IN THE MATTER	of the Resource Management Act 1991 (the Act)
And	
IN THE MATTER	of resource consent applications under section 88 for AFFCO NEW ZEALAND LIMITED for discharges from the AFFCO MANAWATU EXPORT MEAT PROCESSING PLANT

STATEMENT OF EVIDENCE OF DR OLIVIER MICHEL NICOLAS AUSSEIL (WATER QUALITY AND ECOLOGY) ON BEHALF OF AFFCO

26 October 2016

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TABLE OF CONTENTS

INTRODUCTION

1. My name is **Olivier Michel Nicolas Ausseil** (pronounced “O-Say”).

2. I am Principal Scientist – Water Quality at Aquanet Consulting Ltd.

3. My evidence is given in relation to the application for resource consents for discharge of wastewater from the Aorangi meat processing plant in Feilding ("**Project**"), on behalf of AFFCO New Zealand Limited ("**AFFCO**").

EXECUTIVE SUMMARY

4. The Oroua River is one of the main tributaries of the lower Manawatu River. A wealth of monitoring data is available to define the state of water quality and ecology within the Oroua River, including the following:

   (a) Nutrient concentrations (Dissolved Reactive Phosphorus (DRP) and Soluble Inorganic Nitrogen (SIN)) increase going from upstream (Apiti) to downstream (Awahuri Bridge) in the Oroua River.

   (b) The One Plan (OP) target relative to DRP is only just met or marginally exceeded upstream of the AFFCO discharge, and largely exceeded downstream, with further increases downstream of the Feilding WWTP and at Awahuri Bridge. DRP concentrations at Awahuri Bridge have considerably reduced since the implementation of the chemical dosing process at the Feilding WWTP plan in 2008/2009;

   (c) The OP target relative to SIN is met upstream of AFFCO and either met or exceeded by a relatively small margin downstream of AFFCO. Annual average SIN concentrations further increase downstream of the Feilding WWTP and at Awahuri Bridge, where SIN is approximately twice the One Plan target;

   (d) There is no evidence of a significant issue relative to periphyton growth at either Almadale (i.e. 11 km upstream of AFFCO) or upstream of Feilding WWTP (i.e. 2 km downstream of AFFCO). There is evidence of some exceedances of the OP targets downstream of the Feilding WWTP, and at Awahuri Bridge. This means that, in relation to the AFFCO discharge, the effects of primary concern seem to be associated with cumulative effects downstream of the Feilding WWTP, rather than direct effects.

   (e) One limitation of the above comment is that there is no regular monitoring immediately downstream of the AFFCO discharge (after reasonable mixing). We do not know if the AFFCO discharge results in any localised effects on periphyton growth, but we do know that any potential issue that might exist does not extend to the upstream of the Feilding WWTP monitoring site, located 2 km downstream of the AFFCO discharge.

(f) April/May constitutes the key period of interest in relation to the potential effects of the AFFCO discharge on periphyton growth; and

(g) The OP targets relative to Macroinvertebrate Community Index (MCI) are generally met at all sites upstream of the Feilding WWTP (i.e. including upstream and downstream of AFFCO), and not met at times downstream of the Feilding WWTP and at Awahuri Bridge.

5. I developed and applied a water quality model to predict the effects of a range of existing and future discharge regimes on water quality. The model is based on the application of the principle of mass conservation, applied daily over an extended modelling period (20 years in this case).

6. Two scenarios were modelled:

(a) Current: This scenario is representative of the discharge regime as operated under the current resource consent conditions; and

(b) Proposed: This scenario is representative of the proposed discharge regime

7. Six water quality determinands were modelled: DRP, SIN, total ammonia-N, *E. coli*, water clarity, and Soluble carbonaceous five-day Biochemical Oxygen Demand ($ScBOD_5$). My model also incorporates two periphyton growth components.

8. In summer (December to March), the discharge is not allowed to operate at flows below three times the median flow. Both the 'current' and 'proposed' discharge are not expected to result in any more than minor effects.

9. The rest of the year, the following applies to the 'current' discharge:

(a) It is not likely to cause any breaches of the OP targets relating to $ScBOD_5$, POM, water clarity or total ammonia-nitrogen, and is not expected to significantly affect the degree of compliance with the *E.coli* targets.

(b) It is however predicted to result in material increases in in-river nutrient concentrations at flows below Q20[1];

(c) The OP DRP concentration target is just met upstream of the discharge but is predicted to be largely exceeded downstream of the discharge.

[1] Q20 is the river flow exceeded 20% of the time. It is the same statistic as the 20th Flow Exceedance percentile (20th FEP). It is used in the One Plan as a measure of high/flood river flows, above which certain water quality targets (including SIN, DRP, E.coli) do not apply.

(d) The OP SIN concentration target is expected to be met both upstream and downstream of the discharge in spite of predicted increase between the two sites.

(e) The current discharge regime has no material effects on the monthly average SIN and DRP concentrations in the December to March (inclusive) period

(f) The effects of the current discharge on monthly average SIN and DRP concentrations at flows below Q20 are greatest (in decreasing order) in May, June, April and July

(g) Consequential effects on periphyton growth are difficult to predict with certainty, however, the 'current' discharge does occur at times when river flow conditions are suitable for periphyton growth and accumulation, particularly in April and May. Periphyton biomass increases (between upstream and downstream) in the order of 10 to 35% are predicted.

(h) Periphyton growth increases of this order may be measurable, which is supported by the measurable increase in periphyton cover reported by Stark (2011). Whether these increases would lead to actual breaches of the OP periphyton biomass and/or cover targets is not able to be assessed robustly due to insufficient data.

(i) However, as explained above, there is no evidence of a significant issue relative to periphyton growth at either Almadale (i.e. upstream of AFFCO) or upstream of Feilding WWTP (i.e. 2 km downstream of AFFCO), meaning that any issue with periphyton growth is at worst limited to a reach of river less than 2 km long.

10. The following applies to the 'proposed' discharge regime:

(a) It is predicted to result in about an 8 % increase of the total volume of effluent and the total load of contaminants discharged to the river compared with the 'current' scenario. However, the timing of the discharges to the river is different in the two scenarios. The 'proposed' scenario sees a complete elimination of the discharge to the River at flows below 7.950 l/s (10% above median flow). The proposed discharge regime also results in significant reduction in the proportion of effluent and contaminant loads discharged to the river at flows below Q20.

(b) The modelling assessment presented in this report indicates that the 'proposed' discharge is predicted to cause lesser effects on water clarity and on concentrations of $ScBOD_5$, POM, total ammonia-nitrogen and *E.coli* than the 'current' scenario', and thus is not expected to result in any significant adverse effects associated with these water quality determinands.

(c) The effects of the 'proposed' discharge on average in-stream nutrient (DRP and SIN) concentrations (<Q20) are predicted to be 87% less than under the 'current' scenario.

(d) On a monthly basis, the improvements under the proposed scenario are greatest during April and May (93% and 94% reduction respectively).

(e) I consider that the increases in concentrations predicted for April and May (0.001-0.002 g/m^3 for DRP and 0.005-0.010 g/m^3 for SIN) are minor in nature and unlikely to be confidently detected against background concentrations.

(f) The effects of the 'proposed' discharge on periphyton growth are likely to be significantly less than those of the 'current' discharge. Predicted periphyton biomass increases under the proposed scenario are in the order of 0 to 4% (based on the periphyton growth model predictions and SIN based NZPG modelling outputs);

(g) When considering the April-May period specifically, the average biomass is predicted to increase by 3.2% between upstream and downstream, and the peak biomass is expected to increase by 0.1%.

(h) Increases of this magnitude would be very unlikely to be able to be detected using standard monitoring methods, given the large error generally associated with periphyton biomass measurements. In my opinion, the risk of the proposed discharge causing a significant increase in periphyton growth to the point where it would cause exceedances of the One Plan target is relatively low.

11. Only one set of macroinvertebrate data, collected in November 2011 by Stark (2011) is available. On that occasion, the data indicated that, although there was some ambiguity in the testing results, the discharge was not meeting the One Plan target relative to a maximum change in QMCI of 20% between upstream and downstream of the discharge.

12. The key likely mechanisms of effects on macroinvertebrate communities are predicted to be significantly mitigated under the proposed discharge regime, and, in my opinion, the level of effects currently measured will be significantly reduced. It is however not possible to predict with certainty the exact degree of improvement and/or the residual level of effects that may still occur under the proposed discharge regime.

13. Cumulative effects of the AFFCO and the Manawatu District Council Feilding WWTP discharges on nutrient concentrations and loads were modelled, under the current and proposed scenarios, with the following results:

(a) With regard to SIN, the combined predicted effects of the two (AFFCO and MDC) proposed discharge regimes on in-river SIN concentrations is 0.168 g/m^3, i.e. approximately 38% of the One Plan target, as opposed to 0.552 g/m^3 (120% of the One Plan target currently). The SIN concentration downstream of the Feilding WWTP is predicted to be 0.426 g/m^3, i.e. marginally less than the One Plan target of 0.444 g/m^3.

(b) With regard to DRP, the concentration increase caused by the two discharges under the "proposed" discharge regimes is of the order of 0.003 g/m^3 (33% of the OP target) as opposed to 0.012 g/m^3 (120% of the OP target) under the current scenarios. The DRP concentration downstream of the Feilding WWTP is predicted to be 0.013 g/m^3 (as opposed to 0.010 g/m^3 upstream), i.e. still exceeding the OP target but less than it currently is upstream of the Feilding WWTP discharge.

