Date: 30 April 2024

Subject: **Urenui stormwater investigation (2019 – 2022)**

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Document: 3256830

Purpose

1. The purpose of this memorandum is to provide the Committee with an overview of the Urenui stormwater investigation carried out between 2019 and 2022, including a summary of the findings.

Executive summary

2. In August 2019, water samples collected by staff from Te Rūnanga o Ngāti Mutunga (Ngāti Mutunga) and Taranaki Regional Council (TRC) found evidence of sewage contamination in two waterways in the lower Urenui township, discharging into the Urenui Estuary. These findings initiated a joint response between Ngāti Mutunga, TRC, New Plymouth District Council (NPDC) and Te Whatu Ora (TWO), in order to investigate the source of the pollution, assess the broader public health risk, and ultimately work towards rectifying the issue.
3. Extensive investigations were carried out to locate and eliminate direct contamination sources. Four significant contamination sources were located; two discharging into the Ngakoti Street stormwater network and two discharging into the Whakapaki Street modified stream. All four contaminant sources were removed. No further direct contaminant sources were conclusively identified.
4. All reasonable and practicable steps were taken as part of this investigation to identify and resolve the contamination. However, despite the elimination of all identified sources, further faecal source tracking carried out in November 2022 showed evidence of ongoing contamination of the affected waterways. Given the presence of human faecal indicators, the cumulative effects of septic tank discharges infiltrating underground drainage pipes and adjacent surface water bodies, potentially via shallow groundwater in some areas, are the most likely source.
5. It is anticipated that the removal of the four identified contaminant sources will have had a positive impact on water quality, relative to the level of pollution that was likely occurring prior to 2019. Due to limited sampling, it is not possible to confidently determine whether contaminant concentrations have significantly reduced in response to those interventions. However, the available data indicate improved water quality with reduced concentrations of *Escherichia coli (E. coli)*, ammoniacal nitrogen and electrical conductivity observed in both waterways.
6. While further works to address other sources are possible, it is difficult to ascertain whether additional interventions will lead to measurable reductions in contamination. Some interventions may generate issues with drainage and surface flooding; these would need to be carefully managed.

7. Based on observations made throughout the course of this investigation in conjunction with the recent faecal source tracking test results, it appears unlikely that septic tank wastewater contamination in Urenui could be completely eliminated without fundamental changes to the way in which wastewater from the township is treated and disposed of.
8. Wastewater discharge provisions are currently under review as part of the Land and Freshwater Plan development process. Over the coming months, TRC will be working with district councils, iwi and the broader community to ensure discharges such as these are managed appropriately to reduce their environmental impact throughout the region.

Recommendations

That Taranaki Regional Council:

a) receives the Urenui stormwater investigation memorandum

b) notes the findings therein.

Background

9. In August 2019, staff from Ngāti Mutunga and TRC collected water samples to test for evidence of septic tank wastewater discharging into the Urenui Estuary, as part of a Curious Minds citizen science project: Te Āhua o Ngā Kūrei - Ngāti Mutunga Estuary Project[1]. This investigation was in response to questions raised by members of the Urenui community around the possibility of septic tanks in the lower township discharging wastewater into the estuary.
10. Samples were collected from the Punawhakakau Stream, the Whakapaki Street modified stream, and the Ngakoti Street stormwater network (as shown in Figure 1, below). These locations were chosen because the stream and stormwater networks were located in close proximity to numerous properties in the lower township and therefore presented potential flow paths for wastewater to reach the estuary.

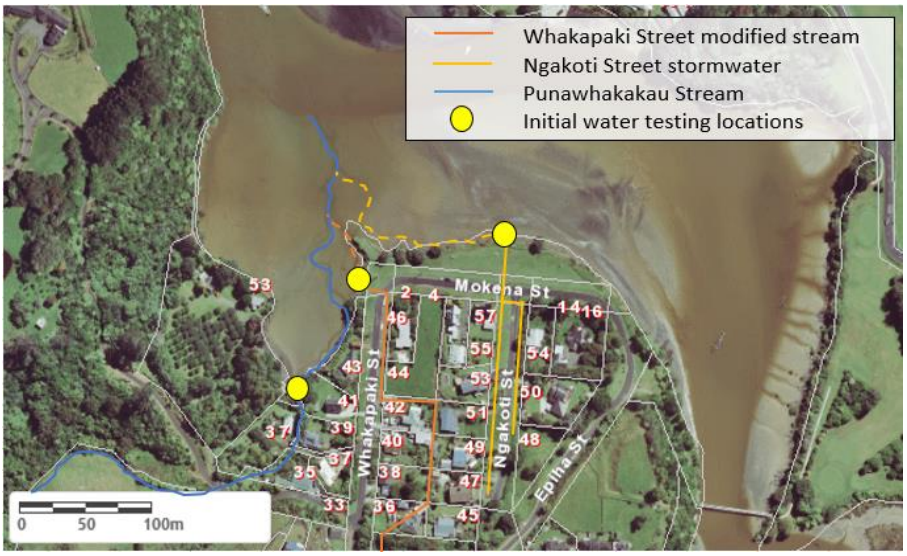

Figure 1 The Lower Urenui Township, with the Punawhakakau Stream (blue), Whakapaki Street modified stream (orange) and Ngakoti Street stormwater network (yellow). Sample locations shown as yellow dots.

[1] An agenda item covering off the broader findings of this project was presented to the Policy and Planning Committee by staff from Te Rūnanga o Ngāti Mutunga and TRC in June 2020.

