets and limits are presented in Table 3.11-1.

2.4 It is my opinion that to allow a level of scientific rigour commensurate with the importance of such critical regional criteria the derivation of targets and limits provided in Table 3.11-1 of PC1 should be clearly described in a single supporting document that is referenced within PC1.

Monitoring and measurement

2.5 The monitoring of the achievement (or otherwise) of water quality targets outlined in Section 3.11.1 of PC1 is to be based on '5 yearly monitoring'. The section 42A report goes further in indicating that, to give effect to the NPS-FM, monitoring would include collection of 60 samples across five years. In my opinion, it is unclear how the monitoring will be undertaken and monitoring results will be compared against the targets outlined in Table 3.11-1 of PC1. For clarity, I recommend that this monitoring be referred to as 'monthly surface water monitoring for a period of five years.

2.6 In my opinion, achievement of targets would be better measured annually, using the monthly monitoring results for the preceding five years, than with five yearly blocks of monitoring. A rolling five yearly average will provide greater resolution in how water quality improvement activities are managed, due to earlier recognition of how water quality is changing.

Changes to the names of short term and long term water quality criteria

2.7 I disagree with the reporting officers' proposed changes to the naming of short and long term water quality criteria to short term targets and the desired water quality states respectively, on the basis that these are inconsistent with the terminology used in the NPS-FM and introduces confusion as to the purpose of the criteria as a means of determining achievement of the freshwater objectives.

2.8 In the context of NPS-FM, the targets reflect a level of water quality which is to be achieved within a defined time frame. This allows for a staged approach to achieving the freshwater objectives and defining limits. Objective 1 of PC1 outlines the need to achieve the long term water quality criteria by 2096 at the latest, providing this as a clear target for achievement.

2.9 In contrast, the short term criteria are designed to provide guidance for theoretical improvements in water quality, achieved through implementation of actions to improve water quality by 2026. Actual achievement of the water quality criteria does not have a defined time frame. Recommendations for alternate wording are proposed.

Monitoring sites

2.10 The fixed monitoring sites referenced in Section 3.11.1 of PC1 are required by the NPS-FM to provide state-of-the-environment water quality samples representative of the Freshwater Management Unit ("FMU") in which they are located. I am concerned that proximity to monitoring locations will influence the consenting process and consideration of new discharges. Future plan changes for moving monitoring sites within the mixing zone of future discharges may be required to avoid undesired outcomes associated with fixed monitoring locations.

3. AMMONIA TOXICITY LIMIT DERIVATION AND UNITS

3.1 Appendix 2 of the NPS-FM provides attribute states for freshwater objectives, including ammonia (toxicity). The units of ammonia (toxicity) are provided as NH_4-N or total ammoniacal nitrogen, based on a pH of 8 and temperature of 20°C. This is the routinely adopted state for ammonia toxicity related water quality criteria, and is used routinely in guidance documents as a standardised measure of ammonia toxicity. Ammoniacal nitrogen concentration is the nitrogen concentration summing together both ammonia (NH_3-N) and it's ionised form, ammonium (NH_4^+-N).

3.2 Under typical freshwater conditions, the majority of ammoniacal nitrogen is made up of ammonium, with the relative proportions changing as a function of pH and temperature. Due to this dynamic distribution there is the need to state the adopted pH and temperature when setting an ammonia (toxicity) criteria, such that the actual concentration of ammonia which the criteria reflects is known.

3.3 For example, an ammonia (toxicity) criteria of 0.003 mg/L total ammonium (NH_4-N) based on a pH of 8 and a temperature of 20°C, has the equivalent concentration of ammonia (NH_3) as a sample with 0.01 mg/L total ammonium (NH_4-N), a pH of 7.6 and a temperature of 15°C.