QUALIFICATIONS AND EXPERIENCE

14. I have the following qualifications and experience relevant to the evidence I shall give:

15. I hold a PhD of Environmental Biosciences, Chemistry and Health from the University of Provence, France. I also hold a Master of Science Degree of Agronomical Engineering from the National Higher Agronomical School of Montpellier, France, and a DEA (equivalent Masters Degree) in Freshwater Environmental Sciences from the University of Montpellier II, France.

16. I have over 14 years' experience in New Zealand as a scientist working in local government and as a private consultant working for regional councils and local authorities, central government and government agencies, and the private sector. Prior to that, I worked as a Research Engineer between 1998 and 2001 for the French Atomic Energy Commissariat during my PhD studies.

17. Prior to forming Aquanet Consulting Ltd, I was employed by the Regional Planning Group of Horizons from July 2002 to June 2007, where I held the positions of Project Scientist, Environmental Scientist- Water Quality, and Senior Scientist - Water Quality.

18. My responsibilities at Horizons included leading the water quality and aquatic biodiversity monitoring and research programme and providing technical support to policy development. I was the primary author of three technical reports underpinning the river classification, river values framework and water quality standards in the notified version of the Proposed One Plan for the Manawatu-Wanganui Region.

19. Since July 2007, I have been Principal Scientist at Aquanet Consulting Limited. In this position, I have been engaged by 17 different regional, district or city councils, the Ministry for the Environment, a number of iwi/hapū, the Department of Conservation, Fish and

Game New Zealand, and various private companies/corporations to provide a variety of technical and scientific services in relation to water quality and aquatic ecology.

20. I am a certified Commissioner under the Ministry for the Environment “Making good decisions” programme. I was a Hearing Commissioner appointed by Horizons to hear New Zealand Defence Force’s consent applications to discharge treated wastewater from the Waiouru wastewater treatment plant to the Waitangi Stream, in June 2011 and February 2012.

21. I have worked as a technical advisor on behalf of the consenting authority, the applicant and/or submitters on well over 150 resource consent applications, compliance assessments and/or prosecution cases for a wide range of activities. In July 2010, I ran a training workshop for Horizons staff on the technical assessment of resource consent applications for discharges to water.

22. My work routinely involves providing assessment of effects on water quality and/or aquatic ecology, recommending or assessing compliance with, resource consent conditions, and designing or implementing water quality/aquatic ecology monitoring programmes. I have designed and implemented a large number of monitoring programmes both at the scale of a specific activity and at a wider catchment or regional scale. As part of my previous role at Horizons I redesigned the state of the environment water quality monitoring programme. I also undertook a detailed review of Environment Southland’s water quality monitoring programme in 2010 and of Environment Bay of Plenty’s in 2012.

23. I have authored or co-authored a number of catchment- or region-wide water quality reports for Greater Wellington Regional Council (whole region), Hawke’s Bay Regional Council on 7 catchments (2008 and 2016), and for Environment Canterbury on the Hurunui catchment and Pegasus Bay.

24. I have authored or co-authored a number of reports making recommendations for water quality limits for regional plan change processes, for Horizons Regional Council, Hawke’s Bay Regional Council and Greater Wellington Regional Council am currently involved in the Waikato Regional Plan Change 1 on behalf of the Five Waikato River Iwi, and in the Gisborne District Freshwater Plan on behalf of the Mangatu/Wi Pere Trusts.

25. With regards to municipal wastewater treatment plants I have worked as a technical advisor on behalf of consenting authorities, applicants and submitters on over 35 resource consent applications for discharges of treated domestic wastewater to land and/or water, from both medium-sized towns and small communities.

26. A number of the above cases included dual land/water discharge systems not dissimilar to the discharge regime proposed by AFFCO. The water quality model I used to assess the effects of the proposed discharge regime from the AFFCO plant was also used in

assessment of effects I produced in relation to the dual land/water discharge regime proposed for the Shannon and Feilding WWTPs using a similar methodology.

27. I am a member of the New Zealand Freshwater Sciences Society and the Resource Management Act Law Association (RMLA).

28. I was the co-recipient of the New Zealand Resource Management Law Association 2016 Chapman Tripp Project Award for an ongoing consultation process associated with the re-consenting of wastewater treatment plant and community water supplies in the Ruapehu District.

29. I confirm that I have read the 'Code of Conduct' for expert witnesses contained in the Environment Court Practice Note 2014. My evidence has been prepared in compliance with that Code. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

BACKGROUND AND ROLE

30. In preparing my evidence I have:

    (a) Prepared a technical report providing a modelling based assessment of the effects of the current and proposed discharge regimes on water quality and periphyton growth in the Oroua River, entitled AFFCO (Feilding Meat Processing Plant) discharge to the Oroua River: Water Quality modelling and assessment of effects of proposed discharge regimes, dated September 2014.

    (b) Undertaken a site visit in June 2014;

    (c) Read the following documents and evidence:

        (i) The Section 42A report prepared by My Logan Brown;

        (ii) The S42A report prepared by Ms Manderson, including the set of draft conditions

        (iii) The Cultural Impact Assessment report prepared by Dr April Bennett.

31. I note that I was involved in the resource consent application and hearing (council and environment court hearings) process for the Feilding WWTP, on behalf of the Manawatu District Council. During that process, I used the same water quality and periphyton model as I used to assess the effects of the AFFCO discharge. The model, including the methodology, calibration and limitations were discussed in detail in expert caucusing, and I will refer to the conclusions reached during that process in my evidence. During the Feilding WWTP process, I also produced an assessment of the cumulative effects of the

two discharges (AFFCO and MDC), both under the current and proposed situations. I will refer to this assessment in my evidence.

32. Through the above process, and a range of other projects, I am familiar with the Oroua River, its catchment, and state of, and pressures on, its water quality and ecology.

SCOPE OF EVIDENCE

33. My evidence addresses the following matters:

   (a) State of fresh water quality and ecology in the Oroua River

   (b) Modelling methodology,

   (c) Predicted effects of the current and proposed discharge regimes on;

      i. Microbiological water quality

      ii. Physico-chemical determinands, such as temperature, pH, water clarity, turbidity, etc.

      iii. Toxicants (ammonia)

      iv. Nutrient concentrations

      v. Periphyton growth

      vi. Macroinvertebrate communities

   (d) Cumulative effects on the water quality of the Oroua and Manawatu Rivers.

34. As indicated above, I have carefully read Mr Brown's S42A report and, where I substantively agree with his evidence, have directly referred to specific sections of his report to avoid duplication.

WATER QUALITY OF THE OROUA RIVER

River values and water quality targets

35. In paragraphs 8 to 15 of his S42A report, Mr Brown provides a description of the Oroua River, the One Plan Water Management Zones and sub-Zones, Schedule B river values and Schedule E water quality targets applicable to the area. Mr Brown's description is consistent with my understanding and knowledge of the area and the One Plan framework, and I will not cover these aspects further in my evidence, apart from the following additional comments.

36. It is important to note that, from a technical point of view different Schedule E targets were defined for different reasons. In particular:

    a. Some of the targets are only defined as "State of the Environment" targets and are not directly applicable to point source discharges. This is, for example, the case for MCI and deposited sediment;

    b. Some of the targets directly relate to (i.e. are a measure of) the state of a given river value. For example, visual water clarity and periphyton cover directly relates to the aesthetic and recreational values of the river. Likewise, MCI provides a direct measure of the river's life-supporting capacity, and the change in QMCI provides a direct measure of the degree of effects of a specific activity on life supporting capacity;

    c. By contrast, other targets, such as DRP, SIN, $ScBOD_5$ or POM targets do not directly relate to effects on river values, rather they are a sub-set of controlling factors to other factors (such as periphyton growth), which can directly affect river values. Specifically it means that, from a technical point of view, in-stream nutrient (DRP and SIN) can be considered subsidiary to the periphyton and macroinvertebrate targets.[2]

37. The above comment has relevance to the decision to apply different targets in different contexts, including in resource consent conditions.

State of water quality in the Oroua River

Periphyton

38. In paragraphs 19 to 30 of his S42A report, Mr Brown provides a very useful summary of the monitoring data relative to periphyton biomass and cover for the Oroua River. It is important to note that the data available includes monthly data at 5 monitoring sites since December 2008. This represents an unusual wealth of data, on which to base a very robust understanding of the of the periphyton growth in the Oroua River.

39. The monitoring sites include (Figure 3, p15 in Mr Brown's evidence provides a map of the various monitoring sites in the catchment):

    a. the Oroua River at Apiti, in the upper catchment;

    b. The Oroua River at Almadale, located approximately 11 km upstream of the AFFCO plant, noting however that a major tributary of the Oroua River (the Kiwitea Stream) joins the Oroua River between Almadale and the AFFCO discharge point;

[2] These aspects were discussed in detail as part of the Feilding WWTP Environment Court process (refer to Joint Witness Statement dated 5 November 2015 (paragraph 24), and accepted by the Court (Interim Decision 22 March 2016 NZENvC53, paragraph 121).

c. The Oroua River upstream of Feilding WWTP, located approximately 2 km downstream of the AFFCO discharge. This site provides an indication of the condition of the river downstream of the AFFCO discharge, although other sources of contaminants may enter the river between these two points;

d. The Oroua River downstream of the Feilding WWTP discharge;

e. The Oroua River at Awahuri Bridge.

