IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER A hearing of application APP-1994001032.01 for resource consent in relation to the discharge of treated meat works effluent to the Oroua River, Discharge of treated wastewater onto and into land that may enter groundwater, Discharge of odour and aerosols into air, Land Use Consent for a discharge structure in the bank of the Oroua River and a bed level control structure in the Otoku Stream from the AFFCO Plant, Feilding.

Section 42A Report of Logan Brown, Freshwater and Partnerships Manager for Manawatu Wanganui Regional Council

5 October 2016

A. QUALIFICATIONS / EXPERIENCE

1. My full name is Logan Arthur Brown. I live in Feilding and I am employed by the Manawatū-Wanganui Regional Council (trading as Horizons Regional Council, HRC) as the Freshwater and Partnerships Manager. Prior to taking on this role I was a Senior Environmental Scientist – Water Quality (until 25 July 2016). I have worked for the Council since July 2010. I hold a Masters in Science (Ecology), Bachelor of Science (Ecology), and a Bachelor of Business Studies (Economics) degree obtained from Massey University.

2. In my previous duties as the Council's Senior Environmental Scientist – Water Quality, I was involved in the State of the Environment (SOE) Water Quality and Aquatic Biodiversity programmes and managed a variety of water quality research projects, many of which I am still involved in the delivery of. These programmes oversaw the periphyton, macroinvertebrate and fish monitoring programmes within the Region. In addition I also oversaw the Coastal and Estuary and Contact Recreation monitoring programmes.

3. I have read and agree to comply with the Code of Conduct for Expert Witnesses as contained in the Environment Court's 'Consolidated Practice Note 2014'.

4. I have been involved in the water quality, periphyton, macroinvertebrate, and fish monitoring that HRC undertakes in the Oroua River, I am therefore familiar with the nature of the Oroua River.

B. PROPOSED ACTIVITIES

5. The proposal as contained in the application is:

- The Applicant operates a meat processing plant located on the outskirts of Feilding. The Applicant currently treats the effluent created from the process via a series of wastewater treatment ponds located adjacent to their site. The treated wastewater is currently disposed of via direct discharge to the Oroua River, direct seepage to groundwater through the base of the wastewater treatment ponds and land irrigation.
- The expired consent operating under existing use rights allows for the discharge of wastewater to the Oroua River based on the flow in the river. When the flow is greater than 4,000 L/s, the discharge is limited to a maximum of 2,000 m^3/day. When the flow is between 3,000 L/s and 4,000 L/s between March and December, the discharge is limited to 1,000 m^3/day.
- For the land irrigation up to 2,000 m^3/day of treated effluent can be discharged onto an area of at least 75 ha.
- The expired consent allows for an unspecified volume of effluent to be discharged to groundwater via seepage through the base of the treatment ponds.
- Current volumes of wastewater produced by the plant are estimated at around 256,100 m^3/year. The daily volume ranges from 250 m^3/day to 1050 m^3/day, with an average volume of around 700 m^3/day.
- The applicant has applied for volumes of effluent produced by the plant to increase by 20% as a result of increased throughput at the factory over the lifetime of any new consents. Therefore, the proposed consents allow for an increased volume of discharge to the Oroua River and to land.
- The proposed discharge to the Oroua River will operate according to the criteria in Table 1.

Table 1: Proposed Oroua River discharge criteria

Flow in the Oroua River at Kawa Wool Gauging Station	Proposed discharge between 1 December and 31 March	Proposed discharge between 1 April and 30 November
Below median flow (0 L/s to 7,590 L/s)	No discharge	No discharge
Median flow to 20th percentile exceedance flow (7,590 L/s to 16,193 L/s	No discharge	Discharge based on rate of DRP load to river up to a maximum of 3,000 m^3/day
Above 20th percentile flow exceedance (> 16,193 L/s)	No discharge*	Up to 3,000 m^3/day
***Emergency contingency discharge if flow is greater than 3 x median (> 20,913 L/s)**	If land application is not possible and ponds are 100 % full, discharge up to 2,000 m^3/day	

- The flow regime above allows for an increased flow into the Oroua River under certain circumstances, although the flow cut off under the proposed consent (7,590 L/s) is higher compared to the flow cut off under the existing consent (3,000 L/s).
- The application proposes no change to the consent to allow for seepage through the base of the ponds into groundwater.
- Under the proposed consent the area of land over which treated effluent can be disposed will increase, from the current area of 75 ha to 145 ha. The Applicant states that the increased area will have a theoretical capacity of up to 331,775 m^3/year, but indicates that in practice the annual volume discharged to land will be in the order of 179,300 m^3/day.

6. The following assessment is based on information held by HRC or in published literature, and information provided by the applicant.

C. REPORT SCOPE

7. The following report contains an assessment of the potential effects from the proposed discharge from the AFFCO WWTP into the Oroua River using data collected by HRC from December 2008 until June 2016 and the assessment of effects (AEE) included in the application. The report covers the following areas:

- Values of the Oroua River and water quality targets (Section D);
- The receiving environment (Section E);
- State of the Environment monitoring (Section F);
- Fish diversity in the Oroua catchment (Section G);
- Effects of the point source discharge (Section h);
- Effects of the diffuse discharge (Section I);
- Fish passage (Section J);
- Comments on the proposed consent conditions and monitoring (Section K);
- Manawatū Estuary (section L); and
- Conclusions (Section M).

D. VALUES OF THE OROUA RIVER AND WATER QUALITY TARGETS

8. Water quality of the Oroua River (the receiving environment) is detailed in the sections below. The values of the Oroua River and the One Plan targets are briefly summarised.

9. The water management framework of the One Plan (OP) recognises the need to manage water bodies within the Region for the different environmental, social and economic values they hold.

10. Water Management Zones (WMZs) are the underpinning geographical component of the integrated water management framework in the OP and are located in Schedule A. Forty-three water management zones have been identified and further divided into 124 water management Sub-Zones.

11. Water body values hang off the surface Water Management Zones and Sub-Zones in the Water Management Framework of the OP as the second level, to recognise the environmental, social, cultural and economic values of each area. These are defined as either reach or zone specific and are located in Schedule B of the OP.

12. The discharge point for the wastewater discharge into the Oroua River occurs within the Middle Oroua (Oroua_12b), which is a Water Management Sub-Zone of the Oroua (Oroua_12) Water Management Zone. The following values have been identified in the Oroua River at the point of the discharge (refer to Figures 1 and 2 for reach specific values of the Oroua catchment):

<u>Zone wide values:</u>

- Life Supporting Capacity – Hill Country Mixed (HM) geology;
- Water supply;
- Aesthetics;
- Mauri;
- Contact Recreation;
- Stockwater;
- Water Supply;
- Industrial Abstraction;
- Flood control and drainage;
- Irrigation; and
- Capacity to Assimilate Pollution.

Reach specific values:

- Amenity value (refer Figure 2 for those points in close proximity to the discharge point);
- Amenity;
- Domestic food supply (applies to the whole Oroua);
- Water supply take point (AFFCO take upstream of the discharge point);
- Water supply (entire catchment upstream of the AFFCO take point);
- Site of Significance – Riparian (400 metres downstream of the discharge point);
- Flood control/drainage; and
- Trout Fishery (TFIII) – Other trout fishery;

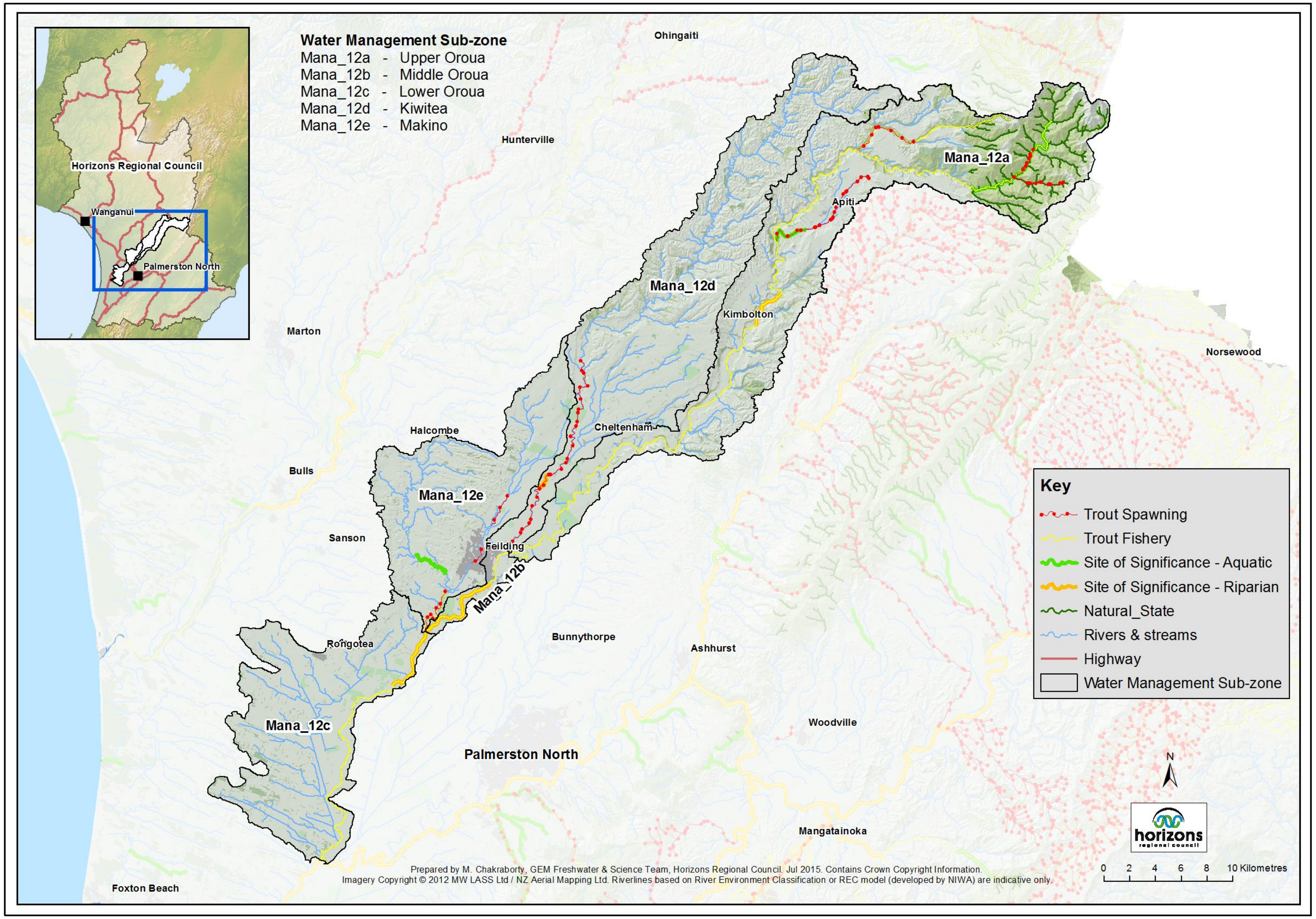

Figure 1: Reach specific values of the Oroua catchment including Sites of Significant Aquatic and Riparian, trout fishery, and trout spawning values.

