BEFORE INDEPENDENT HEARING COMMISSIONERS
APPOINTED BY THE NORTHLAND REGIONAL COUNCIL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications by the Far North District Council for resource consents associated with the operation of the East Coast Bays Wastewater Treatment Plant

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STATEMENT OF EVIDENCE OF
DR JAMIE WILLIAM BOOTH MACKAY
ON BEHALF OF FAR NORTH DISTRICT COUNCIL
10 JUNE 2019

INTRODUCTION

1. My name is Jamie William Booth MacKay. I am a Senior Ecologist at Wildland Consultants Ltd, an ecological consultancy company specialising in ecological assessments, ecological restoration, ecological survey and monitoring, and ecological research. I joined the company in March 2014 and in this role I manage projects and provide technical ecological advice and services to a range of clients.

2. I hold the degrees of Bachelor of Science (Honours) in Ecology from the University of Edinburgh (2004), Master of Science (Applied Ecology and Conservation) from the University of East Anglia (2005), and Doctor of Philosophy (Ecology) from the University of Auckland (2011). Prior to this I had two years' experience as a post-doctoral researcher at the University of Auckland and five years' as an ecologist working for a private consultancy.

3. I have considerable experience in monitoring of aquatic ecosystems to determine compliance with consent conditions imposed under the Resource Management Act 1991 (RMA or the Act). I have worked on projects including water abstraction for the Opononi, Rawene, and Kawakawa Water Treatment Plants (Far North District Council - FNDC), wastewater discharge points for the Pahia and Kerikeri Wastewater Treatment Plants (FNDC), and sediment discharge from large-scale developments in Auckland (A&R Earthmovers Ltd and Clayton Fordham Ltd).

CODE OF CONDUCT

4. I have read and agree to abide by the "Code of Conduct for Expert Witnesses" issued by the Environment Court of NZ, Practice Note, 2014. This evidence has been prepared in accordance with that Code. I confirm that I have not omitted to consider material facts that I am aware of that might alter or detract from the opinions that I express and that this evidence is within my area of expertise. The evidence I am giving is within my area of expertise, except where I state I am relying on the opinion or evidence of other witnesses. I understand it is my duty to assist the Commissioner impartially on relevant matters within my area of expertise.

SCOPE OF EVIDENCE

5. My evidence addresses the following:

   a. Summary of the proposal.
   b. Details of field surveys undertaken in July 2014 and February 2015.
   c. Descriptions of four sampling sites.
   d. Ecological values of the receiving environments.
   e. Effects of ammonia on the receiving environments.
   f. Assessment of the suitability of the compliance point for ongoing monitoring.
   g. Conclusions.

6. My evidence is supported by the following document that was prepared in support of the application:

   a. The ecological assessment prepared by Wildland Consultants Limited (**Wildlands**)

7. The ecological assessment was prepared in April 2015. Given the age of document and its data, I reserve the right to reconsider my evidence should the applicant, the Council or submitters present more recent data at the hearing

8. I have not visited the Taipa Wastewater Treatment Plant and this evidence is based on the ecological assessment prepared by Wildlands for FNDC in 2015. A site visit is scheduled for 24 June 2019 and I reserve the right to reconsider my evidence should changes have occurred at the sites since the report was prepared.

SUMMARY OF THE PROPOSAL

8. Far North District Council (FNDC) has sought resource consent for the discharge of wastewater to water and land, as well as discharges to air for the WWTP. These consents have been sought for a 25-year duration.

9. This current application package is an interim solution while longer-term treatment and disposal options are evaluated by FNDC. These evaluations will also need to consider the ability of the community and FNDC to both fund the construction of any new assets and also to operate them.

10. A total volume of 1,570 m^3 of treated wastewater will be discharged daily to an unnamed tributary of the Parapara Stream. This in an increase from the existing consent which allows for 1,005 m^3 (based on dry weather flows). I understand that this increased in discharge volume is to allow the WWTP to serve the projected population growth within the local area (a population growth rate of 2% per annum is quoted in the AEE).

11. This evidence covers:

    a. An assessment of the habitat quality at the current compliance point (Northland Regional Council Sample Site 5941). This assessment demonstrates that aquatic habitat at the ammonia compliance point is capable of supporting the aquatic fauna that the ammonia limits imposed by the resource consent are intended to protect.
    b. An assessment of an alternative compliance point in the receiving catchment.
    c. A recommendation on whether the existing or alternative compliance point should be selected for future monitoring of ammonia limits.