40. It is noted that a few kilometres downstream of Awahuri Bridge, the bed of the Oroua River changes from being dominated by gravel and cobbles to fine sediment. Fine sediment does not provide attachment for periphyton growth, i.e. Awahuri Bridge is the most downstream site on the Oroua River where monitoring of periphyton growth can sensibly be undertaken.

41. With regard to periphyton biomass,

a. The One Plan targets for periphyton biomass are 50 mg/m^2 at Apiti and 120 mg/m^2 at all other sites. The periphyton biomass target was primarily defined in relation to aquatic biodiversity and ecology values;

b. In my opinion, these targets should not, and were not intended[3] to, be applied as numbers that must never be exceeded (i.e. a 100% compliance level). The 50 mg/m^2 target should be applied using an 80% compliance level, and the 120 mg/m^2 should be applied using a 95% compliance level.

c. With reference to Figure 4 (p19) and Table 6 (p23) of Mr Brown's S42A report:

i. The target was always met at Almadale and upstream of the Feilding WWTP (i.e. downstream of AFFCO);

ii. The target was exceeded on occasion downstream of Feilding WWTP (8% of the time) and at Awahuri Bridge (3% of the time), noting however that the target has always been met at Awahuri Bridge since 2011. Overall, using a 95% compliance level, the target is exceeded downstream of the Feilding WWTP but met at Awahuri Bridge.

d. Mr Brown has also undertaken an assessment against the NPSFM (2014) Attribute State for periphyton biomass (Table 7, p24 of Mr Brown's S42A report), finding that:

i. all sites fall into band A, except

[3] As recommended in Ausseil and Clark (2007). Recommended water quality standards for the Manawatu-Wanganui Region. This was accepted by the Environment Court (Decision, 14 July 2016) NZENvC132, paragraph 17.

ii. downstream of the Feilding WWTP, which falls into Band B overall (and band C when considering the 2012-2015 period).

42. With regard to periphyton cover:

a. The One Plan defines a target of no more than 30% cover for long filamentous algae and 60% cover for thick diatom or cyanobacteria mats. These targets were primarily defined in relation to visual, amenity and recreational values. The technical report recommending these targets is silent on a level of compliance because no cover data were available at the time. I am of a view that the same compliance level as for the periphyton biomass (95%, 1 sample out of 12) is appropriate, for the same reasons;

b. The target relative to 60% cover by thick mats was always met at all sites;

c. The target relative to 30% cover by filamentous algae was:

i. always met at Apiti, Almadale and upstream of the Feilding WWTP (i.e. downstream of AFFCO); and

ii. exceeded on occasion downstream of Feilding WWTP (5% of the time overall, 3% since 2012) and at Awahuri Bridge (4% of the time), noting however that the target has always been met at Awahuri Bridge since 2012.

43. The overall conclusion with regards to periphyton growth, based on the available data, is that there is no evidence of a significant issue (as far as meeting the One Plan targets of NPSFM Attribute State) at either Almadale (i.e. upstream of AFFCO) or upstream of Feilding WWTP (i.e. downstream of AFFCO). There is evidence of some exceedances of the One Plan targets downstream of the Feilding WWTP, and occasionally at Awahuri Bridge, although this site meets the targets overall. This means that, in relation to the AFFCO discharge, the effects of primary concern seem to be associated with cumulative effects downstream of the Feilding WWTP, rather than direct effects.

44. One limitation of the above comment is that there is no regular monitoring immediately downstream of the AFFCO discharge (after reasonable mixing), i.e. there is no data to inform us on any localised effects the discharge might have on periphyton growth. What we do know is that any potential issue that might exist does not extend to the upstream of Feilding WWTP monitoring site, located 2 km downstream of the AFFCO discharge.

45. With regards to the seasonal aspects of periphyton growth raised by Mr Brown in his paragraph 31, I agree that periphyton growth in the Oroua River appears to be strongly associated with the season (the likely underlying controlling factor being the flow regime in the Oroua River). When considering exceedances of the One Plan targets in the lower Oroua River (downstream of Feilding WWTP or at Awahuri Bridge), it is relevant to note

that they have all occurred in the December to May period. The period when periphyton biomass exceeds the One Plan target does extend into April /May period, but only during dry years.

46. Given the proposed regime for the AFFCO discharge (specifically no discharge below 3* median flow[4]), this means that the only period when it may cause, or contribute to, exceedances of the One Plan periphyton targets would be in April and May during dry years. In this I agree with Mr Brown that April/May constitutes the key period of interest in relation to the effects of the AFFCO discharge on periphyton growth. These aspects are discussed further in later parts of my evidence.

Macroinvertebrate health

47. Benthic macroinvertebrates are the insects, snails and worms living on the bottom of streams and rivers. The composition of macroinvertebrate communities is commonly used as an overall indicator of overall river ecosystem health.

48. In paragraph 32 to 44 of his S42A report, Mr Brown provides a detailed summary of the macroinvertebrate data available for the Oroua River. I generally agree with his conclusions.

49. Data indicates that the One Plan “state of the environment” MCI target is generally met at all sites upstream of the Feilding WWTP, and not met at times downstream of the Feilding WWTP and at Awahuri Bridge.

50. I discuss the direct effects of the AFFCO discharge on macroinvertebrate communities later in my evidence.

Nutrients

51. In a river system, nutrients are of environmental concern because they can, under certain conditions, cause excessive growth of periphyton. Periphyton is the green or brown slime growing on hard surfaces on the bottom of streams and rivers; it is a natural and essential part of the ecosystem but can proliferate under certain conditions and affect a number of ecological, recreational and cultural river values.

52. In paragraphs 48 to 51 Mr Brown provides a useful assessment of existing monitoring data against the One Plan targets for DRP and SIN. I note that Mr Brown has provided a year-by year analysis of SIN and DRP concentrations. This method is useful in that it provides a year-to-year breakdown, but presents the disadvantage of being based on a small number of samples collected at the appropriate river flow (i.e. below 20 FEP) each

[4] In the Oroua River, 3* median flow is greater than Q20, this means by default that there will be no direct discharge from the AFFCO plant to the Oroua River below Q20, i.e. when the SIN and DRP targets apply, and when periphyton growth is able to accumulate.

year (typically less than 10 samples per year), meaning that the average value can easily be strongly driven by one unusually low result. Another method of analysis is to use average concentrations calculated over a longer period – typically 3 to 5 years. This latter method presents the advantage of being based on a greater number of results, and thus provide a more robust and overall assessment as to whether a site meets the One Plan target or not. I have used the latter method in the assessment provided in the 2014 Aquanet modelling report.

53. Having said that, Mr Brown's and my analyses generally concur over the following points:

a. the One Plan target relative to DRP is only just met or marginally exceeded upstream of the AFFCO discharge (0.010 mg/L overall,[5] in my analysis, 0.009 to 0.014 mg/L in Mr Brown's against a target of 0.010 mg/L), and largely exceeded downstream (0.023 mg/L in my analysis, 0.018 to 0.032 mg/L in Mr Brown's), with further increases downstream of the Feilding WWTP and at Awahuri Bridge;

b. The DRP concentrations at Awahuri bridge have reduced considerably reduced since the implementation of the chemical dosing process at the Feilding WWTP plan in 2008/2009, from concentrations in excess of 0.110 g/m^3 to those measured in recent years[6].

c. The One Plan target relative to SIN is met upstream of AFFCO (0.253 mg/L in my analysis, 0.164 to 0.368 mg/L in Mr Brown's, against a target of 0.444 mg/L), and either met (0.347 mg/L in my analysis, 0.257 to 0.287 mg/L in 2013 to 2015 in Mr Brown's evidence) or exceeded by a relatively small margin (0.537 mg/L in 2011 and 0.454 mg/L in 2012 in Mr Brown's analysis) downstream of AFFCO. Annual average SIN concentrations further increase downstream of the Feilding WWTP and at Awahuri Bridge, where they are equivalent to twice the One Plan target;

d. It is interesting to note that Mr Brown's analysis seems to indicate a reduction in the effects of the AFFCO discharge over the last three years (2013-2015) versus the first two years of his analysis (2011 and 2012), for both SIN and DRP.

54. It is important to consider these results in the light of the comment I make in paragraph 36, i.e. that the nutrient targets are subsidiary to the periphyton target. In this situation, the One Plan targets relative to periphyton are met upstream of the Feilding WWTP discharge, in spite of the DRP target being largely exceeded.

[5] Aquanet modelling report (2014), Table2, p11

[6] Feilding WWTP , Statement of evidence of Olivier Michel Nicolas Ausseil on the topic of water quality and aquatic ecology. Dated 23 October 2015, paragraph 3.19, p22.

55. In paragraph 47 of his evidence, Mr Brown refers to recent Nutrient Diffusing Substrate results obtained at Almadale, indicating that the growth of periphyton in this reach of the Oroua River appeared to be limited by nitrogen at low flows. I have not reviewed these results, but the conclusion is consistent with the conclusion I reached during the Feilding WTTP assessment process that periphyton growth in summer in this reach of the Oroua River seems to be primarily controlled by SIN concentrations.