11. The testing was completed in two stages; samples were first tested for *E. coli* as a general indicator of faecal pollution. If the results were sufficiently high, additional testing was carried out to determine the specific source(s) of faecal pollution using advanced source tracking analyses. The second phase of testing included the Whakapaki Street modified stream and the Ngakoti Street stormwater samples.
12. The results showed strong evidence of sewage contamination in the modified stream and the Ngakoti Street stormwater network, both sourced from the lower township area (document 3263704). It was determined that *E. coli* numbers in the Punawhakaku Stream were low and did not warrant further testing.
13. These findings prompted a joint response between TRC, Ngāti Mutunga, New Plymouth District Council (NPDC) and Te Whatu Ora (TWO), in order to investigate the source of the pollution, assess the broader public health risk, and ultimately work towards rectifying the issue.

Discussion

Joint response

14. In order to identify options for investigating and remediating the contamination issue, a working group was established with staff from TRC, NPDC and TWO. A steering group was also established with staff from the same agencies and representatives from Ngāti Mutunga in order to retain oversight of the project and provide direction where key decisions were required.
15. Locating the contamination source(s) was a key priority, with the employment of a range of investigative survey methods.
16. NPDC carried out inspections at 32 properties in the lower township. These inspections included risk assessments of septic systems based on proximity to waterways, septic tank specifications, site drainage and flooding susceptibility, and other factors. The findings of these inspections helped to narrow down the investigation area, and prompted the working group to seek further information from some property owners where necessary.
17. TRC carried out further water testing along the Whakapaki Street modified stream and Ngakoti Street stormwater network in order to narrow down the source of the contamination. Between August 2019 and November 2022, water testing surveys were carried out on 22 separate occasions. Additional water testing was also carried out by NPDC. TRC also carried out an assessment of property compliance with respect to Rule 22 in the Regional Freshwater Plan for discharges from on-site domestic wastewater systems.
18. NPDC engaged a contractor to carry out comprehensive CCTV surveys of the Ngakoti Street stormwater network and the piped section of the Whakapaki Street modified stream. As-built schematics were produced which highlighted undocumented underground pipework connections which prompted further investigation.
19. Ngāti Mutunga placed a rāhui on the estuary advising people not to collect shellfish, swim in the estuary or walk on the mudflats.
20. A public health risk assessment for the estuary was undertaken by TWO, and corresponding warning signage was installed by NPDC. This included advising people to avoid collecting shellfish from the estuary, and to avoid the mudflats on the township side of the river.
21. The working group developed information packs and held community open days in order to engage with the community and provide education on managing domestic septic tank systems for optimal performance and reduced environmental risk.

Key interventions

22. The investigation discovered four direct, or semi-direct sources of septic tank wastewater discharging into surface waters and piped drainage in the lower township.

23. The first source originated from a property with an old, undersized septic tank which was piped directly to an adjacent waterway. TRC issued an Abatement Notice to the property owner to cease the discharge and a new system was subsequently designed and installed.
24. The second source was located on a property where the effluent field had been directly connected to a piped waterway. The effluent field was disconnected and the pipe was sealed.
25. The third source was associated with a cracked and flooded stormwater pipe located in close vicinity to the effluent field in an adjacent property. Water testing results indicated that contaminated groundwater was infiltrating this section the stormwater network. Further assessment of the network found that this particular section had become obsolete and redundant. As a result, the pipe was decommissioned and sealed off from the rest of the network.
26. The fourth source was associated with a stormwater sump located on private property which was connected to the street stormwater network. This sump was not sealed, and was collecting water from numerous underground pipes. Results of high frequency conductivity measurements and discrete water quality samples provided strong evidence that septic tank wastewater was entering this sump via one or more of the pipes. This sump was replaced and the pipes of concern were disconnected.
27. Although there was no evidence linking NPDC's Yandle Park public toilet block to any surface water contamination, the effluent disposal system was upgraded as a precautionary measure.
28. Despite extensive investigations, no further sources were conclusively located. However, numerous potential pathways were identified that may have been contributing to the problem.
29. Infiltration of sub-surface flow and shallow groundwater into underground pipes appeared to be a likely contaminant pathway. The Whakapaki Street modified stream originates from a spring in Rattenbury Park, and as such, continual flow discharging from this outlet is not unexpected. However, the year-round flow of water discharging from the Ngakoti Street stormwater network highlights the infiltration of groundwater either as seepage from the grassed swale at the top of Ngakoti Street, sub-surface drainage connections from private properties, and potentially through cracks and broken joins in the network itself. Water was also observed entering the Whakapaki Street modified stream via similar pathways.

Water quality results

30. In November 2022 (following the completion of the interventions described above), water samples were collected and analysed for the same faecal source tracking markers that were originally tested for in August 2019 as a means of assessing whether the investigation and associated interventions had managed to eliminate all sources of septic tank wastewater contamination.
31. Analysis of the faecal source tracking samples showed evidence of ongoing human faecal contamination in the Ngakoti Street stormwater network and Whakapaki Street modified stream (document 3263705). Of the two faecal source tracking methods that were undertaken at the outset of the investigation, the faecal sterol results indicated that human faecal content in both waterways was lower in 2022 compared to the 2019 results. There was also evidence of other faecal sterol sources present in both waterways (i.e. ruminant, avian and plant decay). Results of the fluorescent whitening agent (FWA) test method suggested that wastewater sources were distant and/or diluted by the time they discharged from the two outlets.
32. It is important to interpret these results with caution. Although they do reliably confirm that septic tank wastewater contaminants were still present in both waterways, these results alone cannot be used to infer whether contamination levels had changed meaningfully between 2019 and 2022, given that these samples only depict water quality at two points in time.
33. The ongoing water testing that took place throughout the investigation assessed concentrations of *E. coli*, enterococci, ammoniacal nitrogen, oxidized nitrogen and electrical conductivity as general markers of wastewater contamination (document 3257411). Although these markers were tested on multiple occasions, the same caveat mentioned above also applies to these results as the sample size is limited

and the results only provide snapshots of contaminant concentrations at the time the samples were collected.