SURVEY METHODS

12. Field surveys were undertaken by Dr Tim Martin and Mr Peter Crossley (Wildland Consultants Ltd) on 25 July 2014 during winter high-flow conditions and by Dr Tim Martin and Ms Melissa Marler (Wildland Consultants Ltd) on 20 February 2015 during summer low-flow conditions. Aquatic habitats were described for the following sites (mapped in Appendix 1):

    a. Site 1: the discharge flow path.
    b. Site 2: the receiving drain immediately upstream of its confluence with the discharge flow path.
    c. Site 3: the receiving drain immediately downstream of its confluence with the discharge.
    d. Site 4: the stream into which the receiving drain flows, *c*.650 m downstream of the compliance point at the Parapara Road bridge.

13. During the winter and summer assessments, four Gee minnow traps baited with bread and marmite were deployed at Site 4. During the summer assessment, Gee minnow traps were also deployed further upstream: three in the discharge flow path and three in the reach immediately below the confluence. Kick-netting was also undertaken at all

study sites to assess fish populations, as low water levels during the summer survey made the setting of traps difficult. All fish captured were identified and released.

14. Macroinvertebrates were also sampled at all sites in summer using standard New Zealand macroinvertebrate sampling protocols: a pole kick-net with a 0.5 mm mesh (c.f. Stark *et al.* 2001)[1]. Samples were preserved in ethanol for later analysis. Macroinvertebrates were identified to the level required for the Macroinvertebrate Community Index (MCI) as per Boothroyd and Stark (2000)[2] and Stark *et al.* (2004)[3].

15. Fish species captured at each site and MCI scores are summarised in Appendix 2.

SITE 1 - THE DISCHARGE FLOWPATH

16. The discharge flow path flows in a westerly direction until it reaches its confluence with a farm drain. This reach is fenced to exclude livestock, and is partly shaded by steep banks, overhanging rank grass, and aquatic macrophytes in the stream channel.

17. On 25 July 2014, the discharge flow path comprised runs, riffles, and pools with slow to moderate water flow. Average wetted width was *c*.1 metre, and water depth was 0.2-0.8 metres. The substrate was fine mud and silt. Where the adjacent stream banks were steep, short sections were undercut. The exotic macrophyte water pepper was common, forming dense patches along the channel edges. The discharge flow path supported an abundant population of inanga and common bully, with up to seven inanga and 12 common bullies caught within each 4-5 metre reach. One large longfin eel, *c.*1.5 metres in length, was caught several metres upstream of the confluence within the farm drain.

18. On 20 February 2015, the channel comprised runs and pools with very little flow. Wetted width was 0.5-1 metres, and water depth was 0.1-0.6 metres. The substrate was fine mud and silts, and the entire channel was densely choked by water pepper. Kick-netting was difficult due to the abundance of water pepper and minimal water flows, and no fish were caught using this method. One shortfin eel was caught in a

[1] Stark J.D., Boothroyd I.K.G., Harding J.S., Maxted J.R., and Scarsbrook M.R. 2001: Protocols for sampling macroinvertebrates in wadeable streams. *New Zealand Macroinvertebrate Working Group Report No. 1*. Prepared for Ministry for the Environment, Wellington, New Zealand. 57 pp.

[2] Boothroyd I and Stark J. 2000: Use of invertebrates in monitoring. Chapter 14 in *New Zealand Stream Invertebrates: Ecology and Implications for Management.* Edited by Collier K.J and Winterbourn M.J. Caxton Press, Christchurch. 415 pp.

[3] Stark J.D. and Maxted J.R. 2004: Macroinvertebrate community indices for Auckland's soft-bottomed streams and applications to SOE reporting. *Cawthron Report No. 970*. Prepared for the Auckland Regional Council by the Cawthron Institute. 66 pp.

Gee minnow trap. The MCI score was 74.1, indicative of poor water quality, or "probable severe pollution".

SITE 2 - DRAIN UPSTREAM OF CONFLUENCE WITH DISCHARGE

19. Immediately upstream of its confluence with the discharge flow path, the drain runs parallel to a cattle race. The drain is unfenced on its true right (the side with the race).