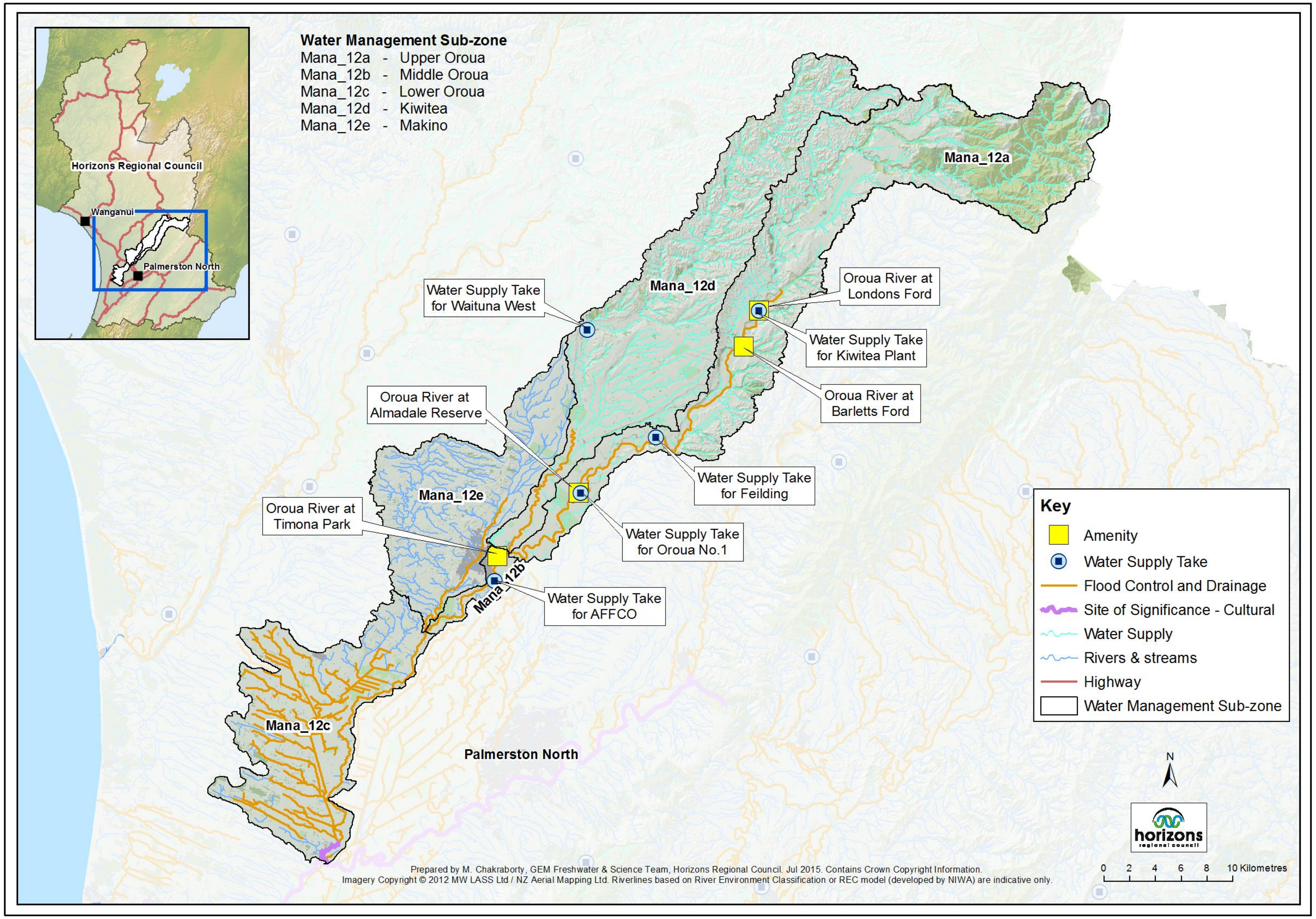

Figure 2: Reach specific values of the Oroua catchment including flood control and drainage, water supply, amenity, and water supply takes.

13. Schedule E of the OP sets out numerical targets to protect the values in the Oroua River (Table 2). These targets have been established using the best available science and expert opinion at the time the Plan was developed.

14. The targets are designed to provide the best level of protection for the values within a Water Management Sub-Zone (Ausseil and Clark, 2007). At the time the plan was being developed it was proposed that if the targets set out in the OP were complied with, the effects of an activity on the receiving water body were likely to be no more than minor.

Table 2: Water Quality targets for all rivers and streams in the Oroua Middle Management Sub-Zone

Abbreviations used in Tables D.1A to D.4A		**Full Wording of the Target**
pH	Range	The pH of the *water*^ must be within the range 7 to 8.5 unless natural levels are already outside this range.
	Δ	The pH of the *water*^ must not be changed by more than 0.5.
Temp (^{o}C)	<	The temperature of the *water*^ must not exceed 22 degrees Celsius.
	Δ	The temperature of the *water*^ must not be changed by more than 3 degrees Celsius.
DO (% SAT)	>	The concentration of dissolved oxygen (DO) must exceed 70 % of saturation.
$sCBOD_5$ (g/m^3)	<	The monthly average five-days filtered / soluble carbonaceous biochemical oxygen demand ($sCBOD_5$) when the *river*^ flow is at or below the 20th *flow exceedance percentile** must not exceed 2 grams per cubic metre.
POM (g/m^3)	<	The average concentration of particulate organic matter when the *river*^ flow is at or below the 50th *flow exceedance percentile** must not exceed 5 grams per cubic metre.
Periphyton (*rivers*^)	Chl *a* (mg/m^2)	The algal biomass on the *river*^ *bed*^ must not exceed 120 milligrams of chlorophyll *a* per square metre.
	% cover	The maximum cover of visible *river*^ *bed*^ by periphyton ~~(~~as filamentous algae more than 2 centimetres long~~)~~ must not exceed 30 %.
		The maximum cover of visible river bed by periphyton as diatoms or cyanobacteria more than 0.3 centimetres thick must not exceed 60 %.
DRP (g/m^3)	<	The annual average concentration of dissolved reactive phosphorus (DRP) when the *river*^ flow is at or below the 20th *flow exceedance percentile** must not exceed 0.010 grams per cubic metre, unless natural levels already exceed this target.

Abbreviations used in Tables D.1A to D.4A		Full Wording of the Target
SIN (g/m³)	<	The annual average concentration of soluble inorganic nitrogen (SIN)[1] when the *river*^ flow is at or below the 20th *flow exceedance percentile** must not exceed 0.444 grams per cubic metre, unless natural levels already exceed this target.
Deposited sediment	% cover	The maximum cover of visible bed by deposited sediment less than 2 millimetres in diameter must be less than 20%, unless natural physical conditions are beyond the scope of the application of the deposited sediment protocol of Clapcott et al. (2010)
MCI[2]	>	The Macroinvertebrate Community Index (MCI) must exceed 100, unless natural physical conditions are beyond the scope of application of the MCI. In cases where the *river*^ habitat is suitable for the application of the soft-bottomed variant of the MCI (sb-MCI) the targets also apply.
QMCI	% Δ	There must be no more than a 20 % reduction in Quantitative Macroinvertebrate Community Index (QMCI) score between appropriately matched habitats upstream and downstream of discharges to *water*^.
Ammoniacal nitrogen[3] (g/m³) (*rivers*^)	<	The average concentration of ammoniacal nitrogen must not exceed 0.4 grams per cubic metre.
	Max	The maximum concentration of ammoniacal nitrogen must not exceed 2.1 grams per cubic metre.

1 Soluble inorganic nitrogen (SIN) concentration is measured as the sum of nitrate nitrogen, nitrite nitrogen, and ammoniacal nitrogen or the sum of total oxidised nitrogen and ammoniacal nitrogen.

2 The Macroinvertebrate Community Index (MCI) target applies only for State of the Environment monitoring purposes to determine if the aquatic macroinvertebrate communities are adequate to provide for and maintain the values in each WMSZ. This target is not appropriate for monitoring the effect of activities such as discharges to water on macroinvertebrate communities upstream and downstream of the activity.

3 Ammoniacal nitrogen is a component of SIN. SIN target should also be considered when assessing ammoniacal nitrogen concentrations against the targets.

Abbreviations used in Tables D.1A to D.4A		Full Wording of the Target
Tox. or Toxicants	%	For toxicants not otherwise defined in these targets, the concentration of toxicants in the *water*^ must not exceed the trigger values for freshwater defined in the 2000 ANZECC guidelines Table 3.4.1 for the level of protection of 95 % of species. For metals the trigger value must be adjusted for hardness and apply to the dissolved fraction as directed in the table.
Visual Clarity (m) (*rivers*^)	% Δ	The visual clarity of the *water*^ measured as the horizontal sighting range of a black disc must not be reduced by more than 30 %.
	>	The visual clarity of the *water*^ measured as the horizontal sighting range of a black disc must equal or exceed 2.5 metres when the *river*^ is at or below the 50th *flow exceedance percentile**.
E. coli / 100 ml (*rivers*^)	< m	The concentration of *Escherichia coli* must not exceed 260 per 100 millilitres 1 November - 30 April (inclusive) when the *river*^ flow is at or below the 50th *flow exceedance percentile**.
	<20th %ile	The concentration of *Escherichia coli* must not exceed 550 per 100 millilitres year round when the *river*^ flow is at or below the 20th *flow exceedance percentile**.

E. THE RECEIVING ENVIRONMENT

15. Landuse in the Oroua catchment is predominantly sheep and/or beef (62.6%), dairy (19.2%), native cover (12.6%), exotic cover (3.2 %), cropping (1.0%), and other (1.3 %) (refer Figure 3).

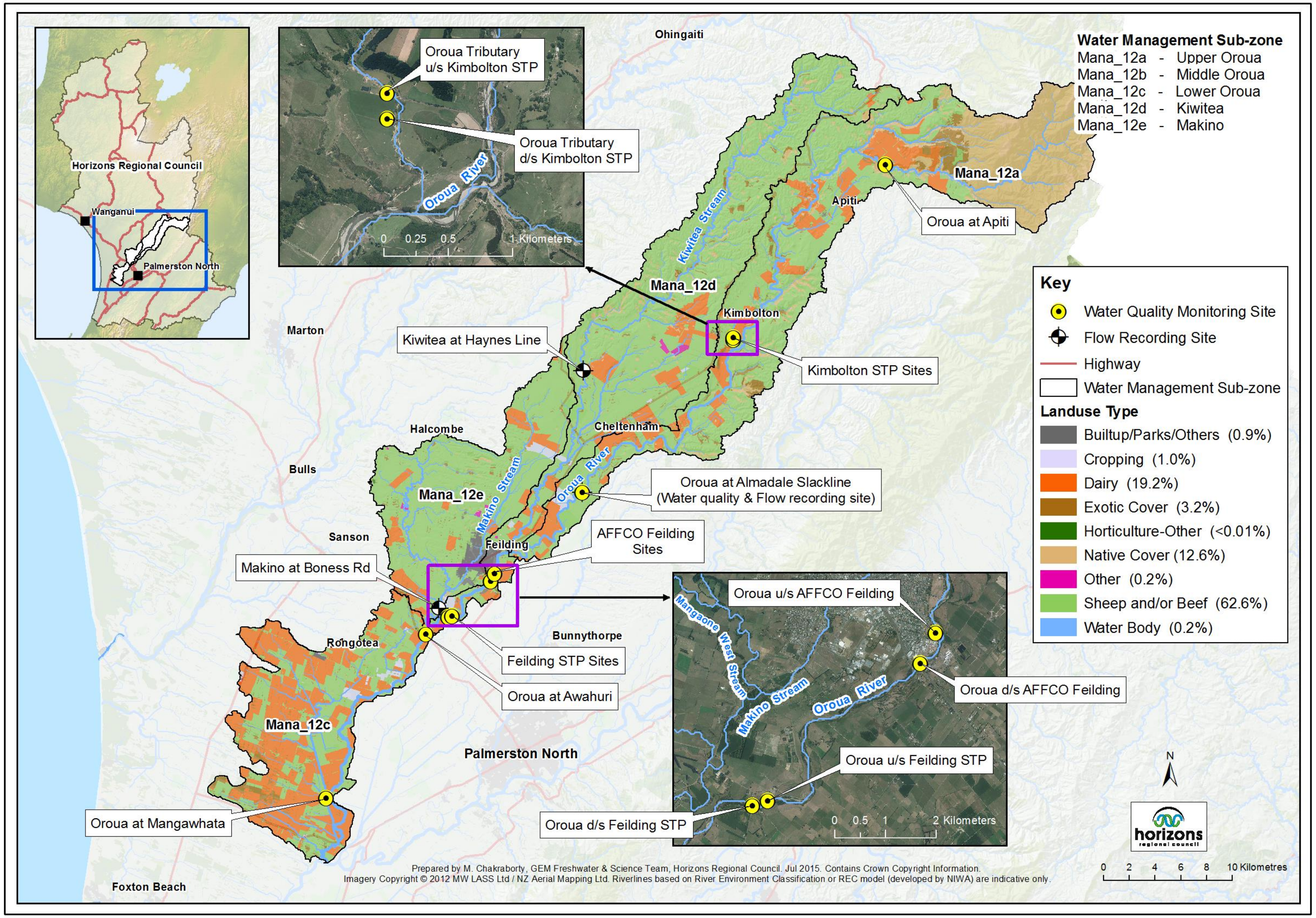

Figure 3: Land use in the Oroua catchment including the water quality monitoring sites, and flow recording sites.