34. With this in mind, the maximum concentrations of these markers in the recent samples collected downstream of the contamination zone were generally lower than those collected prior to the intervention measures. Maximum *E. coli* concentrations were an order of magnitude lower than those in the earlier samples. In the Whakapaki Street modified stream, maximum enterococci concentrations were three orders of magnitude lower. Reduced concentrations in ammoniacal nitrogen and electrical conductivity were also observed.
35. It is also important to note that while these general test methods are useful markers of wastewater contamination, *E. coli* and enterococci are associated with faecal matter from a range of warm blooded animals, including cows, sheep, birds, and possums, and it is not unexpected to have occasional elevated counts of *E. coli* detected in urban stormwater and streams. Therefore, the numbers of faecal bacteria present in water discharging from the two outlets may not always be attributed to domestic wastewater sources. Paired faecal source tracking analyses are necessary to make this distinction.
36. Measured and modelled flow rates of the Whakapaki Street modified stream, Ngakoti Street stormwater outlet, Punawhakakau Stream and Urenui River provide an indication of dilution and mixing potential of these outlet discharges in the receiving waters (document 3257411).
37. Based on field observations, the Whakapaki and Ngakoti street outlet discharges tended to converge with the Punawhakau Stream before joining the Urenui River approximately 300 metres from the coast.
38. At low tide and under median flow conditions, the estimated dilution factor of the combined outlet flow mixing with the Punawhakakau Stream is approximately 1:11 (one part outlet flow to 11 parts stream flow). The estimated dilution factor of the combined outlet flow mixing with the Urenui River is approximately 1:1,228 (one part outlet flow to 1,228 parts river flow). Mixing and dilution potential is greater at high tide when the estuary is inundated with seawater.
39. Previous recreational water quality monitoring results from samples collected near the river mouth during high tide and fine weather conditions found consistently low levels of faecal indicator bacteria (TRC, 2020).
40. Following revision of the recreational water quality monitoring programme in 2021 to collect samples on a fixed day of the week irrespective of weather and tide, results have shown much higher levels of faecal indictor bacteria (TRC, 2023; https://www.lawa.org.nz/explore-data/swimming/). These results reflect the influence of preceding rainfall and the resulting run-off of contaminants from throughout the catchment (consistent with results observed elsewhere in the region), as well as the effects of variable tidal inundation.
41. The public health risk assessment was updated by TWO in September 2023. The review recommended retaining the original public health advice due to the evidence of ongoing contamination. Ngāti Mutunga also reviewed and updated the rāhui to align with this advice.

Conclusions

42. In August 2019, faecal source tracking analyses found evidence of septic tank wastewater contamination in the Ngakoti Street stormwater network and Whakapaki Street modified stream prior to discharging into the Urenui Estuary. It is not known how long the contamination had been occurring prior to its discovery.
43. Extensive investigations were carried out to locate and eliminate direct contamination sources. Four significant contamination sources were located; two discharging into the Ngakoti Street stormwater network and two discharging into the Whakapaki Street modified stream. All four contaminant sources were removed. No further direct contaminant sources were conclusively identified.
44. All reasonable and practicable steps were taken as part of this investigation to identify and resolve the contamination. However, despite the elimination of all identified sources, further faecal source tracking carried out in November 2022 showed evidence of ongoing contamination of the affected waterways.

Given the presence of human faecal indicators, the cumulative effects of septic tank discharges infiltrating underground drainage pipes and adjacent surface water bodies, potentially via shallow groundwater in some areas, are the most likely source.

45. It is anticipated that the removal of the four identified contaminant sources will have had a positive impact on water quality, relative to the level of pollution that was likely occurring prior to 2019. Due to limited sampling, it is not possible to confidently determine whether contaminant concentrations have significantly reduced in response to those interventions. However, the available data indicate improved water quality with reduced concentrations of *E. coli*, ammoniacal nitrogen and electrical conductivity observed in both waterways.
46. While further works to address other sources are possible, it is difficult to ascertain whether additional interventions will lead to measurable reductions in contamination. Some interventions may generate issues with drainage and surface flooding; these risks would need to be carefully managed.
47. Based on observations made throughout the course of this investigation in conjunction with the recent faecal source tracking test results, it appears unlikely that septic tank wastewater contamination in Urenui could be completely eliminated without fundamental changes to the way in which wastewater from the township is treated and disposed of.
48. Wastewater discharge provisions are currently under review as part of the Land and Freshwater Plan development process. Over the coming months, TRC will be working with district councils, iwi and the broader community to ensure discharges such as these are managed appropriately to reduce their environmental impact throughout the region.

Financial considerations—LTP/Annual Plan

49. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

50. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the Local Government Act 2002, the Resource Management Act 1991 and the Local Government Official Information and Meetings Act 1987.

Iwi considerations

51. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the Local Government Act 2002) as outlined in the adopted Long-Term Plan and/or Annual Plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Community considerations

52. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

53. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

References

TRC, 2020: Freshwater contact recreational water quality at selected Taranaki sites. State of the Environment Report Summer 2019-2020. Technical Report 2020-01.