Lack of clarity and supporting information in PC1

3.4 In calculating the ammonia (toxicity) limits and targets in PC1, the laboratory reported ammoniacal nitrogen concentrations appears to have been adjusted to a standardised condition of pH of 8 and temperature of 20°C. However, this is unclear as no reference to this condition is provided in PC1. This enables the user to interpret the targets and limits on an as-measured basis, under whatever temperature and pH condition that was present at the monitoring site at the time of water sample collection.

3.5 By not including the assumed pH and temperature for the ammonia (toxicity) targets and limits, the criteria provided do not reflect a single, fixed concentration for ammonia in water and hence are not meaningful.

3.6 I am concerned by the lack of reference in PC1 as to how the targets and limits have been calculated, with minimal supporting information provided in either of the section 42A and section 32 reports. In my opinion, this lack of supporting information makes the criteria difficult to review, difficult to confirm accuracy and appropriateness and difficult to understand the basis for how the targets and limits should be applied.

3.7 The lack of a clear description as to the manner in which the criteria were derived has, in my opinion, contributed to significant misunderstanding of what the criteria represent and how they should be applied. This is evidenced by:

(a) Submissions concerned that ammoniacal nitrogen targets are lower than the laboratory detection levels. (This is not the case where the sample results, taken at the detection level, have been adjusted to the standardised pH 8 and temperature of 20°C.)

(b) Incorrect referencing of the units of the ammonia (toxicity) criteria in the section 32 report.

(c) The Reporting Officers' comments in Section B5.4.4.5 of the S42 report outlining that the NIWA testing method, with lower detection levels than those applied in the 2010-2014 monitoring, will allow water samples to be compared to the ammonia (toxicity) targets and limits provided in Table 3.11-1 of PC1.

3.8 In particular, I consider that the misunderstanding of the ammonia (toxicity) targets and limits by the Reporting Officer has further contributed to changes to PC1 not adequately addressing previous deficiencies in the way ammonia (toxicity) targets and limits are presented in Table 3.11-1. This is apparent in the note appended to Table 3.11-1 indicating that the ammonia (toxicity) targets and limits have been adjusted for pH, instead of specifically referencing the pH and temperature condition on which the criteria are based upon.

Need for supporting document referenced in PC1

3.9 It is my opinion that to allow a level of scientific rigour commensurate with the importance of such critical regional criteria the derivation of targets and limits provided in Table 3.11-1 of PC1 should be clearly described in a single supporting document that is referenced within PC1. This document should include:

(a) All data which criteria derivation relies upon;

(b) A clear description of the methodology applied and the assumptions made (such as statistical distribution, dealing of outliers and non-detect samples);

(c) Acknowledgement of uncertainty and a discussion of appropriateness of the adopted methodology; and

(d) Worked examples, including any data transformations undertaken for ammonia (toxicity) or other contaminants whose presence or toxicity is dependent upon other water properties.

4. MONITORING OF WATER QUALITY TARGET ACHIEVEMENT

4.1 The monitoring of the achievement of water quality targets outlined in Table 3.11-1 of PC1 is to be based on '5 yearly monitoring'. The section 42A report goes further in outlining that to give effect to the NPS-FM monitoring would include collection of 60 samples across five years.

4.2 In my opinion, it is unclear how the monitoring will be implemented such that it provides a representative measure of the water quality across the

five year period. This has implications for interpreting how temporally variable discharges, such as stormwater and wastewater, or relatively infrequent events, such as droughts or flooding may influence the monitoring results and subsequent achievement of the water quality targets.

4.3 For clarity I recommend that monitoring referred to in Section 3.11.1 of PC1 be 'monthly surface water monitoring for a period of five years. Alternatively, monitoring plans outlining the approach to implementing monitoring of achievement of the targets and desired attribute states, as required by NPS-FM section CB, should be available and appropriately referenced in PC1.

4.4 Additionally, I understand from Section 3.11.1 of PC1 that statistics from five yearly blocks of monitoring data will be used for comparison to and to gauge achievement of the water quality targets and desired states. I consider that such an approach provides relatively low resolution in formally recognising how water quality conditions are changing and hence how activities to improve water quality may be taking affect. Instead, I recommend that a five yearly rolling average be utilised, such that review is provided annually from the preceding five years' monitoring results.