F. STATE OF THE ENVIRONMENT MONITORING

16. HRC monitors at a number of sites within the Oroua catchment with the frequency of monitoring depending on the parameters being tested. These monitoring sites and parameters are (refer to Figure 3 for sites):

- Oroua at Apiti (monthly water quality, periphyton, and annual macroinvertebrates);
- Oroua at Almadale (continuous flow, monthly water quality, periphyton, and annual macroinvertebrates);
- Kiwitea at SH54 (monthly water quality, and annual macroinvertebrates);
- Oroua at upstream AFFCO discharge (monthly water quality);
- Oroua at downstream AFFCO discharge (monthly water quality);
- Oroua at upstream Feilding WWTP discharge (monthly water quality, periphyton, and annual macroinvertebrates);
- Oroua at downstream Feilding WWTP discharge (monthly water quality, periphyton, and annual macroinvertebrates);
- Oroua at Awahuri (monthly water quality, periphyton, and annual macroinvertebrates); and
- Oroua at Mangwhata (monthly water quality).

17. These SOE water quality monitoring sites allow us to look at the changes in water quality as we move down the Oroua catchment. In this section of the report I will look at the changes in periphyton, macroinvertebrates, Dissolved Reactive Phosphorus (DRP), and Soluble Inorganic Nitrogen (SIN) as you move down the catchment.

18. All of the monitoring data and analysis that is shown in the following sections for the Oroua River shows the large effect that the Feilding WWTP discharge has on the Oroua River water quality. The Feilding WWTP is currently going through a large upgrade which involves a volume of the effluent produced being discharged to land rather than the Oroua River during low flows. This will see marked improvements in the water quality of the Oroua River which are not reflected in the monitoring. The Oroua River upstream of Feilding WWTP discharges however, remains a valid comparison point of all the things that occur in the catchment upstream of this discharge of which the AFFCO activities is one of them.

Periphyton

19. The growth of periphyton (diatoms, fungi and algae) within waterbodies is a natural process. Periphyton makes up the primary productive base of the aquatic food chain (Winterbourn, 2004 & Biggs, 2000). The growth of periphyton in waterways is important as it provides a food source to some macroinvertebrate species that graze on the periphyton and these macroinvertebrates provide a food source for fish species. However, problems occur when human induced changes to the environment result in the growth of periphyton reaching nuisance levels. The provision of nutrients, light, suitable substrate, channel form, and stable flows all affect the ability of periphyton to reach nuisance levels (refer to Photo 1 for an example of periphyton growth).

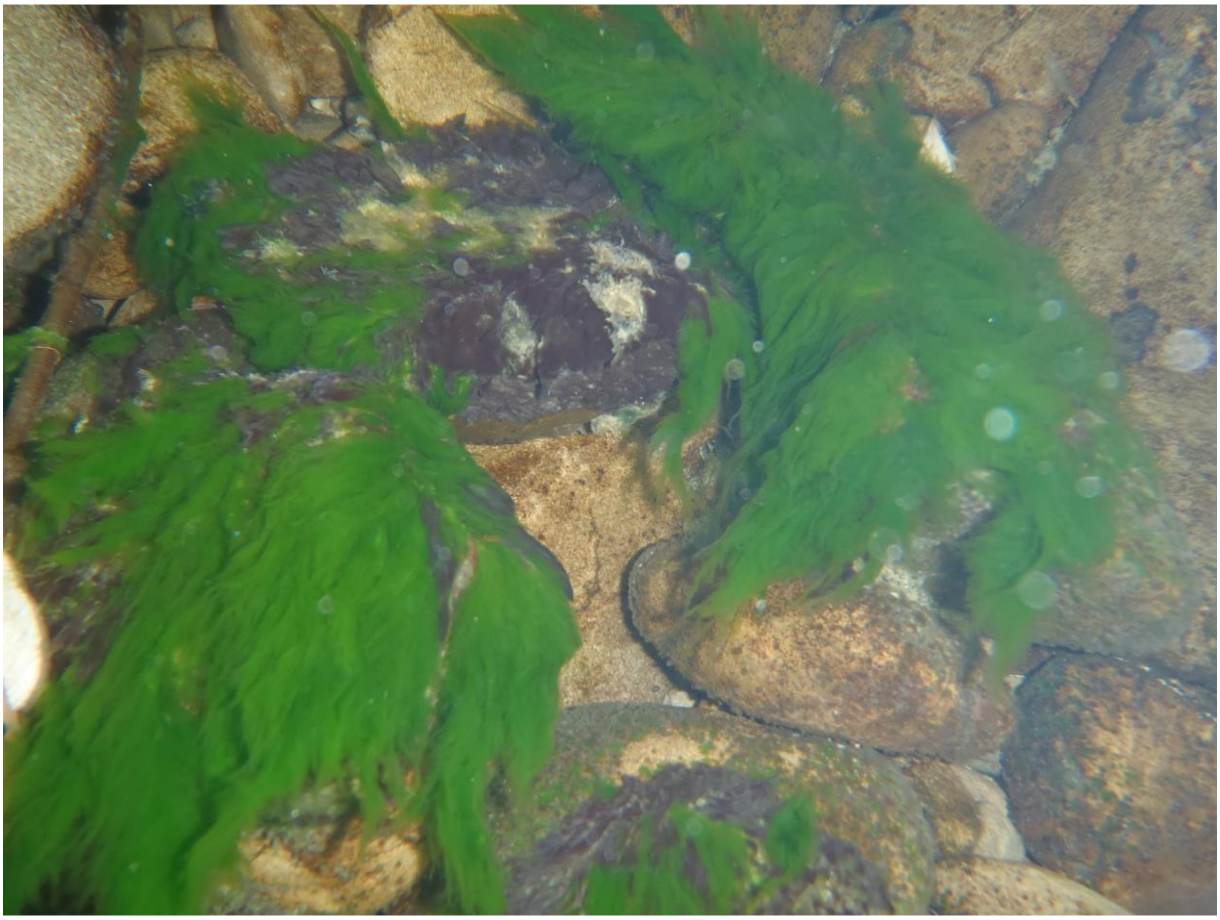

Photo 1: Filamentous and mat (*phormidium*) algae in the Mangatainoka River.

20. In December 2008 Horizons commenced a monthly periphyton monitoring programme. This programme samples sites across the region with 63 sites currently being monitored. Five of these sites are within the Oroua mainstem.

21. The following pages contain the results from the monthly periphyton monitoring programme from the December 2008 until June 2016.

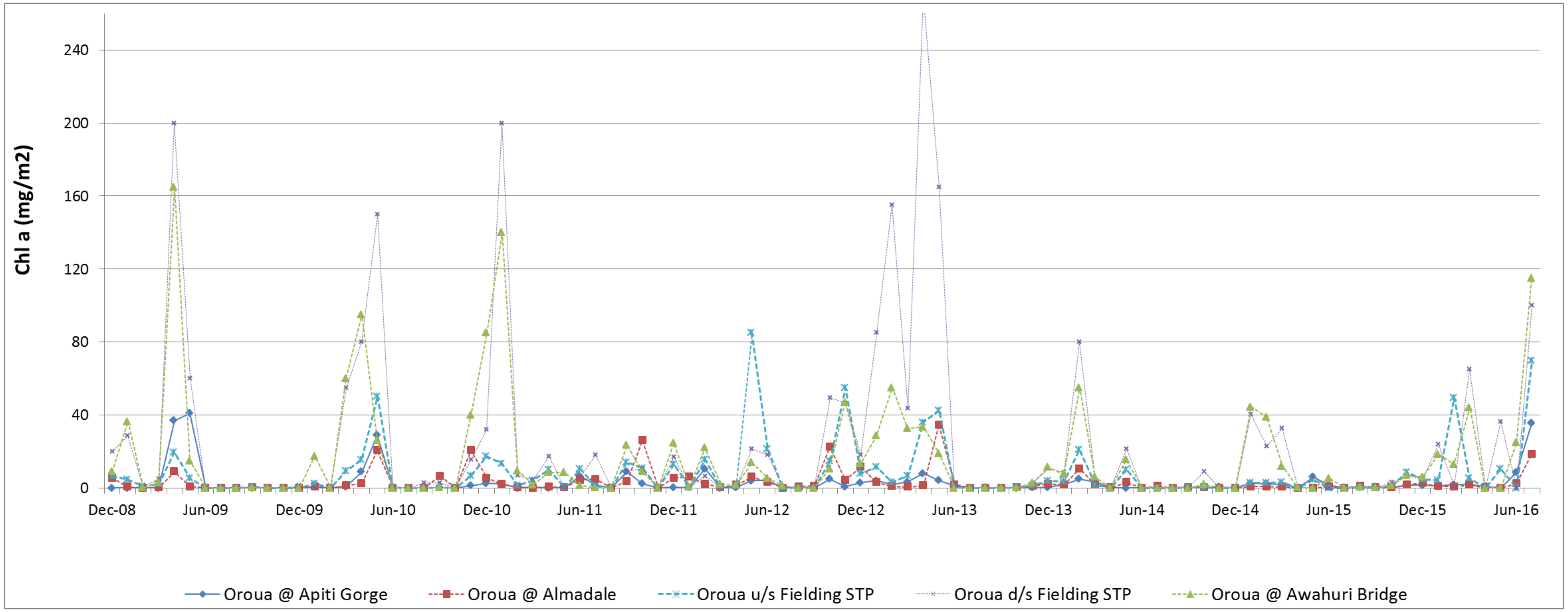

Figure 4: Periphyton biomass measured as Chlorophyll *a* mg/m^2 from monthly monitoring in the Oroua catchment monitoring which commenced in December 2008 with data up to June 2016.

22. The monthly chlorophyll *a* data shows that as you move down the catchment the chlorophyll *a* concentrations that are seen in river generally increase (refer Figure 4). The greatest influence on the chlorophyll a concentrations within the catchment currently being the Feilding WWTP.

23. Horizons has recently had an assessment undertaken of our periphyton monitoring programme using the data collected from the first 6 years of the programme. This assessment included an analysis against the Freshwater NPS attributes, the One Plan and assigning various periphyton metrics to classes from very low through to high. The results of this assessment are contained in the following paragraphs.