TRC, 2023: Can I Swim Here? 2022-2023 Report Card.

Appendices/Attachments

Document 3257411: Key water testing results from the Urenui stormwater investigation

Document 3263704: Urenui Faecal Source Tracking Analysis Report 2019

Document 3263705: Urenui Faecal Source Tracking Analysis Report 2022

Urenui stormwater investigation - key water testing results (2019-2022)

Table 1: Explanation of water quality parameters as wastewater markers

Water quality parameter	Description
Electrical conductivity	Electrical conductivity (EC) is a measure of how well water conducts electricity. EC specifically provides an indication of the amount of dissolved salt or solid material in the water; with pure water being a poor conductor of electricity. Conductivity increases as the amount of dissolved salt increases. Wastewater typically contains elevated dissolved salt content compared to freshwater during base flows. Therefore, in some circumstances EC can be a useful marker of dilute wastewater contamination in fresh water bodies. See the following website for more information on electrical conductivity (https://www.lawa.org.nz/learn/factsheets/groundwater/electrical-conductivity/).
Ammoniacal nitrogen	Ammoniacal nitrogen (NH4-N), also often called 'ammonium', is the concentration of nitrogen present as either ammonia (NH3) or ammonium (NH4). Ammoniacal forms of nitrogen enter waterways primarily through point source discharges, such as raw sewage or dairy shed effluent. It is toxic to aquatic life at high concentrations.
Nitrate + Nitrite nitrogen	Nitrate and nitrite nitrogen are two forms of oxidized nitrogen. In soil and water, ammonia is sequentially converted into nitrite and then nitrate via an oxidative process called nitrification. The relative concentrations of nitrite present in water are generally much lower than nitrate. Nitrate can also become toxic to aquatic life at high concentrations. In this investigation, elevated concentrations of ammoniacal nitrogen relative to nitrate nitrogen were used as another marker of wastewater contamination. See the following website for more information on nitrogen and its different forms (https://www.lawa.org.nz/learn/factsheets/nitrogen/).
E. coli	*Escherichia coli* (*E. coli*) is a species of bacteria which is commonly used as a general marker of faecal contamination in aquatic environments. *E. coli* occur naturally in the intestinal tracts of warm-blooded animals and are therefore indicative of faecal contamination from a range of animals including livestock, birds, and humans. See the following website for more information on faecal indicator bacteria (https://www.lawa.org.nz/learn/factsheets/faecal-indicators/).
Enterococci	Enterococci are a group of bacteria which are also commonly used as a general marker of faecal contamination in aquatic environments. Enterococci are indicative of faecal contamination from warm blooded animals, but some species can also be isolated from the environment in the absence of faecal contamination (e.g. in soils and vegetation), and therefore this marker is less-specific to faecal sources. See the following website for more information on faecal indicator bacteria (https://www.lawa.org.nz/learn/factsheets/faecal-indicators/).
Faecal sterols	Faecal sterols are compounds that are present in animal faeces which are related to the diet of the animal. The ratios of various faecal sterols detected in a water sample provide evidence as to whether faecal contamination can be attributed to humans or other animals. See the attached faecal source tracking reports for further information on interpreting faecal sterol testing results.
Fluorescent whitening agents	Fluorescent whitening agents (FWAs) are chemical compounds commonly found in laundry powders. The presence of FWAs in water above certain concentrations is indicative of wastewater contamination. See the attached faecal source tracking reports for further information on interpreting FWA testing results.

Table 2: TRC Urenui investigation water testing results – Whakapaki Street modified stream (upstream of contaminant sources)

Location	Intervention timeline	Sample	Collected	Time	Discharge rate	Temp.	Electrical Conductivity (EC)	Escherichia coli	Enterococci	Total Ammoniacal N	Nitrate N + Nitrite N
					L/s	°C	mS/m	no. / 100 mL	no. / 100 mL	g/m³	g/m³
Site A (WHA U/S)	n/a	TRC201424	22 May 2020	13:35	n/a		18.3	60	370	< 0.010	1.54
Site B (WHA U/S)	n/a	TRC201960	02 Jul 2020	11:21		12.0	18.1	10	< 10	< 0.010	1.71
Site A (WHA U/S)	n/a	TRC201963	02 Jul 2020	11:52	n/a	12.7	18.1	10	10	< 0.010	1.79
Site B (WHA U/S)	n/a	TRC202193	28 Jul 2020	14:09	1.5	13.8		< 10	10	< 0.010	2.30
Site B (WHA U/S)	n/a	TRC202904	21 Sep 2020	11:20		13.6	18.5	10	10	< 0.010	1.97
Site B (WHA U/S)	n/a	TRC210871	23 Feb 2021	15:05	0.4	16.9	18.4	50	540	< 0.010	1.29
Site B (WHA U/S)	n/a	TRC212306	09 Jul 2021	09:25		12.3	18.1	80	30	< 0.010	1.95
Site B (WHA U/S)	n/a	TRC212371	29 Jul 2021	13:45	1.5	14.3	18.3	110	< 10	< 0.010	2.10
Site B (WHA U/S)	n/a	TRC212558	11 Aug 2021	09:30	1.3	12.1	18.4	< 10	10	< 0.010	2.20
Site B (WHA U/S)	n/a	TRC213587	04 Nov 2021	17:05		14.9	18.3	100	30	< 0.010	2.10

NB: exact sampling locations withheld for property owner privacy

Table 3: TRC Urenui investigation water testing results – Whakapaki Street modified stream (downstream of contaminant sources)