56. The effects of the AFFCO discharge on nutrient concentrations, solely or in combination with the Feilding WWTP discharge are explored in detail in later parts of my evidence.

Microbiological water quality

57. The One Plan defines two in-stream targets relative to *E. coli* concentrations:

    a. 260 E.coli/100mL, applicable in November to April at river flows below median flow; and

    b. 550 E.coli/100mL, applicable year-round at flows below 20th FEP.

58. The data available indicates that;

    a. There is a slight reduction in the proportion of samples meeting the 260 E.coli/100mL target from upstream (77% of samples) to downstream (71% of samples), although the change between upstream and downstream was not statistically significant[7];

    b. There is a slight reduction in the proportion of samples meeting the 550 E.coli/100mL target from upstream (91% of samples) to downstream (84% of samples), although the change between upstream and downstream was not statistically significant[8];

EFFECTS OF THE DISCHARGE

Modelling approach and scenarios

59. I developed and applied a water quality model to predict the effects of a range of existing and future discharge regimes on water quality. The model is based on the application of the principle of mass conservation, applied daily over an extended modelling period (20 years in this case). My 2014 modelling report, provided as part of the original consent application provides details of the model structure and modelling data and assumptions.

60. Two scenarios were modelled:

[7] Based on a Wilcoxon Signed Rank Test, 2014 Aquanet modelling report, p10.
[8] Based on a Wilcoxon Signed Rank Test, 2014 Aquanet modelling report, p10.

a. Current: This scenario is representative of the discharge regime as operated under the current resource consent conditions. It thus represents the historical discharge within recent history;

b. Proposed: This scenario is representative of the proposed discharge regime

61. Both scenarios assume similar effluent quality, based on historical effluent quality. The key difference between the two scenarios lies in the timing and volume of discharge. In particular, the proposed discharge regime does not include any discharge when the Oroua River is below 7.950 l/s in "winter" (April to November inclusive), while the current discharge regime allows discharges at river flows as low as 3,000 l/s in winter.

62. Six water quality determinands were modelled: DRP, SIN, total ammonia-N, *E. coli*, water clarity, and Soluble carbonaceous five-day Biochemical Oxygen Demand ($ScBOD_5$).

63. My model also incorporates two periphyton growth components:

a. The first component uses daily predictions of DRP and SIN concentrations to predict daily periphyton growth rates, and daily river flow to predict removal of periphyton biomass. The combination of daily growth rates and removal by river flow provides predicted periphyton biomass on a daily time step;

b. The second component uses the model published in the New Zealand Periphyton Guidelines (NZPG). The NZPG model predicts peak (i.e. maximum) periphyton biomass based on average nutrient concentrations and the duration of the accrual period. I have applied the NZPG model, using an average accrual period of 30.391 days and the predicted monthly average concentrations at flows below 20^{th} FEP to predict peak periphyton biomass for each calendar month for the current and proposed scenarios.

Model calibration and goodness of fit

64. Details relative to model calibration and goodness of fit are presented in the 2014 modelling report. Calibration focused primarily on nutrient (DRP and SIN) concentrations. The predicted nutrient concentrations both upstream and downstream of the discharge fall within the tolerance range given by the observed concentrations ± one standard deviation, showing acceptable fit between observed and predicted concentrations.

65. In my opinion the satisfactory agreement between measured and modelled DRP and SIN concentrations upstream of the discharge point provides a robust basis for the modelling of the effects of the discharge, including current and future discharge scenarios.

66. Similarly, the satisfactory agreement between measured and modelled DRP and SIN concentrations downstream of the discharge point shows that the model is capable of satisfactorily predicting the effects of the current discharge on water quality, which gives

me confidence that the model is useful to predict the effects of future discharge scenarios on water quality in the Oroua River downstream of the discharge.

67. There are no periphyton data available upstream or downstream of the AFFCO discharge on which to base a calibration of the periphyton components of the model. Model parameters were the same as those I established for the Feilding WWTP.

68. I used the same model and modelling approach in the assessment of the effects of the Feilding WWTPs. As part of these processes, the model's usefulness and limitations were assessed by various water quality experts. The paragraphs below are excerpts from the Water Quality Joint Witness Statement produced as part of the Feilding WTTP Environment Court process, and provided as Appendix one to my evidence. These conclusions are, in my opinion, also applicable to the model as it was applied to the AFFCO discharge.

(a) On the water quality component of the model "*The basic principles of the model, i.e. a mass balance approach over a daily time step basis over an extended period of modelling (17 years). This is the best available approach to assess the water quality effects of the proposed discharge regime*"[9]

(b) On the periphyton growth component of the model: "*The model simulates periphyton growth on a daily basis based on nutrient concentrations. It also incorporates a scour component that simulates periphyton biomass removal due to flow (velocity and abrasion) in the river on a daily basis. The flow inputs to the model are based on historical flow records and are therefore reliable. Nutrient concentration inputs are from the water quality component of the model, and are considered robust. The model is useful in that it incorporates the temporal aspects of the timing of discharges and flow in the river. The model is useful to predict the likely direction of change and scale of change between scenarios. However, key model components such as growth rate and scour have not been measured in the river and therefore could not be calibrated. Therefore absolute values should be taken with caution*"[10]

(c) On the NZPG model:´ *The NZPG model predicts peak (i.e. maximum) periphyton biomass based on average nutrient concentrations and the length of average accrual period*." And "*Using the NZPG, SIN predicted values upstream and downstream (current scenario) more closely match the observed values than the DRP-based predictions and should be used in preference. These outputs are useful to predict the likely direction of change and scale of change between scenarios. The calibration of predicted against observed values upstream of the discharge*

[9] Feilding WWTP Water Quality Joint Witness Statement dated 6 November 2015, paragraph 9
[10] Feilding WWTP Water Quality Joint Witness Statement dated 6 November 2015, Appendix 3, page 37, paragraph 1.3.

somewhat reduces uncertainty. However, absolute values should be ascribed a high level of uncertainty and be used with caution."[11]

Effects of the summer (December to March) discharge (current and proposed)

69. In summer, the discharge is not allowed to operate at flows below three times the median flow. This flow cut-off is higher (more stringent) than any of the flow cut-offs (median or Q20) set in the OP water quality targets. As a result, the discharge (both current and proposed) during the summer months will comply with all the OP water quality targets containing flow cut-offs (DRP, SIN, POM, $ScBOD_5$, water clarity, *E. coli*).

70. A number of the OP targets do, however, apply at all river flows: total ammonia-nitrogen (chronic and acute), water clarity change and biological indicators (periphyton biomass and cover, MCI and changes in QMCI).

71. The assessment presented in my 2014 report shows that both the 'current' and 'proposed' discharge are predicted to comply with the total ammonia-N and water clarity change targets at all times, and thus are not expected to result in any more than minor effects in relation to these water quality determinands.

Effects of the current Winter (April to November) discharge

72. The modelling assessment presented in 2014 modelling report indicates that the 'current' discharge is not likely to cause any breaches of the One Plan targets relating to $ScBOD_5$, POM, water clarity or total ammonia-nitrogen.

73. The predicted 99^{th} percentile of the concentration increases associated with the "current" discharge is 8.2 *E. coli*/100mL (with a maximum of 15 E. coli/100mL). These are quite minor increases compared with the 550 E. coli/100mL target, which seems unlikely to significantly affect the overall level of compliance with that target.

74. The One Plan targets were designed to be set at levels that, if complied with, avoid significant adverse effects on river values. The 'current' discharge is therefore not expected to result in any significant adverse effects associated with these water quality determinands.

75. The 'current' discharge is however predicted to result in material increases in in-river nutrient concentrations at flows below 20^{th} FEP:

    a. The OP DRP concentration target is just met upstream of the discharge but is predicted to be largely exceeded downstream of the discharge (Figure 1).

    b. The OP SIN concentration target is however expected to be met both upstream and downstream of the discharge in spite of predicted increase between the two sites (Figure 3).

[11] Feilding WWTP Water Quality Joint Witness Statement dated 6 November 2015, Appendix 3, page 36, paragraph 1.2.

76. Further analysis indicates that:

a. The current discharge regime has no material effects on the monthly average concentrations in the December to March (inclusive) period;

b. the effects of the current discharge on monthly average concentrations at flows below 20th FEP are greatest (in decreasing order) in May, June, April and July (Figure 2 and Figure 4).

77. Consequential effects on periphyton growth are difficult to predict with certainty, however, the three approaches undertaken (a qualitative risk assessment and two modelling approaches) indicate that the 'current' discharge does occur at times when river flow conditions are suitable for periphyton growth and accumulation, particularly in April and May. Periphyton biomass increases (between upstream and downstream) in the order of 10 to 35% (based on the periphyton growth modelling outputs and NZPG, SIN-based modelling outputs) are predicted[12].

78. Periphyton growth increases of this order may be measurable, which is supported by the measurable increase in periphyton cover reported by Stark (2011). Whether these increases would lead to actual breaches of the OP periphyton biomass and/or cover targets immediately is not able to be assessed robustly due to insufficient data.

79. However, as explained in paragraph 43 of my evidence, there is no evidence of a significant issue (as far as meeting the One Plan targets of NPSFM Attribute State) relative to periphyton growth at either Almadale (i.e. upstream of AFFCO) or upstream of Feilding WWTP (i.e. 2 km downstream of AFFCO), meaning that any issue with periphyton growth is at worst limited to a reach of river less than 2 km long.