24. The latest report on the periphyton communities within the Horizons Region contained a new method on how to assign periphyton to various bands based on thresholds for different periphyton metrics and the levels that each of the metrics reached. These bands and the thresholds are contained in Table 3

Table 3: Definitions of periphyton state in bands from very low to very high chlorophyll *a* and percent cover.

Table 4-1: Definitions of periphyton state in bands from very low to very high chlorophyll *a* and percent cover. Very low represents the best state (i.e., least periphyton) and very high represents the worst state (most periphyton).

	Range of values in coding category					Justification for bands
Periphyton metric	VLow	Low	Mod	High	VHigh	
Mean chlorophyll *a*	<5	5 - <15	15 - <50	50 - <120	>120	Vlow and Low thresholds in range for high quality invertebrates and dominant cover by film. Low – Mod threshold set at mean value to protect biodiversity (Biggs 2000a). VHigh set at One Plan middle range.
Median chlorophyll *a*	<3	3 - <15	15 - <50	50 - <120	>120	As above. VLow – Low threshold lower because mean tends to be higher than median if maximum is high.
92nd percentile, % mats	<5	5 - <15	15 - <30	30 - <60	>60	VLow starts at barely visible peak cover, approximately equivalent to 5 mg/m^2 if no other algae present. VHigh band uses threshold for protection of aesthetic/recreation values in Biggs (2000a).
92nd percentile, % filaments	<2.5	2.5 - <5	5 - <15	15 - <30	>30	As above for mats – range Vlow to Mod covers barely visible to easily visible cover. VHigh band uses threshold for protection of aesthetic/recreation and trout habitat/angling values in Biggs (2000a).
92nd percentile, % cyanobacteria	0	0-<2	2-<10	10-<20	>20	The VLow band is effectively extremely low or no occurrence of cyanobacteria; VHigh is exceedance of the “alert” level in the cyanobacteria guidelines.

25. Taking each of these bands and applying them to the Oroua catchment and the sites that are monitored you can see the worsening in the periphyton metrics as you move down the catchment. With the frequency of moderate and high increasing (and very low and low decreasing) as you move down the catchment (refer Tables 4 and 5). These assessments have been both undertaken over the entire data record and also for the last three years of the data.

Table 4: Bands for periphyton metric groupings.

<table>
<tr><th>Parameter</th><th>Category</th><th>Colour</th></tr>
<tr><td rowspan="5">Mean chlorophyll a

Median chlorophyll a

92nd percentile, % mats

92nd percentile, %filaments

92nd percentile, cyanobacteria</td><td>Vlow</td><td></td></tr>
<tr><td>Low</td><td></td></tr>
<tr><td>Moderate</td><td></td></tr>
<tr><td>High</td><td></td></tr>
<tr><td>VHigh</td><td></td></tr>
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Table 5: Periphyton groupings for monitored sites on the Oroua River.

	All data: 2008 to 2015					Last 3 years: May 2012 to April 2015				
	Ecosystem health		Aesthetics and recreation		Human Health	Ecosystem health		Aesthetics and recreation		Human Health
Site	**Chl a, median**	**Chl a, mean**	**Mats, 92nd Pc**	**Fils, 92nd Pc**	**Cyano, 92nd pc**	**Chl a, median**	**Chl a, mean**	**Mats, 92nd Pc**	**Fils, 92nd Pc**	**Cyano, 92nd pc**
Oroua at Apiti	0.4	3.1	6.9	8.4	0.5	1.5	1.9	3.1	4.5	0.3
Oroua at Almadale	0.9	3.6	1.7	8.0	1.2	1.2	3.9	1.7	3.3	1.1
Oroua at upstream Feilding WWTP	2.7	8.6	3.0	29.9	0.3	3.3	12.0	2.0	20.8	0.3
Oroua at downstream Feilding WWTP	7.0	30.7	21.5	29.5	4.4	18.0	39.5	11.4	21.8	4.6
Oroua at Awahuri	7.5	18.8	19.4	19.0	1.6	11.0	16.3	1.9	7.1	1.6

26. In addition the report undertook an assessment against the Freshwater NPS attribute for periphyton and an assessment against the One Plan (refer to Tables 6 and 7). These assessments have been both undertaken over the entire data record and also for the last three years of the data.

Table 6: Assessment of the periphyton metrics (chlorophyll a, mat coverage, and filamentous algae coverage against the targets in the One Plan).

	% compliance all data			**% compliance 2012 -2015**		
	Chl a	**Mats**	**Fils**	**Chl a**	**Mats**	**Fils**
Oroua at Apiti	100	100	99	100	100	100
Oroua at Almadale	100	100	100	100	100	100
Oroua at upstream Feilding WWTP	100	100	94	100	100	97
Oroua at downstream Feilding WWTP	92	100	95	92	100	97
Oroua at Awahuri	97	100	96	100	100	100

Table 7: Assessment of chlorophyll a against the Freshwater NPS and the attribute classes that the monitored sites fall into.

	All data	2012 -2015
Oroua at Apiti	A	A
Oroua at Almadale	A	A
Oroua at upstream Feilding WWTP	A	A
Oroua at downstream Feilding WWTP	B	C
Oroua at Awahuri	A	A

27. The assessment against the Freshwater NPS has all sites (except the Oroua River downstream of Feilding WWTP) falling into attribute state A over both the six year monitoring period and the shorter three year term. The Oroua downstream of the Feilding WWTP falling into Band B over the entire record and into Band C over the three year period.

28. The monthly monitoring programme also collects data on the visual coverage of periphyton at each of the sites. The One Plan has a target of less than 30% coverage for filamentous algae and less than 60% for mats.

29. The following graphs (Figures 5 through to 10) shows the periphyton coverage at the sites over the 6 years of monitoring.

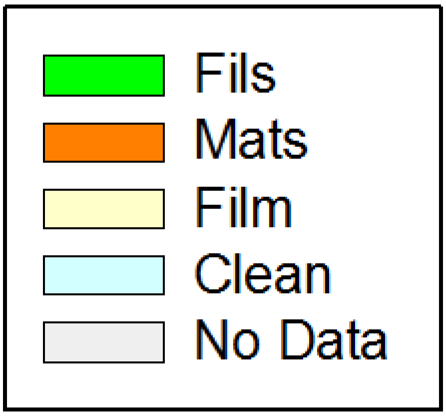

Figure 5: Colours for bar graphs on periphyton coverage in the Oroua catchment.

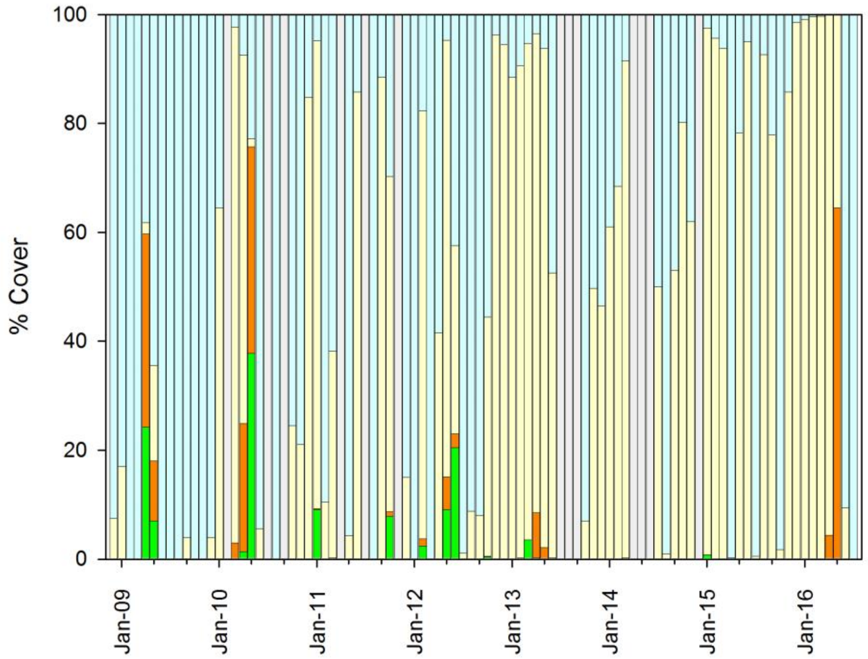

Figure 6: Periphyton coverage at Oroua at Apiti from monthly monitoring data from December 2008 until June 2016.

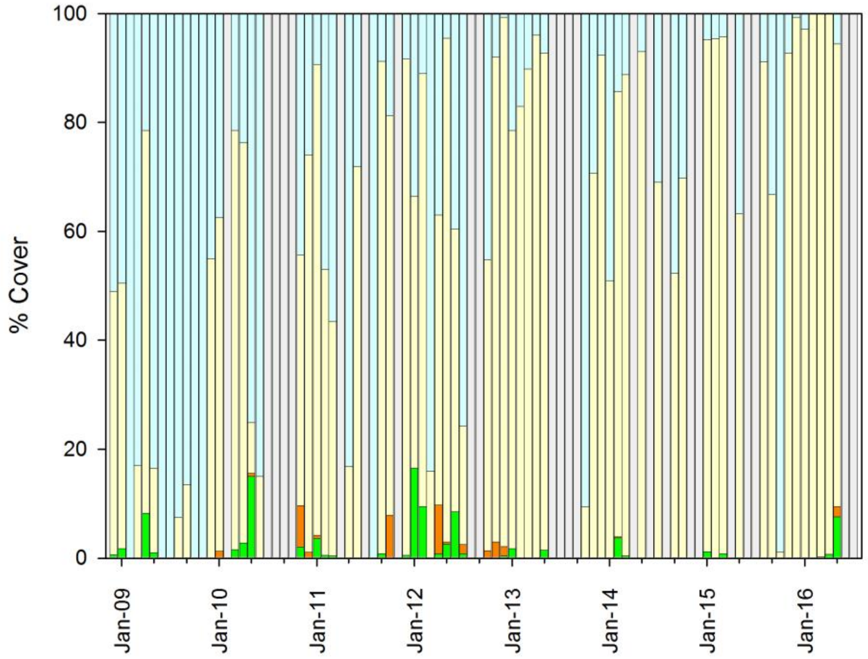

Figure 7: Periphyton coverage at Oroua at Almadale from monthly monitoring data from December 2008 until June 2016.

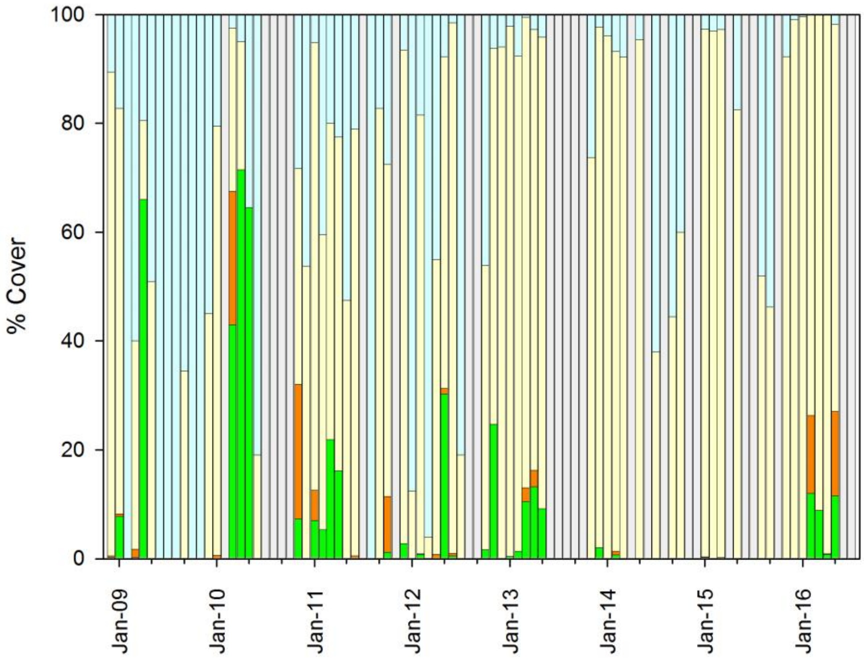

Figure 8: Periphyton coverage at Oroua at upstream of Feilding WWTP discharge from monthly monitoring data from December 2008 until June 2016.