Location	Intervention timeline	Sample	Collected	Time	Discharge rate	Temp.	Electrical Conductivity (EC)	Escherichia coli	Enterococci	Total Ammoniacal N	Nitrate N + Nitrite N
					L/s	°C	mS/m	no. / 100 mL	no. / 100 mL	g/m³	g/m³
Site C (WHA D/S - Outlet)	No intervention	TRC193113*	02 Sep 2019	08:56	1.2	13.4		727			
Site C (WHA D/S - Outlet)	No intervention	TRC201136	23 Apr 2020	11:35	1.0	15.8	21.5	50,000	1,000,000	1.49	1.26
Site D (WHA D/S)	No intervention	TRC201135	23 Apr 2020	11:00	n/a	15.3	20.7	30,000	900,000	1.39	1.25
Site C (WHA D/S - Outlet)	No intervention	TRC201420	22 May 2020	12:40	1.2		19.7	4,000	18,000	0.19	1.62
Site D (WHA D/S)	No intervention	TRC201421	22 May 2020	12:50	n/a		22.7	11,000	38,000	2.60	1.72
Site D (WHA D/S)	No intervention	TRC201958	02 Jul 2020	09:41	n/a	12.3	20.6	7,000	24,000	1.49	2.20
Site E (WHA D/S)	No intervention	TRC201961	02 Jul 2020	10:39	n/a	12.7	19.4	2,000	70	0.28	2.10
Site D (WHA D/S)	No intervention	TRC202191	28 Jul 2020	13:35	n/a	13.9		7,000	27,000	0.12	2.50
Site E (WHA D/S)	No intervention	TRC202192	28 Jul 2020	13:50	n/a	14.0		540	280	0.03	2.60
Site D (WHA D/S)	No intervention	TRC202905	21 Sep 2020	11:30	n/a	14.0	18.7	500	1,300	0.08	2.10

Location	Intervention timeline	Sample	Collected	Time	Discharge rate	Temp.	Electrical Conductivity (EC)	Escherichia coli	Enterococci	Total Ammoniacal N	Nitrate N + Nitrite N
					L/s	°C	mS/m	no. / 100 mL	no. / 100 mL	g/m³	g/m³
Site E (WHA D/S)	No intervention	TRC202903	21 Sep 2020	10:15	n/a	13.6	19.0	360	1,500	0.07	2.10
Site C (WHA D/S - Outlet)	Source 1 removed	TRC204155	11 Dec 2020	10:40	10.0	16.4	20.1	70	160	0.06	2.90
Site D (WHA D/S)	Source 1 removed	TRC204156	11 Dec 2020	10:45	n/a	16.2	20.2	60	170	0.08	2.70
Site E (WHA D/S)	Source 1 removed	TRC204157	11 Dec 2020	10:55	n/a	16.1	20.4	40	60	0.12	2.70
Site C (WHA D/S - Outlet)	Source 1 removed	TRC204415	06 Jan 2021	10:40	1.5	17.8	21.7	9,000	600	1.20	2.20
Site D (WHA D/S)	Source 1 removed	TRC204416	06 Jan 2021	11:00	n/a	17.5	20.1	1,200	380	0.28	1.98
Site E (WHA D/S)	Source 1 removed	TRC204417	06 Jan 2021	11:10	n/a	16.7	20.1	2,600	300	0.47	2.10
Site C (WHA D/S - Outlet)	Source 1 removed	TRC210538	04 Feb 2021	08:15	1.0	16.5	19.7	210	330	0.03	1.46
Site D (WHA D/S)	Source 1 removed	TRC210542	04 Feb 2021	09:10	n/a	17.1	21.5	2,900	2,200	1.55	1.53
Site E (WHA D/S)	Source 1 removed	TRC210543	04 Feb 2021	09:25	n/a	18.2	19.2	1,500	1,600	0.16	1.58
Site D (WHA D/S)	Source 1 removed	TRC210869	23 Feb 2021	13:40	n/a	17.9	18.9	1,700	580	0.03	1.16
Site E (WHA D/S)	Source 1 removed	TRC210870	23 Feb 2021	14:05	n/a	16.8	19.0	480	720	0.04	1.34
Site D (WHA D/S)	Source 2 removed	TRC212304	09 Jul 2021	08:30	n/a	12.7	19.0	50	70	0.03	2.20
Site E (WHA D/S)	Source 2 removed	TRC212305	09 Jul 2021	08:40	n/a	13.3	19.6	1,400	70	0.87	2.10
Site D (WHA D/S)	Source 2 removed	TRC212369	29 Jul 2021	12:45	n/a	14.5	19.4	1,500	180	0.06	2.80
Site E (WHA D/S)	Source 2 removed	TRC212370	29 Jul 2021	12:55	n/a	14.5	19.2	2,100	230	0.17	2.70
Site D (WHA D/S)	Source 2 removed	TRC212556	11 Aug 2021	08:50	n/a	12.4	19.5	600	70	0.11	2.50
Site E (WHA D/S)	Source 2 removed	TRC212557	11 Aug 2021	09:00	n/a	12.7	19.6	1,800	240	0.39	2.50
Site D (WHA D/S)	Source 2 removed	TRC213586	04 Nov 2021	16:54	n/a	16.7	19.0	180	70	< 0.010	1.99
Site C (WHA D/S - Outlet)	Source 2 removed	TRC224734	10 Jan 2022	10:55	n/a		19.3	4,000	7,500	< 0.010	2.30
Site C (WHA D/S - Outlet)	Source 2 removed	TRC226286	13 Apr 2022	14:05	0.7	17.0	19.7	80	260	< 0.010	1.59
Site D (WHA D/S)	Source 2 removed	TRC228440	18 Oct 2022	06:55	n/a		19.9	320	3,800	0.12	2.20
Site D (WHA D/S)	Source 2 removed	TRC228526	25 Oct 2022	12:50	n/a	15.0	19.4	150	90	< 0.010	2.00
Site C (WHA D/S - Outlet)	Source 2 removed	TRC228994*	16 Nov 2022	08:15	1.3	16.3	19.5	290	5	0.10	1.74