20. On 25 July 2014, the channel immediately upstream of the confluence with the discharge flow path had low to moderate flow and included runs and riffles. Wetted width was 1-2 metres, with a water depth of 0.2-0.6 metres. The channel was partly shaded by patches of water pepper. Inanga and common bully were present. Fewer fish were caught than in the discharge flow path, which may be due to the absence of pools. Eels are also likely to be present, at least during higher winter and spring flows.

21. On 20 February 2015, surface water in the drain above the confluence was restricted to a few shallow pools 2-5 centimetres deep. The channel bed was choked with dense growth of water pepper. No fish were recorded and macroinvertebrates were not sampled.

SITE 3 - DRAIN DOWNSTREAM OF CONFLUENCE WITH DISCHARGE

22. This reach also runs parallel to the cattle race, and is also unfenced on its true right (the side with the race).

23. On 25 July 2014, the channel had slow to moderate flow and included pools and riffles. Wetted width was 1-2 metres with a water depth of 0.3-1.0 metres. Water pepper covered 0.5-1.0 metres of the width of the stream channel. Common bullies and inanga were present. Higher numbers were present compared to Site 2 but fewer than Site 1. Eels are also likely to be present.

24. On 20 February 2015, the channel had very low flow and included runs and pools. Wetted width was 1-2 metres with a water depth of 0.1-1.0 metres. Water pepper covered the entire channel except for the deepest. Gambusia (mosquitofish) were abundant in the pools, and inanga were present in the pools in low numbers. One inanga was caught. The MCI score was 80.0, indicative of fair water quality, or "probable moderate pollution".

SITE 4 - STREAM BY PARAPARA ROAD BRIDGE

25. On 25 July 2014, the stream included runs, riffles, and pools. Flow was detectable in the shallow runs and riffles, but not in the pools. Upstream of the bridge, where the stream flows through pasture, wetted width was 1-3 metres, water depth was 0.3-1.0 metres, and water pepper covered 0.5-1.0 metres of the stream width.

26. Under the Parapara Road bridge and further downstream, livestock are excluded from both banks. The stream is shaded by overhanging vegetation and steep banks, and there are several pools of unknown depth. The stream at this location supported an abundant population of inanga, and common bully. Numerous inanga were captured and eels are also likely to be present. This stream is likely to also act as a migration pathway for other species of fish such as banded kōkopu whose larvae hatch in freshwater, are swept out to sea with the downstream currents and tide, and return to rivers and streams in spring.

27. On 20 February 2015, the stream included shallow runs and pools with low flow. Wetted width was 1-3 metres, water depth was 0.2-1.0 metres, and except for the deepest pools. Water pepper covered the entire channel. Inanga, gambusia, and koi carp were present in the pool under the Parapara Road bridge. The MCI score was 50.5, the lowest of the three MCI sites, and indicative of poor water quality, or "probable severe pollution".

ECOLOGICAL VALUES OF THE RECEIVING ENVIRONMENTS

28. The Taipa WWTP discharge empties into a drain and stream that flow through a highly modified catchment. In addition to the wastewater discharge, run-off of stock effluent into the waterways, grazing along the banks of the watercourses, and a lack of overhead shade are likely to contribute to poor water quality in the receiving environment. Overall, the ecological values of the receiving watercourses, relative to other streams in the Far North District, are low.

29. The aquatic habitats of the receiving environment are subject to pronounced seasonal changes. During the wetter winter months, the discharge is diluted in the receiving environment by the combined flows of other drains and streams. Under these conditions the discharge flow path, the receiving drain, and the stream further down in the catchment support populations of at least three indigenous fish species: common bully, inanga, and longfin eel. Other species, such as banded kōkopu, are also likely to

either be resident, or migrate through these reaches as they move between the sea and headwater streams. Two of these fish species, inanga and longfin eel, are classified as “At Risk-Declining”. These species are still widespread, but numbers are in decline nationally due to factors such as overfishing, habitat degradation and loss, and migration barriers. The Parapara Stream and its tributaries therefore provide habitat, at least during the wetter winter months, for at least two indigenous freshwater fish species of conservation concern. During the drier summer months, when the discharge accounts for most, if not all, of the flow in the receiving drain and stream, water quality is fair or poor and fish populations are much reduced. Whilst two indigenous fish species, inanga and shortfin eel, persist in the receiving environment during summer low flows, few were seen or caught during the February survey.