Effects of the <u>proposed</u> Winter (April to November) discharge

80. The 'proposed' discharge regime is predicted to result in about an 8 % increase of the total volume of effluent and the total load of contaminants discharged to the river compared with the 'current' scenario. However, the timing of the discharges to the river is different in the two scenarios.

81. The 'proposed' scenario sees a complete elimination of the discharge to the River at flows below 7.950 l/s (approximately 1.1 times the median flow). Periods of low river flow are usually considered the most critical times for discharges of contaminants to streams and rivers, due to (1) less dilution available and (2) a higher risk of biological effects of contaminants, for example, excessive periphyton growth. By eliminating the discharge to the river at flows below median flow, the proposed discharge regime eliminates any risk of directly causing effects during the most sensitive times.

[12] Aquanet 2014 modelling report, pages 30-31, noting that the DRP-based NZPG modelling predictions are not used here, on the basis that they are unlikely to be useful given the conclusion that periphyton growth in this reach of the Oroua River is likely to be primarily nitrogen limited.

82. The modelling assessment presented in this report indicates that the proposed discharge is predicted to cause lesser effects on water clarity and on concentrations of $ScBOD_5$, POM, total ammonia-nitrogen than the 'current' scenario', and thus is not expected to result in any significant adverse effects associated with these water quality determinands.

83. The predicted 99th percentile of the concentration increases associated with the proposed discharge is 4.8 *E. coli*/100mL (with a maximum of 5.8 *E. coli*/100mL). These are quite minor increases compared with the 550 *E. coli*/100mL target, and the overall level of compliance with that target is not predicted to be affected in a more than very minor way by the proposed discharge.

84. The proposed discharge regime also results in significant reduction in the proportion of effluent and contaminant loads discharged to the river at flows below 20th FEP. As a result, the effects of the proposed discharge on in-stream dissolved nutrient concentrations (DRP and SIN) are predicted to be 87% less than under the 'current' scenario (Figure 1 and Figure 3).

85. On a monthly basis, the improvements under the proposed scenario are greatest April and May (93% and 94% reduction respectively). The predicted effects of the proposed discharge on monthly average concentrations at flows below 20th FEP are:

   a. 0.001-0.002 mg/L for DRP in April and May respectively (vs. 0.012 and 0.027 mg/L under the current scenario) (Figure 2);

   b. 0.005 and 0.010 mg/L for SIN in April and May respectively (vs 0.064 and 0.163 mg/L under the current scenario) (Figure 4).

86. I consider that the increases in concentrations predicted for April and May are minor in nature and unlikely to be confidently detected against background concentrations.

87. Potential effects on periphyton growth were assessed by three methods: one qualitative and two modelling methods. All three methods are in general agreement that the effects of the 'proposed' discharge are likely to be significantly less than those of the 'current' discharge. Predicted periphyton biomass increases under the proposed scenario are in the order of 0 to 4% (based on the periphyton growth model predictions and SIN based NZPG modelling outputs[13])

88. When considering the April-May period specifically, the average biomass is predicted to increase by 3.2% between upstream and downstream, and the peak biomass is expected to increase by 0.1%.

89. If these predictions are correct, increases of this magnitude would be very unlikely to be able to be detected using standard monitoring methods, given the large error generally

[13] Aquanet 2014 modelling report, page 31.

associated with periphyton biomass measurements. In my opinion, the risk of the proposed discharge causing a significant increase in periphyton growth to the point where it would cause exceedances of the One Plan target is relatively low.

90. Although the effects of the discharge under the proposed scenario are predicted to be less than what they currently are, qualitatively, some increase in periphyton growth is still expected, and it is not possible to assess with certainty whether this increase will or not result in exceedances of the OP periphyton biomass or cover targets, and some monitoring of periphyton growth in this reach of the Oroua River would be useful to address this uncertainty.

91. In response to Mr Brown comment at paragraph 60, I can confirm that the comparison of the modelling outputs with the One Plan SIN and DRP targets was undertaken on the basis of daily concentrations predicted upstream and downstream of the discharge at times when the river was below 20^{th} FEP, averaged over the modelling period. Given that the One Plan targets are expressed as annual average concentrations at flows annual average concentrations at flows below 20^{th} FEP, I do believe this is the correct methodology to provide an assessment against the One Plan targets. For the same reason, one should not compare the One Plan target with a concentration increase that may occur on a given day.

92. I agree it would however be insufficient to base an assessment of the risk of effects on periphyton growth solely on the annual average concentrations, as the timing and frequency of discharge in relation to accrual periods is critical in understanding and assessing this risk. For the same reason, it would be equally insufficient to base an assessment of the risk of effects on periphyton growth solely on the maximum concentration increase that may occur on any given day (0.005 mg/L, as referred to in Mr Brown's paragraph 60). This is precisely the reason why my assessment incorporates (1) an assessment based on monthly average concentrations and (2) a daily time-step periphyton growth model, which fully incorporates the timing of the current and proposed discharge regimes in relation to flow conditions in the river.

Macroinvertebrates

93. I am not aware of any modelling method that would allow a robust assessment of the likely effects of the future discharge on macroinvertebrate communities, and only a qualitative assessment can, in my view be provided at this stage.

94. Only one set of macroinvertebrate data, collected in November 2011 by Stark (2011) is available. On that occasion, the data indicated that, although there was some ambiguity in the testing results, the discharge was not meeting the One Plan target relative to a maximum change in QMCI of 20% between upstream and downstream of the discharge.

95. A number of factors associated with the AFFCO discharge may be contributing to this effect:

    a. The deposition of organic matter on the bottom of the river; and/or

    b. Toxic effects associated with Ammoniacal nitrogen; and

    c. The flow on-effects on macroinvertebrate communities arising from increased growth of periphyton downstream of the discharge

96. The deposition of organic matter on the bottom of gravel-bed rivers is known to cause adverse effects on benthic macroinvertebrate communities. The removal of the discharge at flows below median flow will reduce the risk of organic particulate matter settling on the bottom of the river and adversely affecting macroinvertebrate communities.

97. With regards to ammonia, the data available and the modelling results point to a measurable increase in total-ammoniacal nitrogen under the current discharge regime, although the One Plan targets are generally met. The proposed discharge regime is predicted to significantly reduce the effects of the discharge on total ammoniacal nitrogen concentrations in the river[14], therefore further reducing any risk of effects from ammonia on macroinvertebrate communities.

98. Lastly, the increase in periphyton growth caused by the discharge may also contribute to the measured adverse effects on macroinvertebrate communities. As explained earlier in my evidence, I am of the opinion that the effects of the discharge on periphyton growth will be significantly reduced, which will logically lead to a reduction of the flow-on effects on macroinvertebrates.

99. All three likely mechanisms of effects on macroinvertebrate communities are thus predicted to be significantly mitigated under the proposed discharge regime, and, in my opinion, the level of effects currently measured will be significantly reduced. It is however not possible to predict with certainty the exact degree of improvement and/or the residual level of effects that may still occur under the proposed discharge regime. For this reason, I have recommended monitoring of macroinvertebrate communities upstream and downstream of the discharge once the new discharge regime is in place.[15]

[14] 2014 Aquanet modelling report, Section 4.4, page 33.
[15] This is similar to the situation downstream of the Feilding WWTP. The Court findings to this point may be found at paragraphs 116 to 120 of the Interim Decision (NZEnvC53, dated 22 March 2016)

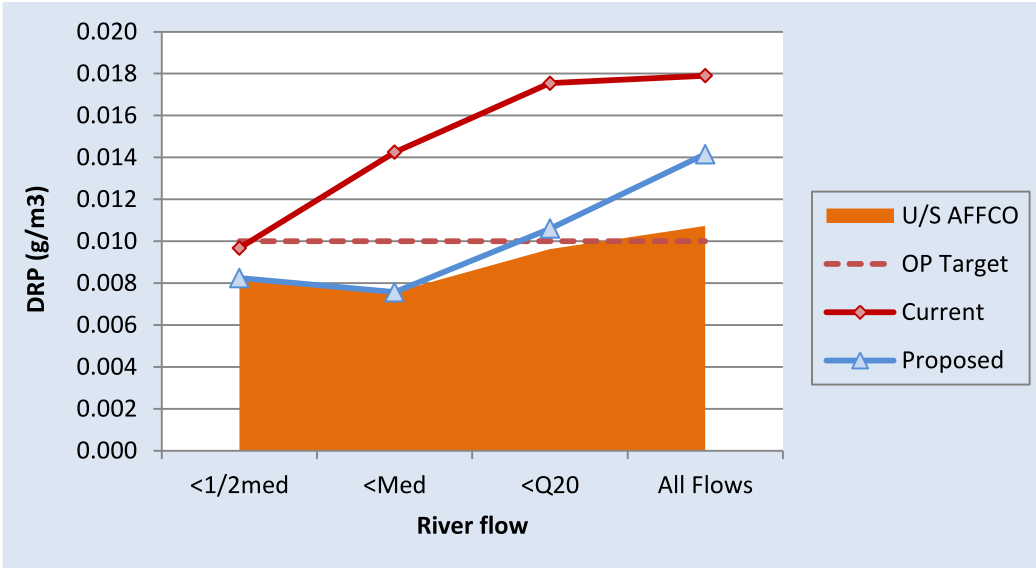

Figure 1: Predicted annual average DRP concentration upstream and downstream of the AFFCO discharge at different river flows under current and proposed discharge scenarios.