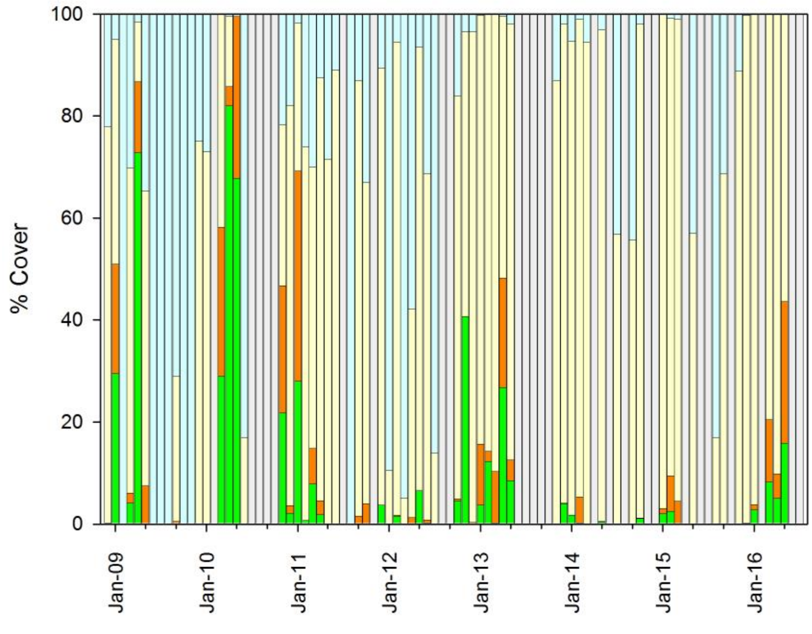

Figure 9: Periphyton coverage at Oroua at downstream of Feilding WWTP discharge from monthly monitoring data from December 2008 until June 2016.

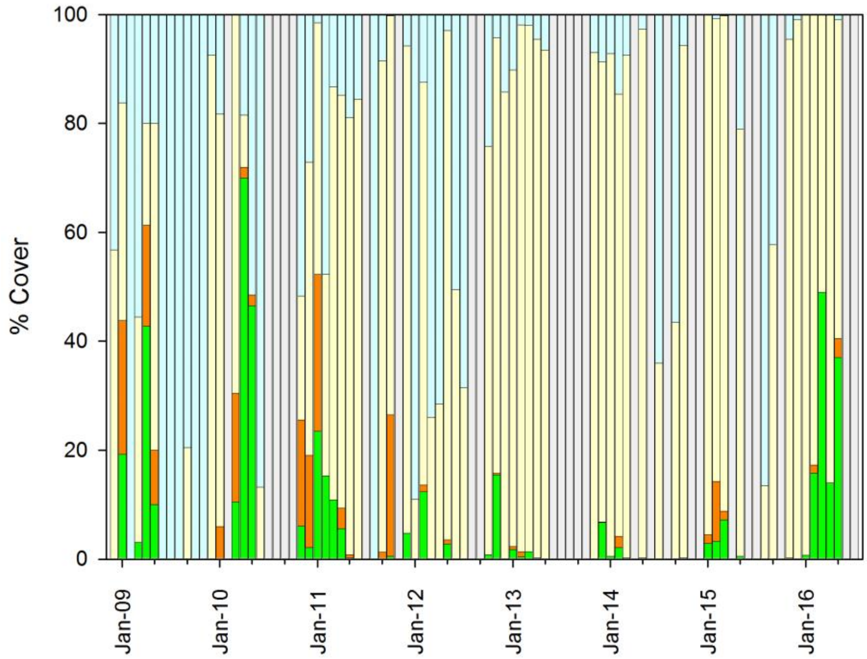

Figure 10: Periphyton coverage at Oroua at Awahuri from monthly monitoring data from December 2008 until June 2016.

30. Not surprisingly the monitoring data shows that as you move down the catchment the amount of periphyton either measured as biomass (chl *a* mg/m^2) or visual coverage (mats and filamentous algae) increases. Given that the catchment experiences the same hydrological regime throughout, the impacts of increases in nutrients become one of the main drivers to explain the variation (increases) between these sites.

31. A point to note based on the above monitoring data and the proposed discharge regime is that the site closest to the proposed discharge point and downstream of it (Oroua River upstream of the Feilding WWTP discharge) is that the months that have the peak annual chlorophyll *a* biomass in any year are frequently associated with the months that AFFCO propose to discharge to the river under the application (refer Table 8). Although the peak annual biomass of chlorophyll *a* was under the One Plan target of 120 mg/m^2 on each of the monitoring occasions, the point of pulling this out in the data is to show that simply relying on months of the year to eliminate effects provides a false sense of security, in that stable flows (and therefore peak biomass) can and do occur in the months that fall outside of the summer months in the Oroua catchment. Elimination of the discharge to the Oroua River during these months (April/May) will further reduce the risk of an adverse effect on the life supporting capacity of the Oroua River.

Table 8: Month of peak annual biomass (chlorophyll *a*) in the Oroua River upstream of the Feilding WWTP discharge.

Year	Month annual peak biomass reached (chl *a* mg/m^2) (January to December year)	Chlorophyll *a* mg/m^2
2009	April	19.5
2010	May	50
2011	September	14
2012	May	85
2013	May	42.5
2014	February	21
2015	November	8.5
2016 (Up to June)	May	70

Macroinvertebrates

32. Aquatic macroinvertebrates are critical components of the ecosystem and are used as indicators of ecosystem health in rivers and streams due to their presence in the system over time. Macroinvertebrates, as well as adding to biodiversity, play a vital role in freshwater ecosystems as they graze on periphyton communities and provide a food source for native and introduced fish species. Many macroinvertebrates have life cycles that involve being present as nymphs in the water for up to 12 months, therefore representing what has been occurring in the ecosystem over time. They therefore provide a longer term picture which compliments nutrient sampling. As such, national protocols have been developed which allow us to use macroinvertebrates to monitor water quality.

33. The Macroinvertebrate Community Index (MCI) and its quantitative variant the Quantitative Macroinvertebrate Community Index (QMCI) are indices of

macroinvertebrate community health that relate to the impact of organic enrichment developed by Stark (1985). The original indices were developed for stony bottomed streams on the Taranaki Ring Plain but since their development in the mid 1980s these indices have been widely applied as a useful resource management tool to describe the impact of enrichment on aquatic ecosystems (Boothroyd and Stark, 2000). The Macroinvertebrate Community Index works by allocating enrichment sensitivity scores to individual aquatic invertebrate taxa. A sample of the macroinvertebrate community is collected and then the scores of the invertebrates present in the sample are summed and standardised to determine a score between 0 and 200, with a high score indicating a lesser degree of impact from enrichment.

34. The QMCI uses the same enrichment sensitivity scores for each taxa as the MCI, in addition to data on the abundance of taxa, rather than just the presence / absence resolution of the MCI. A QMCI score is determined from a formula using the sensitivity scores and abundance data to give a value in the range of 0 to 8, with a score of 8 indicating an unimpacted macroinvertebrate community. The QMCI is also a widely used index and there are standardised national protocols for collecting and enumerating macroinvertebrates to determine MCI or QMCI scores (Stark et al., 2001; Stark and Maxted, 2007). Additionally, a soft-bottom MCI and a semi-quantitative version (SQMCI) have been developed to incorporate different stream substrates.

35. In terms of reporting on water quality using macroinvertebrate indices there are a number of measures which can be used and assessed. These being the %EPT taxa, %EPT abundance, MCI, QMCI, SQMCI and analysis looking at the difference in community composition. All of these indices have their place and tell us slightly different things about macroinvertebrate communities.

36. Once calculated the MCI and QMCI values can be assigned to categories which provide us with an indication of water quality. These categories are reproduced in Table 9.

Table 9: Interpretation of MCI and QMCI classes after (a) Stark and Maxted (2007) and (b) Wright-stow and Winterbourn (2003); Source (Stark, 2008).

Quality class	MCI		QMCI		Degradation category
	(a)	(b)	(a)	(b)	
Excellent	> 119	> 124	> 5.99	> 6.1	Clean
Good	100-119	105-115	5.00-5.90	5.2-5.7	Mild
Fair	80-99	85-95	4.00-4.99	4.2-4.7	Moderate
Poor	<80	<75	<4.00	<3.8	Severe

37. The OP has identified MCI targets for each of the management and Sub-Management Zones within Schedule E. The entire Oroua Management Zone has a target of an MCI score to be above 100 (clean water class/moderate degradation category). The data showing the MCI scores from 2009 to 2015 are shown in Figure 11.

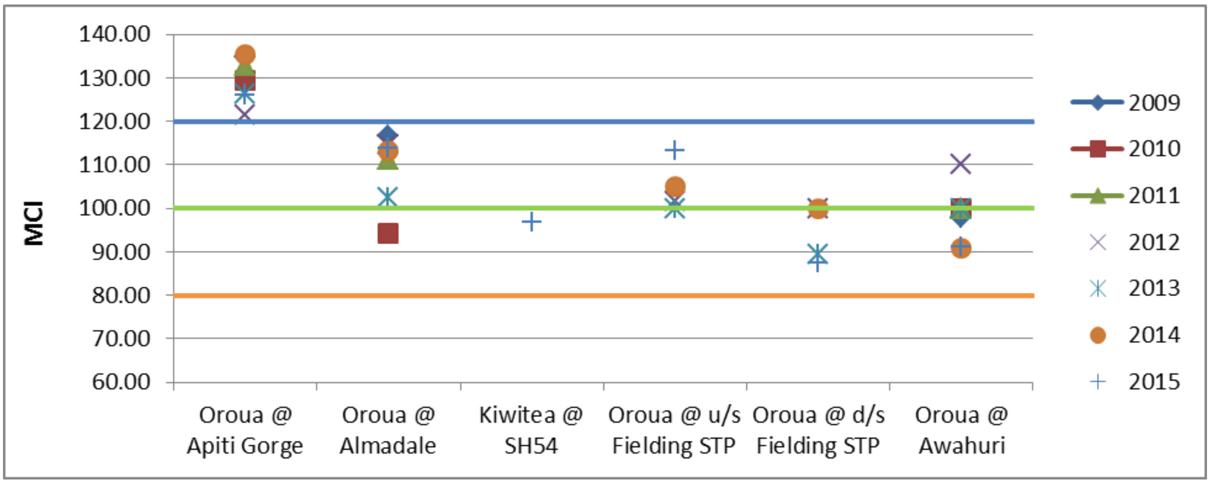

Figure 11: Macroinvertebrate community index (MCI) as you move down the Oroua catchment, monitoring data from 2009 through to 2015.

38. The monitoring data for the MCI shows that as you move down the catchment the monitoring sites move from excellent at Oroua at Apiti site, to mostly good at Oroua at Almadale and Oroua upstream Feilding STP discharge and then into mostly the fair category for the Oroua downstream of Feilding STP and at Awahuri.