30. Based on the MCI scores for the three sites sampled in February 2015, water quality, and associated aquatic habitat values, decline from the compliance point in a downstream direction. This is likely to be attributable to grazing of the banks of the watercourse by cattle, and potential input of effluent from a dairy shed oxidation pond.

31. Mr Ben Tait notes in the Northland Regional Council notified Staff Report that the land is no longer being used as a dairy farm; however, no comment is made in the report about the current state of the dairy shed oxidation pond.

EFFECTS OF AMMONIA ON THE RECEIVING ENVIRONMENT

32. Ammonia concentrations in lowland streams can fluctuate dramatically over short time periods due to changes in pH, temperature, and the input of ammoniacal nitrogen. Richardson (1997) tested the acute toxicity of ammonia to seven New Zealand freshwater fish species, including the three species confirmed as present at the compliance point by this study. No lethal or sub-lethal effects occurred for any New Zealand fish species after exposure for one hour to ammonia concentrations of *c*.2 mg/L. This can be regarded as the ideal maximum concentration for ammonia, because it would result in no adverse effects on freshwater fish.

33. Ammonia concentrations of up to 0.4 mg/L are common for lowland streams which pass through agricultural land. In comparison, ammonia concentrations for the compliance point for the period April 2009-March 2010, averaged 1.1 mg/L.

34. In dry conditions, the ammonia concentrations at the compliance point can be similar to the discharge from the treatment plant. In February 2015, ammonia concentrations

ranged from 17-20 mg/L for the discharge flow path, and 8-8-13 mg/L at the compliance point. High concentrations of ammonia at the compliance point is expected in dry conditions, as little or no mixing of the discharge occurs until it reaches confluences with flowing streams further down the catchment.

35. During the winter months, water volumes within the receiving environment are much higher, and consequently there is more mixing of the discharge with the receiving waters. Minor peaks in ammonia can occur at the compliance point, with concentrations frequently between 1-2 mg/L, but these peaks are below the levels at which lethal or sub-lethal effects would be expected (Richardson 1997). It is probable that fish, including inanga, common bully, and eels, are present at the compliance point during high flows.

36. Background levels of ammonia are also monitored at the settlement of Parapara, upstream of where the discharge tributary meets the Parapara Stream. Trends and peaks in ammonia concentration appear to be closely correlated with concentration at the compliance point. However, the similarity in trends between the compliance point and the Parapara Stream upstream of the discharge, are likely to be caused ammonia being concentrated during low flow conditions throughout the catchment. Upstream at Parapara, this may possibly be caused by inflows from septic tanks within the settlement. Whilst the discharge is a significant source of ammonia, the Parapara Stream receives ammonia from multiple sources other than the wastewater treatment plant.

37. A dairy shed oxidation pond is located *c*.200 metres downstream of the compliance point and when effluent is being discharged from the pond, ammonia concentrations are likely to be much higher in the stream as effluent ammonia can frequently exceed 360 mg/L (Hickey and Vickers 1994)[4]. Below the dairy shed oxidation pond, aquatic life in the watercourse may be limited by ammonia toxicity from both the discharge from the wastewater treatment plant and the dairy oxidation ponds. As noted above however, the farm is no longer a dairy farm and there may no longer be ammonia input from the effluent ponds.

38. Ammonia concentrations in excess of 10 mg/L, coupled with stagnant or low flow conditions, are likely to explain the marked decrease in the abundance of inanga and the absence of common bully (refer to Table 1) during low summer flows. It is unknown

[4] Hickey C.W. and Vickers M.L. 1994: Toxicity of ammonia to nine native New Zealand freshwater invertebrate species. *Archives of environmental contamination and toxicology 26*: 292-298

whether the fish present during the wetter winter months die during low-flow peaks in the concentration of ammonia, or move to more suitable habitats downstream. However, based on MCI scores, water quality was at its lowest *c*.650 metres downstream of the compliance point, where the receiving stream passes under the Parapara Road bridge. Therefore, opportunities for fish to survive adverse conditions at the compliance point by moving elsewhere in the catchment may be limited.