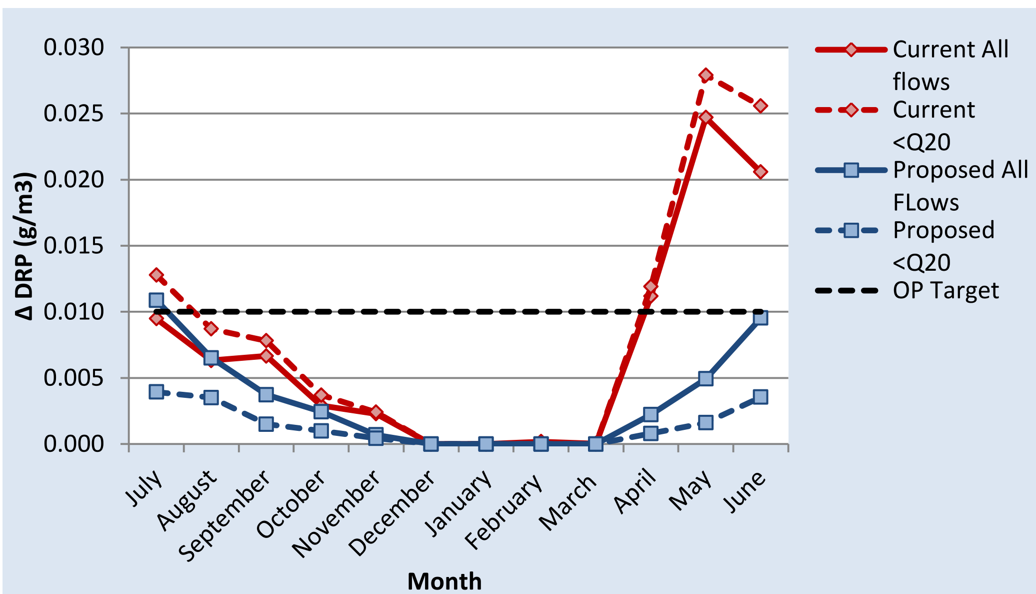

Figure 2: Predicted <u>monthly</u> average DRP concentration <u>increases</u> caused by the AFFCO discharge at different river flows under current and proposed discharge scenarios.

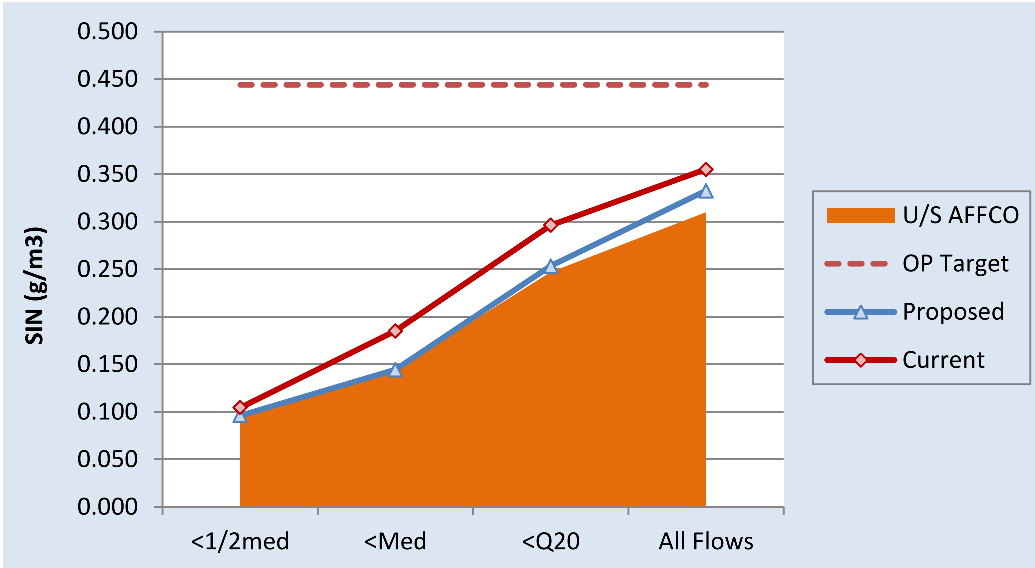

Figure 3: Predicted annual average SIN concentration upstream and downstream of the AFFCO discharge at different river flows under current and proposed discharge scenarios.

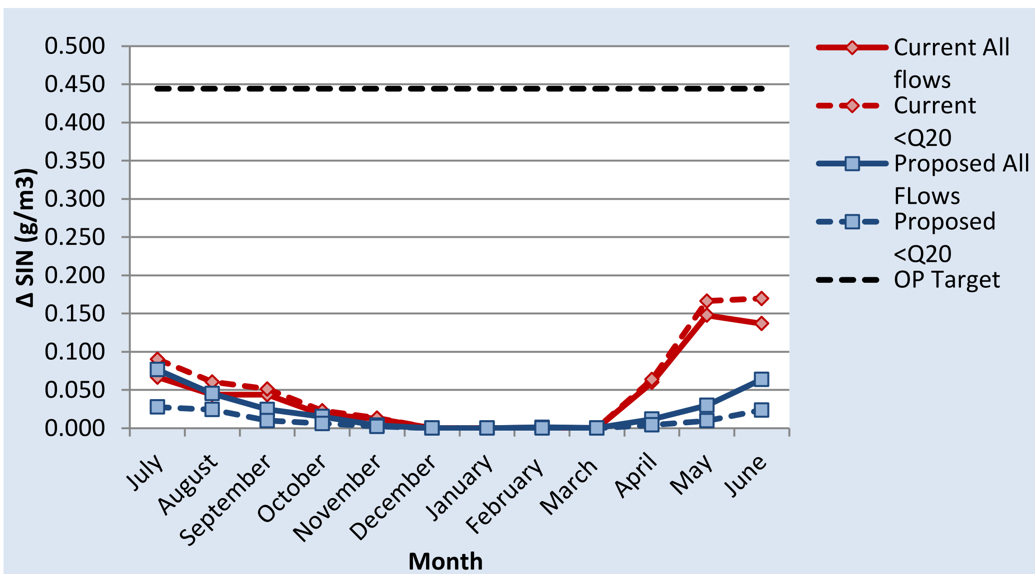

Figure 4: Predicted monthly average SIN concentration increases caused by the AFFCO discharge at different river flows under current and proposed discharge scenarios.

Cumulative effects – Oroua River

100. The evidence prepared for the Environment Court hearing in relation to the Feilding WWTP discharge included an assessment of the nutrient concentrations along the Oroua River, and cumulative effects of the AFFCO and MDC Feilding WWTP discharges, both

under their respective "current" and "proposed" discharge regimes. The following paragraphs make extensive use of my Feilding WWTP evidence, with a number of additions or alterations to provide direct comments in relation to the AFFCO discharge.

101. The following paragraphs provide a summary of the current SIN and DRP concentrations along the Oroua River, based on monitoring data.

102. For SIN, the annual average concentrations at flows below Q20 (i.e. when the One Plan SIN target applies) are (from upstream to downstream):

(a) 0.080 g/m^3 at Apiti. The Oroua catchment above Apiti is largely undeveloped, and this concentration can be used as an indication of natural or near-natural SIN concentrations in the Upper Oroua River ("reference conditions"). It represents 9.5% of the concentration measured downstream of the Feilding WWTP and 18% of the One Plan SIN target applicable to the lower Oroua River;

(b) At Almadale there is a 0.054 g/m^3 concentration increase compared with Apiti. This increase represents 6.4% of the concentration measured downstream of the Feilding WWTP, and 12% of the One Plan target;

(c) The increase in SIN concentration between Almadale and upstream of the Feilding WWTP (0.162 g/m^3) represents 19% of the concentration measured downstream of the Feilding WWTP and 36% of the One Plan SIN target. Of this, the contribution he concentration difference between upstream and downstream of the AFFCO discharge is 0.134 g/m^3, which represents 16% the concentration measured downstream of the Feilding WWTP and 30% of the One Plan SIN target;

(d) The increase between upstream and downstream of the Feilding WWTP discharge is 0.554 g/m^3, and represents 65% of the concentration measured downstream of the Feilding WWTP and 125% of the One Plan SIN target applicable to the lower Oroua River; and

(e) The SIN concentration downstream of the Feilding WWTP is 0.852 g/m^3, which is close to twice the One Plan target.

Table 1: Summary of annual average SIN concentration increases at various monitoring sites along the Oroua River, and contribution of the various reaches to the SIN concentration predicted downstream of the Feilding WWTP.