4.5 This annual review of five years' monitoring will enable:

(a) Earlier response to degrading conditions;

(b) Earlier validation of the influence of water quality improvement activities; and

(c) Earlier recognition of investments made into improving water quality.

5. CONSISTENCY OF TARGETS WITH NPS-FM

5.1 Section 3.11.1 of PC1, outlines that achievement of the attribute targets in Table 3.11-1 will be determined through analysis of 5-yearly monitoring data, presumably collected from the monitoring sites. This is consistent with Objective 1 for long term targets, but there is no indication within the PC1 Objectives that water quality monitoring will be used to determine achievement of short term targets by 2026.

5.2 Instead, Objective 3 outlines that it is the "actions put in place and implemented by 2026", sufficient to achieve the short-term water quality attribute states, which are the measure of achieving the objective. This interpretation is confirmed in the S42 report, Section B4.3.3., which

outlines that short term goals for a 10-year period, to show the first step toward full achievement of water quality consistent with the Vision and Strategy, will rely on measurement and monitoring of actions taken on the land to reduce pressures on water quality.

5.3 Further discussion provided in Section 3.11.1, in the section 32 and section 42 reports makes it clear that issues of relatively slow groundwater movement and sediment flux from drains and tributaries, will introduce significant lag into the flux of contaminants to both rivers, with this resulting in ongoing discharges of contaminants, the potential 'load-to-come' and the potential for conditions to get worse before they get better. This assessment is consistent with my observations of groundwater conditions in the Waikato and my knowledge of contaminate transport.

Issue with Objective 3

5.4 I am concerned that Objective 3 and the wording of Section 3.11.1 regarding achievement of short term targets is unclear, leaving uncertainty as to whether these targets are required to be achieved at the monitoring sites by 2026. In addition, the nomenclature used within PC1 is inconsistent with the NPS-FM, which adds further uncertainty in the interpretation of short term targets.

5.5 The NPS-FM targets refer to numerical goals of water quality improvement that are required to be achieved within a defined time frame. As the PC1 short term water quality targets are not required to be met at the designated monitoring locations within the 10 year period, they are not consistent with the definition of a target provided in the NPS-FM. Rather, they represent a theoretical target or goal to be achieved in the undefined, "short term", achievable assuming the influence on water quality of mitigating actions are consistent with modelled predictions for a reduction in emissions, and ignoring delayed impacts of historical activities and corresponding delayed influence of improvements.

5.6 In addition, section B5.4.3.1 of the section 42A report outlines that:

> *'…the Officers consider it inappropriate to include a date by which those targets are likely to be reached, as those times are likely to be variable'.*

5.7 I support the use of short term criteria to create the impetus for improving water quality in the short term and set a path for future improvements. However, I consider that it is confusing in the context of giving effect to the NPS-FM, to refer to these water quality criteria as targets. An alternate

naming, such as 'short term water quality goal' or 'short term water quality to be achieved by actions' is recommended to better reflect:

(a) The transitional nature of the criteria in moving towards achievement of the long term freshwater objectives; and

(b) The theoretical nature of the criteria when applied in the 10 year time frame of PC1 or lack of time constraints for actual achievement of equivalent water quality at the monitoring sites.

Objective 1

5.8 With respect to the long term targets in Objective 1, where improvement in water quality is required to be realised by 2096 at the latest, these meet the definition of targets provided in the NPS-FM, being measurable improvement in water quality within a defined timeframe.

6. INFLUENCE OF MONITORING LOCATIONS ON CONSENTING OF DISCHARGES

6.1 The fixed monitoring sites referenced in Section 3.11.1 of PC1 are required by Policy CB1 of the NPS-FM to provide water quality samples representative of the FMU in which they are located. I am concerned that the stationary nature of the proposed monitoring sites and proximity to these monitoring sites may influence how discharges may be considered in the context of potential influence on water quality.