* = Faecal source tracking samples also collected (recorded as Site 2 in 2019 report)

NB: exact sampling locations withheld for property owner privacy

Table 4: TRC Urenui investigation water testing results – Ngakoti Street stormwater network (downstream of contaminant sources, at outlet)

Location	Intervention timeline	Sample	Collected	Time	Discharge rate	Temp.	Electrical Conductivity (EC)	Escherichia coli	Enterococci	Total Ammoniacal N	Nitrate N + Nitrite N
					L/s	°C	mS/m	no. / 100 mL	no. / 100 mL	g/m³	g/m³
Site F (NGA - Outlet)	No intervention	TRC193114*	02 Sep 2019	09:16		13.9		579			
Site F (NGA - Outlet)	No intervention	TRC201133	23 Apr 2020	09:45	0.1	17.5	19.1	1,300	170	1.01	0.82
Site F (NGA - Outlet)	No intervention	TRC201423	22 May 2020	12:25	0.1		19.0	40,000	430	1.04	1.00
Site F (NGA - Outlet)	No intervention	TRC202006	02 Jul 2020	14:21	0.6		19.8	2,100	290	0.82	0.83
Site F (NGA - Outlet)	No intervention	TRC202190	28 Jul 2020	14:27	0.6	14.1		2,600	4,000	1.58	0.77
Site F (NGA - Outlet)	No intervention	TRC202356	13 Aug 2020	14:45	0.4	13.8	19.3	11,000	1,900	0.91	0.54
Site F (NGA - Outlet)	No intervention	TRC202900	21 Sep 2020	09:20	0.3	14.1	22.0	26,000	6,800	3.90	0.47
Site F (NGA - Outlet)	No intervention	TRC204153	11 Dec 2020	10:10	1.0	17.3	20.0	1,000	2,100	0.52	1.32
Site F (NGA - Outlet)	No intervention	TRC204413	06 Jan 2021	10:25	0.8	18.7	20.7	500	80	1.96	0.67
Site F (NGA - Outlet)	No intervention	TRC210537	04 Feb 2021	08:00	0.1	19.3	16.7	80	180	0.11	0.52
Site F (NGA - Outlet)	Source 1 removed	TRC212307	09 Jul 2021	09:55	0.6	14.1	19.9	1,300	160	1.43	0.87
Site F (NGA - Outlet)	Source 1 removed	TRC212372	29 Jul 2021	13:05	0.6	14.3	18.9	2,300	60	0.93	1.03
Site F (NGA - Outlet)	Source 1 removed	TRC212559	11 Aug 2021	11:15	0.4	13.8	23.0	400	90	1.67	0.69
Site F (NGA - Outlet)	Source 1 removed	TRC213588	04 Nov 2021	17:15	0.3	16.0	17.7	300	430	0.30	0.45
Site F (NGA - Outlet)	Source 1 removed	TRC224735	10 Jan 2022	10:50			24.0	7,000	180	5.00	1.12
Site F (NGA - Outlet)	Source 1 removed	TRC226287	19 Apr 2022	13:55	0.1	18.4	19.6	130	190	0.44	1.19
Site F (NGA - Outlet)	Source 2 removed	TRC228441	18 Oct 2022	06:20	0.3		18.6	3,000	7,400	0.25	0.77
Site F (NGA - Outlet)	Source 2 removed	TRC228523	25 Oct 2022	12:15		15.6	18.9	2,000	10	0.13	0.49
Site F (NGA - Outlet)	Source 2 removed	TRC228995*	16 Nov 2022	07:50	0.3	17.4	18.6	700	80	0.27	0.56

* = Faecal source tracking samples also collected (recorded as Site 3 in 2019 report)

Table 5: Median flows and estimated dilution factors for the outlets and receiving waters (at low tide)

		Punawhakakau Stream	Urenui River
		15.5 L/s	1,963 L/s
Ngakoti Street outlet	0.4 L/s	40	4,909
Whakapaki Street outlet	1.2 L/s	14	1,637
Combined outlet flow	1.6 L/s	11	1,228

NB: Outlet flows measured (see Table 2, Table 3). Stream and river flows estimated (https://shiny.niwa.co.nz/nzrivermaps/).

Science for Communities

16 October 2019

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REPORT ON FAECAL SOURCE TRACKING ANALYSIS

The following samples were received on 6 September 2019 and were analysed for faecal sterols and fluorescent whitening agents (FWAs) as requested.

ESR Number	Client Reference	Date Sampled	Sterols Volume (mL)
CMB191001	Site 2 (stormwater)	2/9/19, 08:56	3,500
CMB191002	Site 3 (stormwater)	2/9/19, 09:15	3,500

Results of faecal sterol analysis:

ESR Number	Client Reference	coprostanol	24-ethylcoprostanol	epicoprostanol	cholesterol	cholestanol	24-methylcholesterol	24-ethylepicoprostanol	stigmasterol	24-ethylcholesterol	24-ethylcholestanol	total sterols
CMB191001	Site 2	3963	925	*39*	5377	330	862	*11*	276	2130	122	14035
CMB191002	Site 3	8235	2268	232	2895	541	577	56	420	1282	237	16743

NOTES: All values are reported in parts per trillion (ppt).
Coloured values indicate that the measured level is close to or below the lowest measurement standard and caution should be used in calculation of some ratios.
Values in italics are below the lowest measurement standard.
Bold results generated from a linear calibration curve because could not be extrapolated from normal quadratic curve.