River Reach	SIN Concentration increase (g/m^3)	% of concentration D/S Feilding WWTP	% One Plan target
Upper catchment (upstream of Apiti)	0.080	9.5%	18%
Apiti to Almadale	0.054	6.4%	12%

Almadale to upstream of Feilding WWTP	0.162 (Incl. AFFCO: 0.134)	19% (Incl. AFFCO: 16%)	36% (Incl. AFFCO: 30%)
Upstream to downstream of Feilding WWTP	0.554	65%	125%
Total	0.852	100%	192%

103. I have modelled the cumulative effects of the AFFCO and MDC current and proposed[16] discharge regimes on the concentrations of nutrients in the Oroua River, by superimposing the effects of the Feilding WWTP discharge on those of the AFFCO discharge. One of the key limitations of the exercise is that it assumes no inputs or attenuation of SIN or DRP between the two discharges. The current predicted SIN concentration (taken as an average concentration at flows <Q20) downstream of the AFFCO discharge is 0.307 g/m^3, which is in reasonable agreement with the concentrations measured (0.288 g/m^3) or predicted (0.297 g/m^3) upstream of the Feilding WWTP discharge. Similarly, the predicted current SIN concentration downstream of the Feilding WWTP discharge in this modelling (0.859 g/m^3) matches well with the measured concentration (0.851 g/m^3), which indicates that this modelling is useful in assessing the cumulative effects of the two discharges.

104. With regards to SIN (Figure 5), the combined predicted effects of the two (AFFCO and MDC) proposed discharge regimes on in-river SIN concentrations is 0.168 g/m^3, i.e. approximately 38% of the One Plan target, as opposed to 0.552 g/m^3 (120% of the One Plan target).

105. As a result of the above combined improvements, the annual average SIN concentration at flows <Q20 downstream of the Feilding WWTP is predicted to be 0.426 g/m^3, i.e. marginally less than the One Plan target of 0.444 g/m^3.

106. These results suggest that the One Plan target may be able to be met downstream of the Feilding WWTP discharge once (and if) both the AFFCO and the MDC proposed discharge regimes are implemented. However, it is important to bear in mind that the above modelling predictions are long-term average concentrations, based on 17 years of modelling. This means that there will be years with an annual average concentration above, and other years below, that predicted value. One should also bear in mind that the SIN concentrations downstream of the Feilding discharge depend not only on the AFFCO and MDC discharges themselves, but also on any other SIN inputs, including from other point source (e.g. stormwater from the Feilding township) or non-point sources (e.g. nitrate losses from land use) in the catchment.

107. With regards to DRP (Figure 6), the proposed changes, the concentration increase caused by the two discharges under the proposed discharge regimes is of the order of

[16] As granted by the Environment Court Decision NZ EnvCourt 53.

0.003 g/m^3 (33% of the OP target) as opposed to 0.012 g/m^3 (120% of the OP target) under the current scenarios. The combined increase under the proposed scenarios is less than the increase currently caused by the AFFCO discharge alone (approximately 0.007 g/m^3).

108. As a result of the above combined improvements, the DRP concentration as an annual average at flows <Q20) downstream of the Feilding WWTP is predicted to be 0.013 g/m^3, i.e. less than what it currently is upstream of the Feilding WWTP discharge.

109. The DRP concentration upstream of the AFFCO discharge is already essentially at the One Plan target. This means that, although relatively minor, the increase in DRP concentrations predicted to be caused by the proposed AFFCO discharge is sufficient for the One Plan target to be exceeded downstream of the AFFCO discharge. This also means that the One Plan target is expected to still be exceeded (although by a significantly lesser amount) both upstream and downstream of the Feilding WWTP discharge.

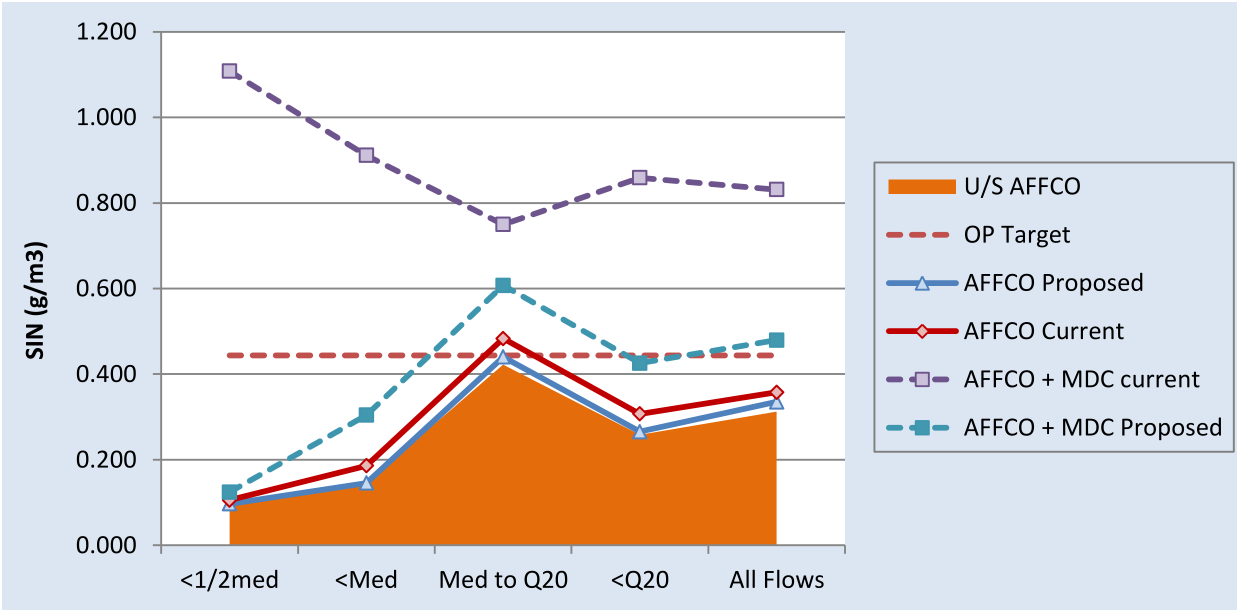

Figure 5: predicted annual average SIN concentrations upstream and downstream of the AFFCO and Feilding WWTP discharges, at different river flows under different discharge scenarios.

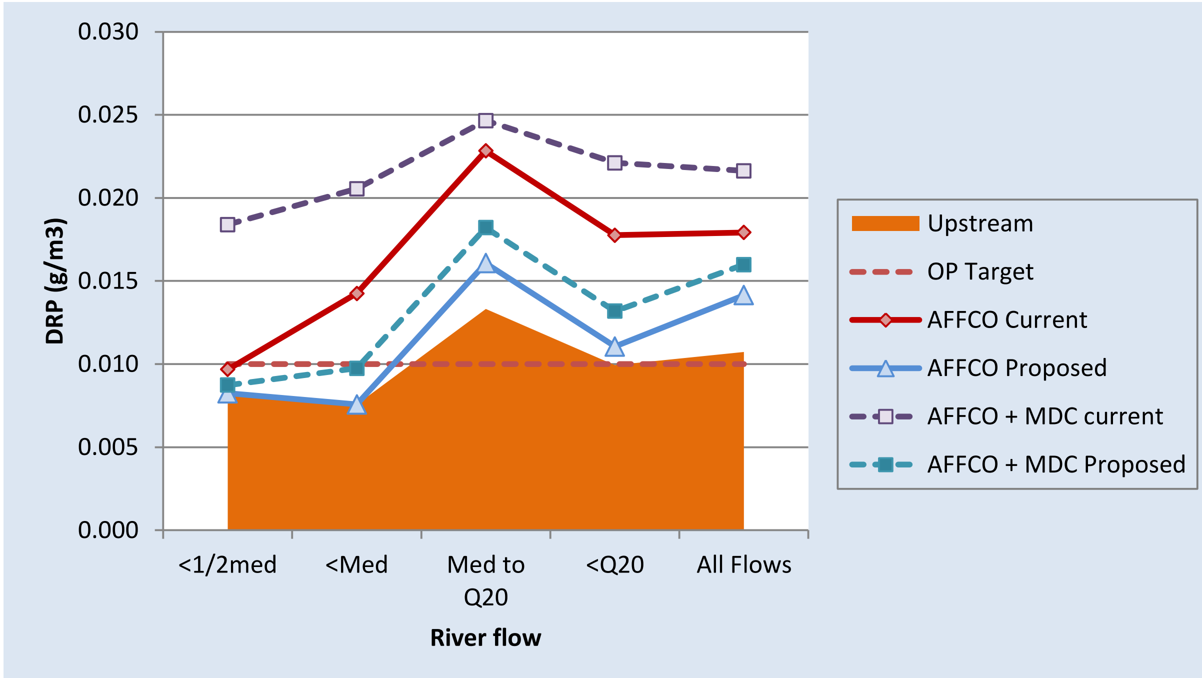

Figure 6: predicted annual average DRP concentrations upstream and downstream of the AFFCO and Feilding WWTP discharges, at different river flows under different discharge scenarios.

Cumulative Effects – Manawatu River

110. Table 2 and Table 3 below provide estimates of the DRP and SIN loads and their potential contribution to the loads estimated in the Manawatu River at Shannon. The loads for the Manawatu River at Shannon (upstream of the Shannon WWTP discharge) were calculated using a similar modelling methodology. The data, assumptions and methods are summarised in an earlier technical report[17].

111. It is noted that the estimated contributions to the nutrient loads in the Manawatu River at Shannon do not account for any attenuation of nutrient loads between Feilding and Shannon, and are therefore overestimations of the actual contribution to nutrient loads in the lower Manawatu River.