39. The data showing the SQMCI scores from 2009 to 2015 are shown in Figure 12.

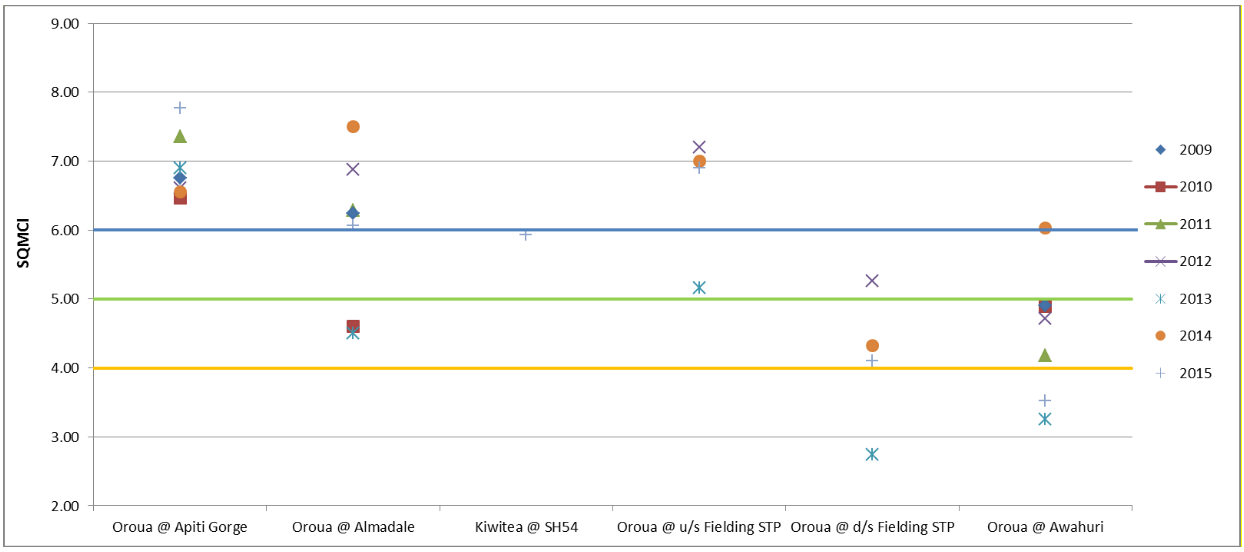

Figure 12: Semi-Quantitative Macroinvertebrate community index (SQMCI) as you move down the Oroua catchment, monitoring data from 2009 through to 2015.

40. The SQMCI shows the same change in categories as the MCI does as you move down the catchment. With the biggest change being seen downstream of the Feilding WWTP discharge to the Oroua River.

41. In addition to the MCI and QMCI further indices are used as an indication of water quality through EPT (Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). Generally a high percentage of EPT taxa indicates good stream health. A threshold for %EPT abundance and richness was proposed in Death, 2009:

- Greater than 60%, clean water;
- 10% to 60%, mild to moderate pollution; and
- Less than 10%, severe pollution.

42. The data showing the % EPT richness and abundance scores from 2009 to 2015 are shown in Figures 13 and 14.

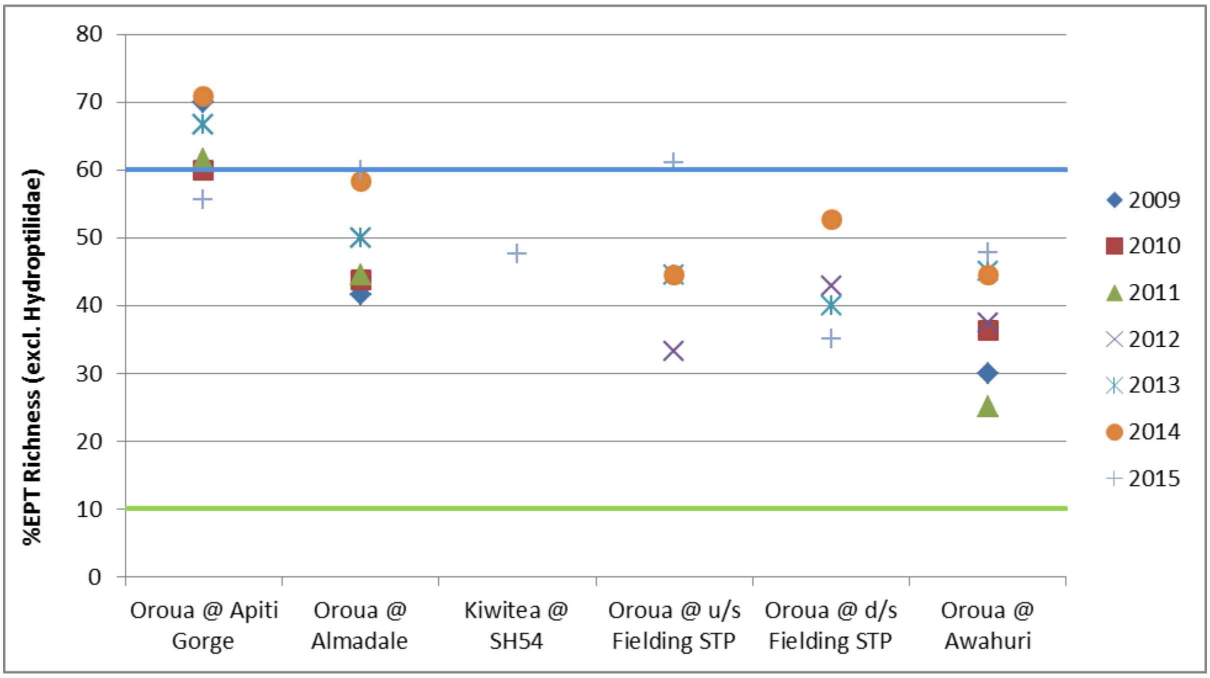

Figure 13: %EPT richness as you move down the Oroua catchment, monitoring data from 2009 through to 2015.

43. The % EPT richness shows the same pattern as the MCI and SQMCI as you move down the catchment with mostly a movement out of clean water into the lower end of mild to moderate pollution at the lowest site monitoring in the catchment.

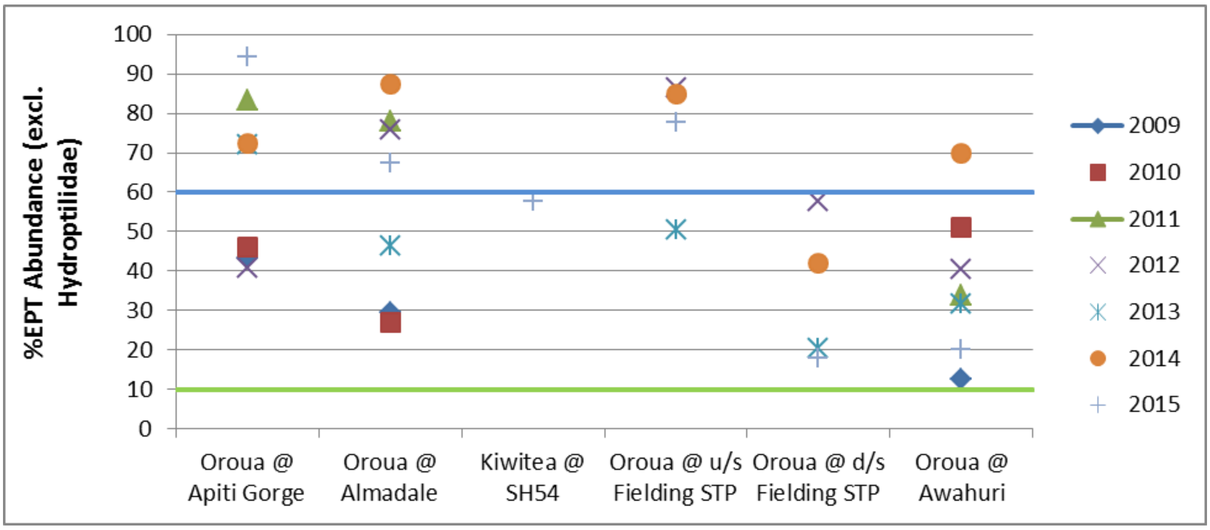

Figure 14: %EPT abundance as you move down the Oroua catchment, monitoring data from 2009 through to 2015.

44. The % EPT abundance shows the same pattern as the MCI and SQMCI as you move down the catchment with mostly a movement out of clean water into the lower end of mild to moderate pollution at the lowest site monitoring in the catchment.

45. As part of the consent renewal the applicant undertook one round of macroinvertebrate monitoring in November 2010 under the consented regime. The results of this monitoring were *"These results suggest that, on 19 November 2010, the AFFCO discharge did not have a noticeable impact on the growth of periphyton in the Oroua River, but that there was a significant adverse effect on macroinvertebrate communities that was in breach of the proposed QMCI standards in the One Plan"*. The QMCI at the two upstream sites being 4.41 and 4.19 and the two sites downstream being 2.19 and 2.44. The current discharge was therefore having a significant adverse effect on the macroinvertebrate communities at the time of sampling. The current (expired) discharge regime is different to the current proposal.

Nutrients

46. Bioavailable nitrogen is known as Soluble Inorganic Nitrogen (SIN = nitrate + nitrite-N + ammonia N) and bioavailable phosphorus is known as Dissolved Reactive Phosphorus (DRP). Both nitrogen and phosphorus are needed for periphyton growth, in an average mole ratio of 16:1 (nitrogen:phosphorus), or 7:1 by weight (Wilcock et al., 2007).

47. One way to assess what nutrient a river is particularly sensitive to in terms of periphyton growth is to use nutrient diffusing substrates (NDS) within rivers during stable flows. These diffusing substrates work on the basis of having known additions of nitrogen and phosphorus added to agar and this is slowly released during the deployment of the equipment. There are four states of agar within NDS trials – nitrogen only, phosphorus only, nitrogen and phosphorus, and a control. Recent work done in the Oroua at Almadale during low flows has suggested that the periphyton growth was nitrogen limited meaning that the river is particularly sensitive to the inputs of nitrogen from the catchment.

Dissolved Reactive Phosphorus (DRP) levels

48. The One Plan target for the Upper, Middle and Lower Oroua sub-management zones is 0.010 g/m^3.

49. Monitoring data from 2011 to 2015 (refer Table 10) shows that the annual average concentration of DRP target is met at the Oroua at Apiti, Almadale, and on most occasion at the Oroua upstream of the AFFCO discharge and this changes to the target not being met at all sites downstream of the AFFCO discharge.

Table 10: Annual average DRP concentrations (g/m^3) for sites monitored in the Oroua mainstem.

Year	Oroua at Apiti	Oroua at Almadale	Oroua at u/s AFFCO	Oroua at d/s AFFCO	Oroua at u/s Feilding STP	Oroua at Awahuri
2011	0.0061	0.007	0.009	0.032	0.0188	0.023
2012	0.0064	0.008	0.009	0.021	0.0226	0.030
2013	0.0067	0.010	0.010	0.018	0.0140	0.037
2014	0.0065	0.010	0.014	0.018	0.0111	0.011
2015	0.0051	0.009	0.010	0.017	0.0263	0.028

Soluble Inorganic Nitrogen (SIN) levels

50. The One Plan target for the Upper Oroua sub-management zone is 0.167 g/m^3 and for the Middle and Lower Oroua sub-management zones is 0.444 g/m^3.

51. Monitoring data from 2011 to 2015 (refer Table 11) shows that at:

- Oroua at Apiti the SIN target concentration is always met;
- Oroua at Almadale the SIN target concentration is always met;
- Oroua at upstream AFFCO discharge the SIN target concentration is always met;
- Oroua at downstream AFFCO discharge the SIN target concentration is met 60% of the time;
- Oroua at upstream Feilding WWTP discharge the SIN target concentration is met 60% of the time;
- Oroua at Awahuri the SIN target concentration is never met.