Interpretation of faecal sterol ratios:

ESR Number	**Client Reference**	**Total Sterols** ppt	**Faecal** F1, F2	**Human** H1, H2, H3	**Ruminant** R1, R2, R3	**Wildfowl**	**Conclusion**
CMB191001	Site 2	14035	F1+F2	Yes (H1+H2+ H3+H4)	(R1)	No	Strong human source
CMB191002	Site 3	16743	F1+F2	Yes (H1+H2+ H3+H4)	(R1+R3)	No	Strong human source

NOTES: Sterol levels below 2000 ppt may be too low for some sterol interpretations.
For Human and Ruminant sterols, the ratio's meeting thresholds are noted in brackets.
Where Yes is also in brackets this indicates a lower degree of certainty.

Results of FWA analysis:

ESR Number	Client Reference	FWA µg/L	Conclusion
CMB191001	Site 2	0.11	Human source detected
CMB191002	Site 3	0.02	Low level detection of human source

NOTE: Refer appendix for interpretation guidance

Summary:

ESR Number	Client Reference	Faecal Sterols	FWAs	Overall Conclusion
CMB191001	Site 2	Strong human	Human	Human
CMB191002	Site 3	Strong human	Low level detection of human source	Human

Notes:
Brief details of the methods of analysis are available on request.
These results relate to samples as received.
This report may not be reproduced except in full.

Brent Gilpin
Science Leader

Susan Lin
Scientist

APPENDIX: Assay Interpretation Guidance Notes

PCR Marker interpretation notes

- Each marker is strongly associated with, but not exclusive to the source tested for. They each have some degree of non-specificity.
- Each marker is a separate test and the levels of the various markers within the same sample cannot be compared. For example, if sample A has a BacH result of 1,000 and a BacR of 100 it is not valid to say there is more human contamination than ruminant in sample A.
- Levels of the same marker in different samples can be compared. For example;
    - If sample A has a BacH result of 1,000 and sample B has a BacH of 10,000 it is valid to conclude there is more human faecal contamination in sample B than in sample A; or
    - If site H sampled in January has a GFD result of 500 and when sampled in February has a GFD result of 10,000, it is valid to conclude the level of avian faecal contamination in February is greater.
    - To be classified as a significantly greater or lesser result the level of marker should vary by a factor of 10.
- Both Human markers are required to be present for a positive human result.
- Ruminant specific markers are reported using a percentage value based on levels of this marker relative to the general marker in fresh ruminant faeces.
    - Samples reported as 50-100% ruminant are consistent with all of the general faecal marker having come from a ruminant source.
    - The lower levels reported (10-50%) may be a consequence of the presence of other sources of pollution, or in fact ruminant sources may still account for all the pollution, but this may include aged faecal material where relative levels of the ruminant marker decline more rapidly than the general marker.
    - Levels less than 10% ruminant suggest a very minor contribution from ruminant sources.

The detection limits of these methods vary depending on the volume of water filtered for analysis. We recommend a minimum volume of 200 mls and a maximum of 1000 mls, this range gives the following detection limits:

mls sample filtered	General GenBac / 100 mls	Human BacH / 100 mls	Human BiADO / 100 mls	Human HumM3 / 100 mls	Ruminant BacR / 100 mls	Ruminant Sheep / 100 mls	Ruminant Cow / 100 mls
< 400 mls	<110	<83	<110	<8	<91	<100	<11
400-700mls	<42	<33	<43	<3	<36	<41	<5
700-1000mls	<21	<17	<21	<2	<18	<21	<2

mls sample filtered	Dog DogBac / 100 mls	Avian GFD / 100 mls	Avian E2 / 100 mls	Gull- 2
> 400 mls	<79	<72	<99	presence / absence test
400-700mls	<31	<29	<40	
700-1000mls	<16	<14	<20	

Valid as at: July 2017

FWA interpretation notes

The analysis of FWAs in septic tank and community wastewater consistently identifies levels between 10 and 70 µg/L. In previous analysis of water samples levels of FWA greater than 0.1 µg/L suggest human sewage, with levels greater than 0.2 µg/L strongly indicative of human sewage. Levels greater than 0.1 µg/L correlate well with other indicators of human pollution and indicate a local or recent source of pollution. FWAs degrade under sunlight exposure and will undergo dilution. Levels lower than 0.1 µg/L may be indicative of dilute or distant sources of human pollution.

Reference: Devane M., Saunders D. and Gilpin B. (2006). Faecal sterols and fluorescent whiteners as indicators of the source of faecal contamination. Chemistry in New Zealand 70(3), 74-7. http://www.nzic.org.nz/CiNZ/articles/Devane_70_3.pdf

Faecal sterol Intepretation Notes:

Faecal sterol ratios must be interpreted with consideration to the levels of sterols, and relative to one another. For example H1 is typically also above 5-6% in ruminant faeces. Human and ruminant sources generally require at least two of three ratios to reach thresholds.
Plant sterols and mixed sources also have differing effects on sterol interpretations which must be considered.