6.2 In particular, where a mixing zone for a future discharge overlaps with a monitoring site, water samples will provide an unrealistically poor representation of water quality within the FMU. Requirements to achieve water quality improvement may then drive limitations on development in the vicinity of the monitoring sites.

6.3 To avoid such an undesired outcome, a future plan change providing for relocation of a monitoring site to a more representative location will be required when considering relevant future discharges.

7. CONCLUSIONS

7.1 I am supportive of the intent of PC1 described in the section 32 report and the need to take a staged approach to improving water quality in the Waikato and Waipa River catchments.

7.2 However, in my view the intent of PC1 and how the targets and limits outlined in Section 3.11.1 are to be applied would be better communicated where greater consistency with the NPS-FM terminology is maintained.

Where criteria do not meet the definition of objectives, states, limits or targets outlined within the NPS-FM, I recommend adoption of an alternate naming convention.

7.3 In addition, I consider that a lack of appropriate referencing for ammonia (toxicity) limits and targets has led to significant misunderstanding by the submitters of the basis for these criteria and how they should be applied. I also consider that the lack of supporting information regarding derivation of the water quality criteria provided in Table 3.11-1 is a cause for concern, and most likely contributed to the Reporting Officers' misunderstanding as to how these criteria are applied and appropriate referencing of water properties which make the criteria meaningful. Inclusion of pH and temperature references as a note to ammonia (toxicity) criteria will provide clarity to users of PC1 as to how they will be used.

7.4 Nevertheless, it is my opinion that to enable review and understanding of the targets and limits outlined in Table 3.11-1 of PC1, commensurate with the importance of these regional targets and limits, a single document that outlines criteria derivation methodology in detail should be referenced within PC1 and available to the public.

7.5 It is also my opinion that the communication of water quality degradation or improvement, the more timely validation of improvement activities and the acknowledgement of investment in water quality, would be better achieved where the achievement of targets is determined annually, using the preceding five years of monthly data, in a rolling median and 95 percentile method.

Anthony Kirk
25 February 2019

Appendix 1 – My recommended changes to the Officers' "Tracked Changes" document

Section 3.11.1 List of Tables and Maps/Te Rārangi o ngā Ripanga me ngā Mahere

(a) Reference to single document which details the derivation of the water quality targets and limits provided in Table 3.11-1.

(b) '*The achievement of the attribute targets in Table 3.11-1 will be determined through analysis of 5-yearly monitoring data'*. To be replaced with:

'Achievement of 80 year attribute targets in Table 3.11-1 will be determined through annual analysis of monthly monitoring data collected over the preceding 5 years.'

(c) References in the explanatory section to *'Short term water quality limits and targets'.* To be replaced with:

Short term water quality goals.

(d) References in the explanatory section to *'long term numerical desired water quality states'*. To be replaced with:

Long term water quality targets.

Table 3.11-1

Reference standardised pH and temperature conditions for ammonia (toxicity) targets and limits.

3.11.1 Values and uses for the Waikato and Waipa Rivers

'*The values and uses set out below apply to all FMU's unless explicitly stated, and provide background to the freshwater objectives, and the attributes and attribute states outlined in Table 3.11-1.'* To be replaced with:

'The values and uses set out below apply to all FMU's unless explicitly stated, and provide background to the freshwater objectives, the attributes and attribute states, and the targets and limits outlined in Table 3.11-1

3.11.2 Objectives/Ngā Whāinga

Objective 3

'Actions put in place and implemented by 2026 to reduce diffuse and point source discharges of nitrogen, phosphorus, sediment and microbial pathogens, are

sufficient to achieve the short-term water quality attribute states in Table 3.11-1.'
To be replaced with:

'Actions put in place and implemented by 2026 to reduce diffuse and point source discharges of nitrogen, phosphorus, sediment and microbial pathogens, are sufficient to achieve the short term water quality goals in Table 3.11-1.'