Table 11: Annual average SIN concentrations (g/m^3) for sites monitored in the Oroua mainstem.

Year	Oroua at Apiti	Oroua at Almadale	Oroua at u/s AFFCO	Oroua at d/s AFFCO	Oroua at u/s Feilding STP	Oroua at Awahuri
2011	0.0872	0.157	0.368	0.537	0.5530	0.758
2012	0.0788	0.137	0.360	0.454	0.4315	0.703
2013	0.1280	0.183	0.164	0.257	0.2595	0.789
2014	0.0643	0.174	0.250	0.287	0.4044	0.612
2015	0.0679	0.279	0.217	0.276	0.5374	1.236

G. FISH DIVERSITY IN THE OROUA CATCHMENT

52. The NZ Freshwater Fish Database (NFFDB), administered by the National Institute of Water and Atmospheric Research (NIWA), contains records of 15 aquatic freshwater species being encountered when surveying within the Oroua catchment these are:

- Red fin bully;
- Banded kokopu;
- Giant kokopu;
- Koaro;
- Torrentfish;
- Common bully;
- Inanga;
- Smelt;
- Short fin eel;
- Long fin eel;
- Brown trout;
- Rainbow trout:
- Upland bully;
- Crans bully; and.
- Freshwater crayfish (koura).

53. Some of the freshwater species found in the catchment are considered to be threatened and are contained within the New Zealand threat classification system (Table 12) (Goodman *et al*., 2013, and Grainger *et al*, 2014).

Table 12: Threat classification of the freshwater species found in the Oroua Catchment. Freshwater fish threat classification based on 2013 publication and koura based on 2014 publication.

Common name	Scientific name	Threat ranking
Koura (Freshwater crayfish)	*Paranephrops planifrons*	Not threatened
Red fin bully	*Gobiomorphus huttoni*	At risk – declining
Koaro	*Galaxias brevipinnis*	At risk – declining
Torrentfish	*Cheimarrichthys fosteri*	At risk – declining
Inanga	*Galaxias maculatus*	At risk – declining
Long fin eel	*Anguilla dieffenbachia*	At risk – declining
Common bully	*Gobiomorphus cotidianus*	Not threatened
Banded kokopu	*Galaxias fasciatus*	Not threatened
Common smelt	*Retropinna retropinna*	Not threatened
Upland bully	*Gobiomorphus. Breviceps*	Not threatened
Crans bully	*Gobiomorphus basalis*	Not threatened
Short fin eel	*Anguilla australisi*	Not threatened*
Brown trout	*Salmo trutta*	Introduced and naturalized*
Rainbow trout		Introduced and naturalized*

54. Migrational pathways between rivers and the sea are extremely important components of healthy riverine ecosystems and aquatic biodiversity in New Zealand. The migration times of diadromous fish (requiring access to the sea at some stage during their life cycle) differ according to species, however, fish are migrating throughout the year in the Oroua catchment (refer Table 13).

Table 13: Summary of migration timing of diadromous / migratory fish in the Oroua River Catchment. Arrows pointing to the left indicate downstream migration to estuaries or the sea, arrows pointing to the right indicate upstream migration into freshwaters.

Species	Winter	Spring	Summer	Autumn
Koaro	→ ←	→		←
Eels	←	→	→	←
Torrentfish		→	→ ←	←
Common smelt		→ ←	→ ←	→ ←
Banded kokopu	→ ←	→		←
Red fin bully		→ ←	→	
Inanga	→ ←	→		←
Common bully		→ ←	→ ←	
Spawning trout	→	→		

55. Anything that affects the ability of fish to be able to migrate within the catchment has the chance of being able to affect the recruitment of fish into freshwater systems. The parameters of concern in regard to this application would be the ammonia concentrations in the Oroua River as a result of the discharge. The modelling that was done as part of the application shows compliance with the One Plan ammonia targets and this should therefore not be a factor for this discharge. The only other impact could be as a result of periphyton growth and the associated changes in dissolved oxygen levels within the Oroua River. Periphyton growth is dealt with in more detail below.

H. EFFECTS OF THE POINT SOURCE DISCHARGE

Nutrients

56. The applicant has proposed the following discharge regime to the Oroua River:

Flow in the Oroua River at Kawa Wool Gauging Station	Proposed discharge between 1 December and 31 March	Proposed discharge between 1 April and 30 November
Below median flow (0 L/s to 7,590 L/s)	No discharge	No discharge
Median flow to 20th percentile exceedance flow (7,590 L/s to 16,193 L/s	No discharge	Discharge based on rate of DRP load to river up to a maximum of 3,000 m^3/day
Above 20th percentile flow exceedance (> 16,193 L/s)	No discharge*	Up to 3,000 m^3/day
***Emergency contingency discharge if flow is greater than 3 x median (> 20,913 L/s)**	If land application is not possible and ponds are 100 % full, discharge up to 2,000 m^3/day	

57. The application overall seeks to increase the total load that is discharged to the Oroua River. The report entitled "AFFCO (Feilding Meat Processing Plant) discharge to the Oroua River: Water Quality modelling and assessment of effects of proposed discharge regimes" contains the following information in relation to the discharge nature:

- In regards to DRP the proposed discharge regime results in a 7.3% increase in the average total DRP load discharged to the river compared to the current scenario (from 2.21 to 2.37 tonnes per year). This is compared to an upstream load of 4.5 tonnes per year.
- However, the timing of load discharge changes compared to the current regime with the resultant changes in loads as shown in Table 14.

Table 14: Average increase in DRP load discharged to the Oroua as a result of the proposal compared to the current discharge regime and compared to the upstream load.

Flow	Current	Proposed	Upstream (catchment load)
Below median	0.48 T/yr	0 T/yr	0.4 T/yr
Below 20th FEP	1.3 T/yr	0.25 T/yr	1.6 T/yr
All flows	2.21 T/yr	2.37 T/yr	4.5 T/yr

- In regards to SIN the proposed discharge regime results in an 11% increase in the average total SIN load discharged to the river compared to the current scenario (from 14.1 to 15.7 tonnes per year). This is compared to an upstream load of 154 tonnes per year.
- However, the timing of load discharge changes compared to the current regime with the resultant changes in loads as shown in Table 15.

Table 15: Average in increase in SIN load discharged to the Oroua as a result of the proposal compared to the current discharge regime and compared to the upstream load.

Flow	Current	Proposed	Upstream (catchment load)
Below median	2.9 T/yr	0 T/yr	
Below 20th FEP	8.5 T/yr	1.6 T/yr	
All flows	14.1 T/yr	15.7 T/yr	154 T/yr

58. Because of the change in the timing of the discharge the ability to comply with or get closer to achieving the One Plan nutrient targets also changes as the majority of the discharge will occur when the One Plan targets do not apply (above the 20th FEP). The reason for the One Plan nutrient targets not applying at these flows was based on the approach that periphyton would not be able to grow at flows above the 20th FEP.

59. The modelling done as part of the application shows that the discharge will cause the annual average DRP concentration to exceed the One Plan target of 0.010 g/m^3. This mostly being a result of the annual average sitting at 0.0096 g/m^3 upstream of the discharge and the discharge moving it to 0.0106 g/m^3.

60. One thing to note in the application in regards to the DRP levels is that the annual average modeling that has been completed as part of the assessment is its method of calculation. The annual average I believe has been calculated by taking all the monthly data including the data when the discharge to the river does not occur. Although this is one way to calculate the annual average this is not necessarily what the river sees in terms of allowing for periphyton growth. Therefore the modelling for the discharge may show a small increase in the annual average DRP concentration (in this case 0.001 g/m^3 or 10% of the One Plan target), the actual increase in the concentration is up to 0.005 g/m^3 as proposed in the consent. The application therefore seeks to increase the DRP concentration in the river by half of the One Plan target concentration in the river. It is the nutrient concentrations during the accrual[4] period of periphyton growth that is the important factor in the terms of the levels that periphyton will reach, not the average of the data over the entire year.

[4] The accural period is the amount of time between two flow events that causes periphyton to be scoured from the stream bed i.e. the amount of time that periphyton has available for growth.

61. In regards to SIN the application includes an assessment of the contribution that the discharge will make to the Oroua River. Under the current scenario (60% of the time over the last 5 years) and the proposed scenario the Oroua River downstream of the discharge point will meet the One Plan target of 0.444 g/m^3 for this reach of the river. However, once again it is the nutrient concentrations during the accrual period for periphyton growth that is the important factor in terms of the levels that periphyton will reach not the average of the data over the entire year. In addition the SIN target of 0.444 g/m^3 was never developed to achieve the periphyton biomass target in the One Plan. Placing too much reliance on meeting the SIN target in the One Plan and therefore by default being able to meet the periphyton targets may create an unrealistic expectation as to in-river outcomes.

62. The outcomes of most relevance to the nutrient targets are the periphyton levels that are reached in-river. The modelling undertaken as part of the application for periphyton growth suggests that the biomass levels (chlorophyll *a*) of periphyton will be well below the target in the One Plan. However, with all models the collection of data is required to valid the outputs from such a model. Therefore the monitoring of periphyton levels in conjunction with nutrient levels will allow the refinement of the discharge regime to ensure that the effects of the discharge are acceptable on the majority of the values that have been identified in the Oroua River.

63. As discussed in the above sections the peak annual periphyton biomass in the Oroua River tends to be April/May of each year and the removal of the discharge (below the 20th FEP) during these months would further reduce any potential risk of nuisance periphyton growth and associated effects on the life supporting capacity of the Oroua River.

<u>Contact recreation</u>

64. The proposal will not involve a discharge to the Oroua River between 1 December and the 31 March of each year unless land application is not possible, the ponds are 100% full, and the flow in the Oroua River is over 20,913 l/s. These criteria exclude the times when people are most likely undertaking primary contact recreation (swimming and any activities that rely on full immersion) within the Oroua River. If the discharge was occurring at flows above 20,913 l/s during this period the river would be in flood excluding people from being able to use it.

65. The river assessment of effects report does not appear to have undertaken an assessment of the effects of the discharge on contact recreation values of the river or compare them to the One Plan targets other than to mention that the increase as a result of the discharge will be small. The discharge is not proposed to occur during flows below median, so the effects on contact recreation values below these flows and the One Plan target of 260 mpn/100ml becomes irrelevant as the discharge cannot influence the *E.coli* concentrations. However, an assessment can be undertaken for when the Oroua River flows are below the 20th FEP. At times when flows are below the 20th FEP the One Plan has a target of below 550 mpn/100ml (excluding the times when the 260mpn/100ml mentioned above applies).

66. During the development of the One Plan a number of technical documents were developed to help inform the plan. The reports identified values within the regions waterways and another report recommended targets/standards and the method of assessing compliance to ensure protection of the values that had been identified. In regards to *E.coli* concentrations compliance was suggested to be assessed at the 95th percentile for the following reasoning:

- *"However, due to the nature of the microbiological results, where an unsatisfactory result can commonly be several orders of magnitude greater than a satisfactory sample, the 95th percentile may be misleadingly high when it is calculated on a small number of samples (ie. one very high sample out of 20 samples can lead to a high 95th percentile even if the 19 other results are satisfactory). The 95th percentile approach is suitable (and recommended) when the number of sample is sufficient (eg. 50 samples). When the number of samples is less than 50, the recommended approach is to compare the 90th percentile of the data to the standard. (page 140)"*

67. Using the current information for the Oroua River upstream of the proposed discharge we have 72 sample points with 15 of these samples being above 550 mpn/100ml. Compliance with the 95th percentile is therefore not achieved at this site in relation to *E.coli* concentrations and the One Plan.