Conclusions are the best interpretation of sterols in our opinion. Conclusions in **bold** are highly supported by the sterol data, conclusions in brackets are supported by sterol data with some variation from a pure source, or with a lower degree of certainty.

Ratio Key:

Ratios indicative of faecal pollution (either human or animal)		
F1	coprostanol/cholestanol..	>0.5 indicative of faecal source of sterols
F2	24ethylcoprostanol/ 24-ethylcholestanol.	>0.5 indicative of faecal source of sterols.
Human indicative ratios (values exceeding threshold in red)		
H3	coprostanol/ 24-ethylcoprostanol	Ratio >1 suggests human source
H1	% coprostanol	Ratio >5-6% suggests human source
H2	coprostanol/(coprostanol+cholestanol)	Ratio >0.7 suggests human source
H4	coprostanol/(coprostanol+24-ethylcoprostanol)	Ratio >0.75 suggests human source
Ruminant indicative ratios (values exceeding threshold in blue)		
R3	24-ethylcholesterol/24-ethylcoprostanol	Ratio <1 suggests ruminant source, ratio >4 suggests plant decay
R1	% 24-ethylcoprostanol	Ratio >5-6% suggests ruminant source
R2	coprostanol/(coprostanol+24-ethylcoprostanol)	Ratio <30% suggests ruminant source
Avian indicative ratios (values exceeding threshold in yellow)		
A1	24-ethylcholestanol/(24-ethylcholestanol+24-ethylcoprostanol+24-ethylepicoprostanol)	A1 Ratio >0.4 suggests avian source AND A2 Ratio >0.5 suggests avian source
A2	cholestanol/(cholestanol+coprostanol+epicoprostanol)	

Science for Communities
He Pūtaiao, He Tāngata

22 December 2022

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FINAL REPORT ON FAECAL SOURCE TRACKING ANALYSIS

The following samples were received on 17th November 2022 and was analysed for faecal source PCR markers, FWA and faecal sterols as requested.

ESR Number	Client Reference	Date Sampled	Site Description	*E.coli* cfu / 100mL
CMB220822	TRC228994 STW001162	16/11/2022 09:15	Whakapaki Street stormwater outlet	290
CMB220823	TRC228995 STW001165	16/11/2022 08:50	Ngakoti Street stormwater outlet	700

Results of faecal source PCR Marker Analysis:
Please refer to the appendix for guidance on interpretation of these results

ESR Number	Client Reference	Site	*E.coli* cfu / 100mL	General GenBac / 100 ml	Human BiADO / 100 ml	Human HF183 / 100 mls	Human crAssphage / 100 mls	Conclusion
CMB220822	TRC228994 STW001162	Whakapaki Street	290	5,900,000	1,800	9,800	29,000	Human faecal source detected
CMB220823	TRC228995 STW001165	Ngakoti Street	700	940,000	360	140	1,600	Human faecal source detected

Abbreviations: NA = sample was not analysed for this marker.
NC = not calculated
LOQ = limit of quantitation

Comment PCR Markers:
Significantly more human faecal source markers were detected in the Whakapaki Street stormwater outlet than in the Ngakoti Street stormwater outlet.

Results of FWA analysis:

ESR Number	Client Reference	Site	Fluorescent Whitener #1 (ppb)	Conclusion
CMB220822	TRC228994 STW001162	Whakapaki Street	0.01	Human faecal source detected
CMB220823	TRC228995 STW001165	Ngakoti Street	0.01	Human faecal source detected

Results of faecal sterol analysis:

ESR Number	Client Reference	Site Description	coprostanol	24-ethylcoprostanol	epicoprostanol	cholesterol	cholestanol	24-methylcholesterol	24-ethylepicoprostanol	stigmasterol	24-ethylcholesterol	24-ethylcholestanol	total sterols
CMB220822	TRC228994 STW001162	Whakapaki Street	512	111	*7*	1307	137	321	*0*	257	886	230	3767
CMB220823	TRC228995 STW001165	Ngakoti Street	442	168	*31*	1580	157	504	101	441	1090	279	4793

NOTES: All values are reported in parts per trillion (ppt).
Coloured values indicate that the measured level is close to or below the lowest measurement standard and caution should be used in calculation of some ratios.
Values in italics are below the lowest measurement standard.

Interpretation of faecal sterol ratios:

ESR Number	Client Reference	Site Description	Total Sterols ppt	Faecal F1, F2	Human H1, H2, H3	Ruminant R1, R2, R3	Wildfowl	Conclusion
CMB220822	TRC228994 STW001162	Whakapaki Street	3767	F1+(F2)	Yes	No	(Yes)	Human
CMB220823	TRC228995 STW001165	Ngakoti Street	4793	F1+F2	Yes	No	(Yes)	Human

NOTES: Sterol levels below 2000 ppt may be too low for some sterol interpretations.
Where Yes is also in brackets this indicates a lower degree of certainty.

Comment Faecal Sterols:
There is clear human sterol signature in both samples. Plus a possible wildfowl / plant signature.

Summary:

ESR Number	Client Reference	Site Description	Faecal Sterols	FWAs	PCR Markers	Overall Conclusion
CMB220822	TRC228994 STW001162	Whakapaki Street	Human	Human	Human faecal source detected	Human
CMB220823	TRC228995 STW001165	Ngakoti Street	Human	Human	Human faecal source detected	Human

Notes:
Brief details of the methods of analysis are available on request.
These results relate to samples as received.
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Beth Robson
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Scientist

Brent Gilpin
Senior Science Leader

APPENDIX: Assay Interpretation Guidance Notes

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