112. With regard to SIN, the AFFCO discharge is estimated to contribute about 0.8% of the SIN load in the Manawatu River at Shannon (at river flows <Q20). This contribution is expected to reduce to approximately 0.2% after implementation of the "proposed" discharge regime.

[17] Aquanet (2013). Shannon WWTP discharge to the Manawatu River - Water quality modelling and assessment of effects of the proposed future discharge regime. 31 October 2013.

113. Cumulatively, the AFFCO and the Feilding WWTP discharge are estimated to contribute 48 Tonnes of SIN per year (T/yr) currently, which represents approximately 4% of the SIN load in the lower Manawatu River (at flows <Q20). Following the implementation of both proposed discharge regimes, the cumulative contribution is predicted to reduce to 31 T/yr, approximately 2.6% of the load in the lower Manawatu River.

114. With regard to DRP, the AFFCO discharge is estimated to contribute about 3.6% of the DRP load in the Manawatu River at Shannon (at river flows <Q20). This contribution is predicted to reduce to 0.8% under the proposed discharge regime.

115. Cumulatively, the AFFCO and the Feilding WWTP discharge are estimated to contribute 1.87 Tonnes per year (T/yr), which represents approximately 5% of the DRP load in the lower Manawatu River at flows below Q20 (and about 53% historically) . Following the implementation of both proposed discharge regimes, the cumulative contribution is predicted to reduce by more than half, to 0.72 T/yr, approximately 1.7% of the load in the lower Manawatu River.

Table 2: Estimated annual DRP loads (in T/Yr) under different flow conditions. Numbers in brackets are the contribution to the loads in the Manawatu at Shannon for the same flow range.

	Manawatu River at Shannon	Oroua River upstream of Feilding WWTP	Feilding WWTP discharge (historical)	Feilding WWTP discharge (current)	Feilding WWTP discharge (Stage 1)	AFFCO Feilding Current	AFFCO Feilding Proposed	AFFCO + MDC Current	AFFCO + MDC proposed
At all river flows	90 (100%)	6.8 (7.5%)	26.8 (30%)	0.70 (0.8%)	0.57 (0.6%)	2.21 (2.5%)	2.37 (2.6%)	2.91 (3.2%)	2.94 (3.3%)
Under Q20	41	4.0 (9.8%)	20.2 (49%)	0.53 (1.3%)	0.39 (0.9%)	1.48 (3.6%)	0.33 (0.8%)	1.87 (4.9%)	0.72 (1.7%)
Under Median flow	13	1.3 (9.8%)	11.3 (87%)	0.30 (2.3%)	0.16 (1.2%)	0.48 (3.7%)	0 (0%)	0.64 (6.0%)	0.16 (1.2%)
Under half median flow	3.3	0.26 (7.8%)	5.1 *(>100%)*	0.14 (4.2%)	0.008 (0.2%)	0.03 (1.0%	0 (0%)	0.17 (5.3%)	0.008 (0.2%)

Table 3: Estimated annual SIN loads (in T/Yr) under different flow conditions. Numbers in brackets are the contribution to the loads in the Manawatu at Shannon for the same flow range.

	Manawatu River at Shannon	Oroua River upstream of Feilding WWTP	Feilding WWTP discharge (Current)	Feilding WWTP discharge (after treatment upgrade)	Feilding WWTP discharge (after implementation of land discharge)	AFFCO Feilding Current	AFFCO Feilding Proposed	AFFCO + MDC Current	AFFCO + MDC proposed
At all river flows	2,900	157 (5.4%)	77 (2.7%)	51.1 (1.8%)	42.1 (1.4%)	14.1 (0.5%)	15.7 (0.5%)	65.2 (2.2%)	57.8 (2.0%)
Under Q20	1,206	80 (6.6%)	58 (4.8%)	38.6 (3.2%)	28.9 (2.3%)	9.4 (0.8%)	2.15 (0.2%)	48.0 (4.0%)	31.0 (2.6%)
Under Median flow	359	15.4 (4.2%)	32 (8.9%)	21.5 (6.0%)	11.3 (3.1%)	2.9 (0.8%)	0 (0%)	24.4 (6.8%)	11.3 (3.1%)
Under half median flow	79	1.4 (1.8%)	14 (18%)	9.5 (12%)	0.46 (0.6%)	0.2 (0.3%)	0 (0%)	9.7 (12.3%)	0.5 (0.6%)

CULTURAL IMPACT ASSESSMENT REPORT

116. I have been asked to review the Cultural Impact Assessment (CIA) report prepared by Dr Benett. For clarity, I will not comment on any aspects relative to cultural values, or the effects of the discharge on these values, as these are outside my field of expertise. My review is strictly limited to Section 7 of the report, which provides a summary of the state of water quality in the Oroua River, and of the findings of my report.

117. Section 7 of the report provides a summary of the state of water quality in the Oroua River, primarily based on three reports produced by Horizons Regional Council. Whilst these reports are relevant, there are dated 2005, 2006 and 2007, which raises the question of whether they are representative of the current (as opposed to historical) situation.

118. In the case of the Oroua River, a number of significant changes in water quality have occurred since 2007, the most obvious being the implementation of a number of upgrades at the Feilding WWTP in 2008/2009, leading to significant reductions in the concentrations of solids and DRP in that discharge, and significant reduction in the in-river DRP concentrations (refer to paragraph 53b of my evidence). As a result, the pre-2007 reports do not, in my view, provide an accurate representation of the current state of water quality and freshwater ecology in the Oroua River. The assessment provided by Mr Brown and in my evidence should, in my opinion, be used in preference when considering the current state of the water quality in the Oroua River.

119. I note that since 2007 Horizons have produced a number of technical reports relevant to water quality and ecology in the Oroua River and/or the wider Manawatu catchment. These reports are available from Horizons on request.

120. Paragraphs 8.6 to 8.11 of the report quotes conclusions from the 2014 Aquanet modelling report. However, some of these conclusions are incomplete or taken out of context, and it would be preferable to read these conclusions as part of the actual report, where full context is provided.

121. Paragraph 8.11 raises the point that the 2014 Aquanet modelling report does not provide an assessment of the likely effects of the proposed discharge on macroinvertebrate communities, and that this must be addressed. This is a fair comment, although the reason for not including it in the modelling report is that the effects of the discharge on macroinvertebrate communities cannot be directly modelled. I have covered aspects relative to macroinvertebrate communities in paragraphs 93 to 99 of my evidence.

MONITORING AND CONSENT CONDITIONS

122. The following are typically considered in relation to monitoring of point source discharges:

    (a) Monitoring of the discharge timing and volume

    (b) Monitoring of the discharge quality

    (c) Monitoring of in-stream water quality upstream and downstream (after reasonable mixing) of the discharge

    (d) Monitoring of ecological indicators, such as macroinvertebrates and periphyton upstream and downstream (after reasonable mixing) of the discharge

123. In my opinion, robust monitoring and recording of the timing and volume of treated wastewater discharged to the river is important, because the risk of discharge causing any effects on water quality and/or ecology is highly dependent on the timing and volume of discharge in relation to river flow.

124. Similarly, robust monitoring of the quality of the discharge is important. I understand from the evidence of Mr Lowe that the quality of the final treated effluent is likely to be relatively stable given the long residence time and buffering in the ponds. On this basis, monthly monitoring of effluent quality appears sufficient.

125. In-stream monitoring of river water quality poses a number of interesting challenges dues to the stop-and-go nature of the discharge and the proposed discharge regime, including, but not limited to, that the discharge will not be operating during significant periods of time and that the river will often be in high flows when it is operating, raising health and safety issues for the operators.

126. With regards to the periphyton monitoring, I note Mr Brown's recommendation that periphyton monitoring be undertaken monthly for a period of three years. This monitoring would present the advantage of providing a robust dataset on which to base an overall assessment against the One Plan targets and NPSFM Attribute State (which require a minimum of 3 years of monthly data). However, the significant cost associated with such monitoring needs to be balanced against the finding that the period of the year during which the AFFCO discharge may cause significant effects (as in causing or contributing to cause exceedances of the One Plan targets) on periphyton growth is limited to April and May, and the view I express that the risk of the "proposed" discharge regime causing significant effects in April or May is low. On that basis it may be equally effective but significantly cheaper to focus any periphyton monitoring be focused on the critical April/May period.

127. With regards to macroinvertebrates communities, I recommend that sampling be undertaken annually in the April/May period following nationally established protocols. Such monitoring may be discontinued after a 3-5 years period, provided the results do not indicate significant exceedances of the OP target. I note that good practice requires that macroinvertebrate sampling be undertaken after a period of 2-3 weeks of stable river flows. These conditions may not occur every year in Apri/May. Further, if low river flows extend in the April/May period, it is uncertain whether the discharge will have been operating in the weeks preceding the sampling, as the discharge regime explicitly aims at avoiding discharges under low river flow conditions.

128. With regards to monitoring sites, the existing sites are adequate to monitor the effects of the direct discharge, although the exact locations of any macroinvertebrate and periphyton sampling will have to be determined on site during low river flows to ensure that upstream and downstream sites present adequately matched habitat characteristics (such as velocity, depth, shading, etc.).

129. In paragraph 71, Mr brown recommends additional monitoring sites, however it is not clear exactly what activity or activities are sought to be monitored, and for what purpose. I will seek clarification before commenting on these aspects in caucusing statement or supplementary evidence.

Olivier Ausseil

26 October 2016