39. Although beyond the scope of this study, the toxic effects of ammonia on macroinvertebrates should be acknowledged, given their critical role in aquatic ecosystems. For instance, Hickey and Vickers (1994) tested the toxicity of ammonia on nine indigenous macroinvertebrate species, the four most sensitive of which yielded a final acute value of 0.15mg/L. This level is lower than the current compliance limit of 0.18mg/L and significantly lower than the lethal doses of ammonia for eels, inanga, and common bully.

ASSESSMENT OF THE COMPLIANCE POINT

40. The existing compliance point provides habitat during higher winter flows for several indigenous freshwater fish species, two of which are classified as "At Risk-Declining". Indigenous fish species are also present at the compliance site during low summer flows, albeit in much lower numbers. Therefore, the aquatic habitat at the ammonia compliance point supports fauna that the ammonia limits imposed on the resource consent are intended to protect. Furthermore, the compliance point had the best MCI score (and therefore potentially the best quality fauna habitat) of the three sites sampled.

41. During the wetter winter months, flow in the receiving drain increases substantially when it meets a tributary *c*.160 metres downstream of the compliance point. However, two dairy shed oxidation ponds are located on the stream banks near the confluence. An alternative compliance point here or further downstream at the Parapara Road bridge would mean that the compliance data would be confounded by inputs from this tributary and associated dairy shed effluent.

42. The existing compliance point should be retained. However, it should be acknowledged that, during low flow conditions, little or no dilution of the discharge occurs upstream of Parapara Road. Any site that allows for dilution of the discharge at all times would receive pollutants from multiple sources other than the wastewater treatment plant.

CONCLUSION

43. Aquatic habitats of the Taipa WWTP discharge and its receiving environment were surveyed during high flow conditions in July 2014 and low flow conditions in February 2015. During high winter flows, longfin eel, inanga and common bully were recorded in the discharge flow path. Inanga and common bully were found in the receiving drain both upstream and downstream of the confluence of the discharge flow path. During low summer flows, one shortfin eel was recorded in the discharge flow path. Inanga were present in the discharge flow path and the receiving drain downstream of the confluence. The MCI scores for summer low flows indicated that all of the sampled sites were polluted, and that the degree of pollution increased between the compliance point (Site 3) to where the stream passes under Parapara Road (Site 4) *c.*650 metres downstream of the compliance point.

44. All of the fish species confirmed as being present in the receiving environment are susceptible to ammonia toxicity at levels much less than the ammonia concentrations of the discharge during low flow conditions (10-20 mg/L). To ensure the freshwater fish species present at the compliance site are unaffected by the discharge, the ammonia concentrations, post-mixing with the drain, would need to be less than 2 mg/L. The greater abundance of inanga in July 2014, and the presence of common bully, is likely to be attributed to reduced ammonia concentrations during the high flow conditions. However, the volume of flow in itself, which influences the availability of open water habitat, is also likely to affect fish populations to some degree.

45. Potential alternative ammonia compliance points in the receiving environment were assessed. An ideal compliance point would have the following characteristics: permanent flow, populations of species sensitive to ammonia toxicity, and only receiving ammonia from the WWTP discharge. No alternative site met all of these requirements. Any compliance point located further downstream would be subject to fluctuations in ammonia concentrations sourced from the WWTP and also the adjacent dairy farm, and dairy oxidation ponds.

46. The existing ammonia compliance point should be retained, with monitoring of ammonia levels to occur during the wetter winter months. This is when the receiving environment is known to have sufficient flows to dilute the ammonia in the WWTP discharge.