68. The application proposes no changes to the quality of the effluent in regards to *E. coli* concentrations. Although not a significant contributor of *E.coli* when the discharge is operating the discharge adds to the cumulative load of *E. coli* within the Oroua River. UV treatment is a method of *E. coli* removal that is used for effluent treatment in the majority of newer consents where there is a discharge to water component at times when the river may be used for contact recreation proposes. In this case at flows between median and the 20th FEP. However, in this situation the treatment of the effluent with UV may not be effective as the effectiveness of the UV is governed by effluent clarity.

I. EFFECTS OF THE DIFFUSE DISCHARGES:

69. The evidence of Mr Thomas covers the effects of the diffuse discharges from the leakage from the ponds and also the irrigation area. It is important to note that in the evidence of Mr Thomas he states *"It is useful to note that some effect from the ponds could bypass the more distant monitoring bores by a more direct pathway towards the Oroua River."*

70. The evident of Mr Thomas also states that for the land irrigation area *"If the maximum value of nitrate nitrogen (26 mg/L) observed in the monitoring bores adjacent to the river (and closer to the location where land discharge currently occurs) is representative, that groundwater discharge to the river at low flows (around 1,240 L/s) would increase concentration of nitrate nitrogen in the river by up to around 0.08 mg/L.".* Although this may be seen as a relatively small contribution compared to the One Plan target for this management zone it does add to the cumulative effects of land use within the catchment. This is in addition to the Oroua catchment being known as being nitrogen sensitive. In addition the current upstream and downstream monitoring points within the Oroua River would not capture the effects of this land discharge as the monitoring is focused on the point source discharge which would have the upstream point capturing some of the effects from the activity as a whole (i.e. the land irrigation areas).

71. I would therefore recommend the inclusion of an additional two (four sites in total) monitoring sites to capture the effects of the land discharge on the river. These sites being:

- Oroua River upstream of the land irrigation area (control);
- Kiwitea Stream (to enable the elimination of this input in any effects assessment);
- Oroua upstream discharge point (control for point source discharge); and
- Oroua downstream discharge point (assessment of effects for the point source discharge).

J. FISH PASSAGE

72. The applicant has proposed as part of the discharge structure to fish passage be reinstated to the Otoku Stream. The fish species that are mostly likely to utilize the Otoku Stream would be short fin eels. The proposed design of the fish pass structure will enable eels to be able to access the Otoku Streamwhich is currentl accessible. The current design has the outlet of the fish pass being below MALF stream level so should be useable for species at most flows in the Oroua River.

K. COMMENTS ON THE PROPOSED CONSENT CONDITIONS AND MONITORING

73. The applicant has proposed a number of consent conditions in Appendix L of the application. I do not intend to comment on the wording of the conditions however, I provide comment on the intent and where I see deficiencies in the proposed conditions.

74. At condition 2(c) of the proposed consent conditions for the discharge to water the applicant proposes to assess the Oroua River flows at 9am each morning to provide an indication of the volume of wastewater that can be discharged to the river on a daily basis. This condition is slightly deficient in two aspects:

- That only taking a reading at one point in the day fails to consider the effects that may occur as a result of the discharge occurring at that continuous rate for the day. Take for example that at the time of the reading the flow was recorded at 20,000 l/s. The discharge from the plant would then be able to occur at its maximum rate for the day. If however, over the course of the day the river flow was to drop to 10,000 l/s the ammonia concentrations in river would not necessarily be aligned with those in the consent conditions.
- The mixed concentrations in themselves may not be an issue however, given the current state of technology and the ability to be able to automate these processes one would be safely able to assume that this risk can simply be eliminated.

75. Proposed condition 5 (in relation to signage) in the water discharge permit proposes the erection of signage on the true left bank of the Oroua River to advise river users of the discharge of treated wastewater entering the river. The placement of signage is advisable but I'm unsure to the reason for only placing it on the true left hand side of the river given that the true left needs to be accessed through AFFCO land and the true right side is open to the public of Feilding. To appropriately advise river users signage should be placed on both the true left and right hand side of the river. In addition to ensure that people use the river as much as possible when the discharge is not operating it would be advisable that this signage be removed/closed so it was only in place when the discharge was operating i.e. when there actually was a risk to river users.

76. Proposed condition 6 and 7 state the distance downstream and also the standards that should apply to the Oroua River after reasonable mixing. The in-river standards are extremely light with only four parameters proposed to be covered with three of these relating to “floatables” on the water surface. Given the similarities between the discharges contaminants between the Feilding WWTP discharge and the AFFCO discharge I would recommend that the standards align between these two consents. The in-river standards from the Feilding WWTP are:

The permit holder shall ensure that the discharge, after reasonable mixing at 200m downstream of the discharge point does not cause or breach any one or more of the following:

i. the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or

ii. bacterial and / or fungal slime growths visible to the naked eye as plumose growths or mats; or

iii. the receiving water to become unsuitable for consumption by farm animals; or

iv. a reduction in horizontal visibility exceeding 30%; or

v. a reduction in QMCI of greater than 20%; or

vi. the DO concentration to fall below 70% saturation; or

vii. the rolling annual average ammonia concentration to exceed 0.400 g/m^3; or

viii. the maximum ammonia concentration to exceed 2.1 g/m^3; or

ix. the Particulate Organic Matter concentration to exceed 5 g/m^3 (an average over any 12 month period) when flows are below median flows; or

x. the Chlorophyll *a* concentration to exceed 120 milligrams of chlorophyll *a* per square metre on more than 1 occasion in 12 consecutive samples; or

xi. the soluble carbonaceous BOD_5 concentration due to dissolved organic compounds (that is, material passing through a GF/C filter) to exceed 2 grams per cubic metre at river flows below the 20th FEP; or

xii. the maximum cover of visible streambed of periphyton as filamentous algae more than 2cm long to exceed 30% in a run habitat; or

xiii. the maximum cover of visible streambed of periphyton as mat algae more than 0.3cm thick to exceed 60% in a run habitat.

77. The applicant has proposed at condition 8 of the water discharge permit to undertaken monitoring on a three monthly basis during April to November (inclusive) each year. I'm unsure of the reasoning for three monthly monitoring but this frequency of monitoring does not align with any of the Regional Council's monitoring programmes or any consents and associated monitoring that I have worked on in the last 6 years. Monitoring of this frequency does not allow a thorough assessment of the effects of an activity. At the proposed rate only two in-river samples would be collected per year, this frequency would not allow any relationships to be developed between nutrient concentrations and periphyton levels (discussed more below) if an effect was seen from the periphyton monitoring. In addition the applicant proposes to sample a reduced number of parameters in the discharge compared to those normally included on consents. I would recommend the inclusion of the following to align with recently granted Feilding consent:

i. pH (field measurement);

ii. Temperature (field measurement);

iii. Dissolved oxygen (field measurement);

iv. Total Suspended Solids;

v. $scBOD_5$ (Dissolved carbonaceous biochemical oxygen demand being material passed through a GF/C filter);

vi. Total Nitrogen;

vii. Nitrate Nitrogen;

viii. Ammoniacal Nitrogen;

ix. Nitrite-Nitrogen;

x. Dissolved Reactive Phosphorus;

xi. Total Phosphorus;

xii. Particulate Organic Matter; and

xiii. *E.coli*.

78. Consistent monitoring of point source discharges allows accurate assessments of cumulative effects to be undertaken in a catchment.

79. Proposed consent condition 11 and 12 for the discharge to water consent have proposed monthly monitoring of periphyton for a 12 month period. This monitoring may cease after this time, I'm unsure as to the reason for only a 12 month period. Only one years' worth of monitoring while the discharge application is for 35 years does not allow for any climatic variation to be represented within the monitoring data. Although the point source discharge is only to occur at flows above median flow periphyton will still grow and will be present up to flows at 3x median flow for the Oroua catchment. Monitoring should therefore occur for a minimum of three years at monthly intervals to look at the effects of the discharge on the Oroua River.

L. MANAWATŪ ESTUARY

80. Frequently during these processes the effects of such discharges on the Manawatū Estuary are raised as an issue that needs to be considered.

81. The Manawatū Estuary was declared a Wetland of International Importance under the Ramsar Convention in July 2005 following a nomination from the Royal Forest and Bird Protection Society with the support of the Manawatū Estuary Trust. As part of the on-going responsibility of recognising the estuary as a RAMSAR site there is a need for a management plan to be created between the organisations that are party to the agreement (the current plan is the Manawatū Estuary Management Plan 2015-2025). The organisations that are part of this management plan include representatives from the Department of Conservation, Horizons Regional Council, Horowhenua District Council, the Manawatū Estuary Trust, and iwi. Within the management plan the vision for the Manawatū Estuary is "For the Manawatū Estuary Ramsar site to be sustained, known, respected, and enjoyed as a regional treasure and estuarine ecosystem of international significance".

82. The Ramsar status of the Manawatū Estuary acknowledges the ecological importance of the area as a site for wading birds, its vegetation, and landforms. In addition the Manawatū Estuary is one of the largest estuaries in the lower North Island.

83. The Manawatū Estuary extends inland from the coast to the Whirokino Cut. The Ramsar site includes areas of beach, sand dunes, salt marsh, mud flats, and river channel. The total site covers an area of 558 ha, made up of 386 ha of land (dry land and land that is tidally flooded) and 172 ha of river channel (refer to Map 1 for the area of the RAMSAR site).

84. Being able to model the effects on the Manawatū Estuary of the proposed discharge with current knowledge is impossible. There are multiple factors and processes between the discharge point and the Manawatū Estuary. Processes such as in-river attenuation by periphyton and nutrient spiralling are currently not accounted for in any of the load models that are available. All we are able to say is that any nutrients discharged into Oroua River will cumulatively add to the effects on the Manawatū River and ultimately the coastal environment as the final receiving environment.

M. CONCLUSIONS

85. AFFCO have applied for a resource consent to allow for the discharge of wastewater from their meat processing plant in Feilding to both land and the Oroua River.

86. The discharge to water seeks to increase the overall total load of DRP and SIN to the Oroua River as a result of increases in production at the plant. However, the timing of the discharge will change so that no wastewater is discharged to the Oroua River at flows below median flow at all times of the year and no discharge occurs to the Oroua River during 1 December to 31 March of year (unless certain circumstances occur).

87. The discharge will result in the One Plan annual average DRP target being exceeded in the Oroua River. The discharge will not cause the One Plan annual average target to be exceeded in the Oroua River. Although this needs to be treated with caution as the SIN target of 0.444 g/m^3 was never developed to achieve the periphyton biomass target in the One Plan for the Oroua River. Placing too much reliance on meeting the SIN target in the One Plan and therefore by default being able to meet the periphyton targets may create an unrealistic expectation as to in-river outcomes.

88. The modelling undertaken as part of the application for periphyton growth suggests that the biomass levels (chlorophyll *a*) of periphyton will be well below the target in the One Plan. However, with all models the collection of data is required to valid the outputs from such a model. The removal of the discharge from the Oroua River during April/May when the peak annual periphyton biomass is seen will further reduce the effects on the life supporting capacity of the Oroua River.

89. The application involves the removal of the discharge to the Oroua River during those times that the peak primary contact recreation will occur. However, the discharge adds to the cumulative inputs of *E.coli* to the Oroua River for which the application proposes no reductions in the E.coli concentrations of the wastewater discharged to the Oroua River.

90. The applicant has proposed a number of consent conditions for the discharge to water and land. I have provided comments on these above with an increase in the monitoring frequency, parameters, and sites being the major focus to allow the actual effects of the proposal to be established.

91. The discharge will add to the cumulative effects on the Manawatū Estuary and the coastal environment. However, the current state of scientific knowledge does not allow these effects to be adequately established.

Logan Brown

5 October 2016

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