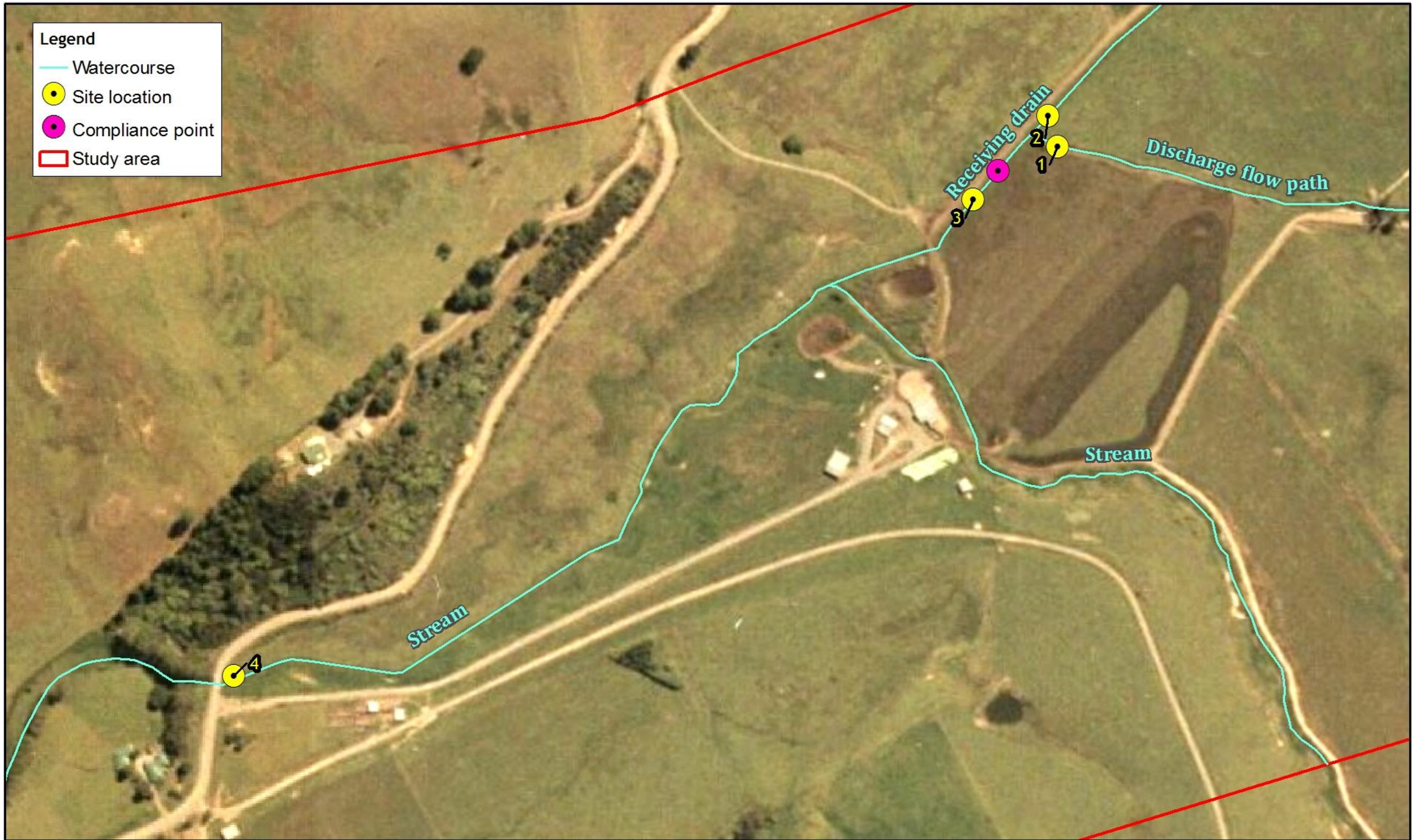
47. Overall, I consider that the proposed discharges can be granted consent, subject to the conditions recommended by the Council.

Dr Jamie William Booth MacKay
Senior Ecologist
Wildland Consultants Limited

10 June 2019

ATTACHMENTS

Appendix 1: Location of sample sites
Appendix 2: Results summary table



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Data Acknowledgment

Imagery from MFE 2000

Report: 3458
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Figure 1. Taipa WWTP discharge and receiving environment

0 100 200 m

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Scale: 1:3,500
Date: 29/08/2014
Cartographer: KM
Format: A4R

Site	Season	Description	Fish species present	MCI score	MCI interpretation
Site 1	Winter	Discharge flowpath	Inanga, common bully, longfin eel	n/a	n/a
	Summer		Shortfin eel	74.1	Poor, probable severe pollution
Site 2	Winter	Drain upstream of confluence with discharge	Inanga, common bully	n/a	n/a
	Summer		none	n/a	n/a
Site 3	Winter	Drain downstream of confluence with discharge	Inanga, common bully	n/a	n/a
	Summer		Inanga, gambusia	80	Fair, probably moderate pollution
Site 4	Winter	Stream by Parapara Road Bridge	Inanga, common bully	n/a	n/a
	Summer		Inanga, gambusia, koi carp	50.5	Poor, probable severe pollution