# Northland Regional Council
# Recreational Bathing
# Safeswim Summer Review
# 2022/2023


Northland
REGIONAL COUNCIL
Te Kaunihera ā rohe o Te Taitokerau

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# 1.0 Background

## 1.1 Recreational Swimming Water Quality Programme

Northland's Recreational Swimming Water Quality Programme (RSWQP) has been running since 2009 and was developed following the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE 2003). The aim of the programme is to provide information on microbiological contamination at popular freshwater and coastal swimming sites in Northland, allowing the public to make informed decisions about where to swim. The RSWQP was established as a joint project administered by the Northland Regional Council (NRC), in partnership with Ngā Tai Ora, National Public Health Service (NPHS) Te Whatu Ora, the Far North District Council (FNDC), the Whangārei District Council (WDC) and the Kaipara District Council (KDC).

The guidelines indicate a safe level of faecal indicator bacteria for contact recreation, based on the relationship between bacteria and pathogens based on previous epidemiological studies. *Escherichia coli* (*E. coli*) and enterococci (Ents) have been used as indicator of microbial contamination risk in freshwater and coastal environments respectively. The guidelines have 3 categories:

*Table 1 Recreational Bathing Guidelines and responses.*

| Category | Freshwater sites (E. coli) | Open coastal Sites (Enterococci) | Enclosed Coastal Sites (Ent. and FC) | Response |
|---|---|---|---|---|
| **Suitable** | ≤260/100mL | ≤140/100mL | *FC* ≤150/100mL **AND** *Ent.* ≤140/100mL | No response necessary – continue weekly sampling |
| **Alert** | 260-550/100mL | 140-280/100mL | *FC* 150- 600/100mL **OR** *Ent.* 140 - 280/100mL | Collect follow-up sample. Consider microbial source tracking to isolate source of faecal contamination. |
| **Action** | >550/100mL | >280/100mL | *FC* >600/100 mL **OR** *Ent.* >280/100mL | Collect follow-up sample. Undertake microbial source tracking to isolate source of faecal contamination. Undertake sanitary survey when applicable. Erect warning signs. |

Traditionally, the monitoring programme commenced from December through to March with samples collected every Monday, results received back from the laboratory on Wednesday, with any follow up action and results communicated to the public usually 48 hours after sampling took place. A shortfall of this approach is by the time

the results have been communicated to the public the conditions may have changed at the swimming location and the information provided out-of-date and may not reflect current water quality.

## 1.2 Safeswim

Recognising the limitations with the traditional sampling approach, Auckland Council developed the Safeswim programme in 2017 to provide real-time predictions ensuring water users were able to make informed decisions on where and when to swim based on current information. Safeswim combines current environmental data (e.g., rainfall) with predictive models, underpinned by regular sampling, to provide real-time microbial water quality predictions at swimming sites. It has proven to be a very successful and useful tool for informing the public of the associated health risks, winning numerous international awards, and recognised by the World Health Organisation as best practice.

The Northland Regional Council, along with the other Northland partners, recognised the benefits of predictive modelling for Northland's popular swimming sites, and working with Auckland Council and other Safeswim partners, looked to utilise the wealth of water quality data collected over the years to inform predictive modelling. Over 16,000 samples have been collected at over 100 swimming sites across Northland along with continuous hydrological data over nearly 20 years of the programme.

Following a successful trial over several bathing seasons, from 1 December 2022, 49 coastal and 20 freshwater sites went live on the Safeswim website, displaying the predicted water quality in real time.

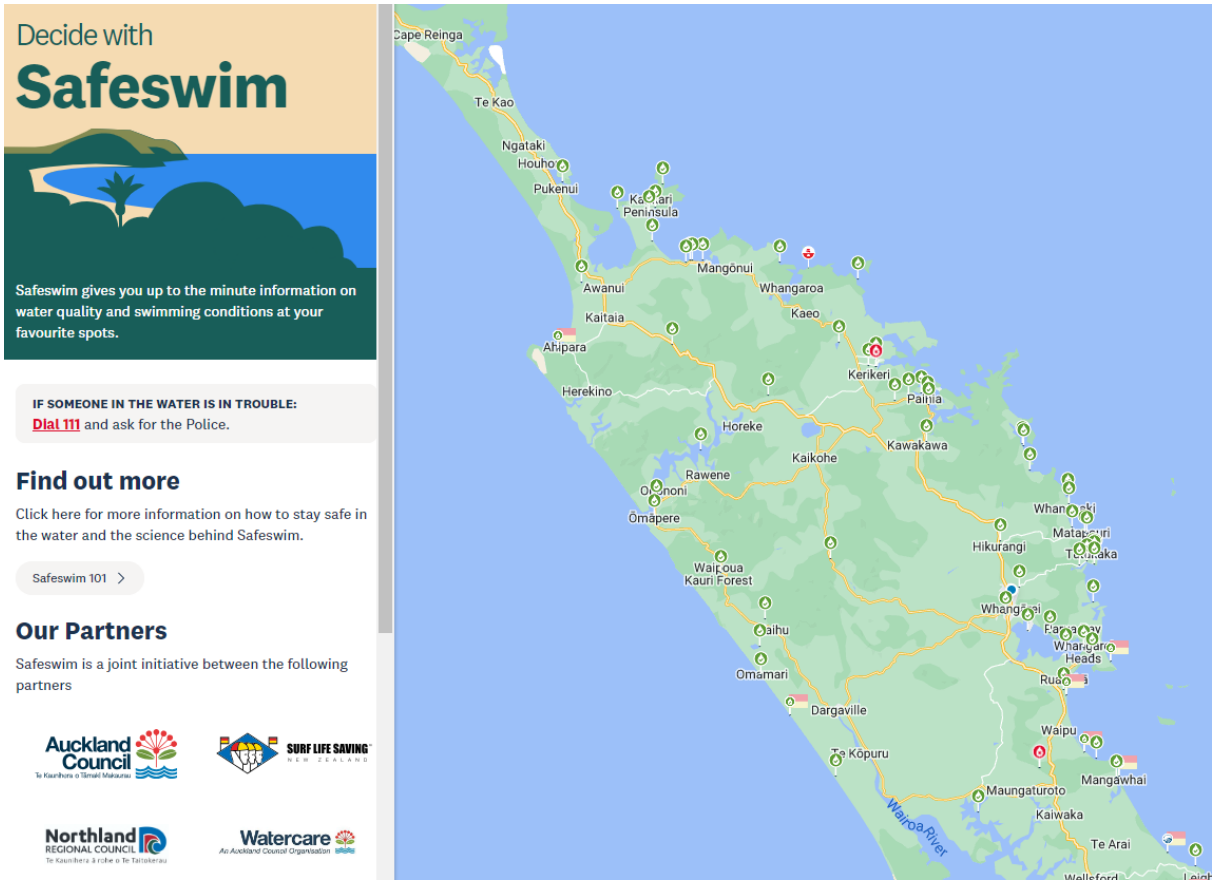


*Figure 1 Northlands popular bathing sites displayed on Safeswim.*

The Safeswim website https://www.safeswim.org.nz/ provides 15 to 60-minute predictions depending on the model, of the risk of swimming providing a 3-day water quality forecast. There is also additional information available with regards to lifeguarded beaches, tides, weather, physical hazards, and information about the site.

When water quality is predicted to meet the national guidelines for safe swimming a green water droplet indicating a low risk of illness from swimming will be displayed (Figure 2). When water quality is predicted to exceed the national guidelines a red water droplet advising unsuitable swimming conditions.

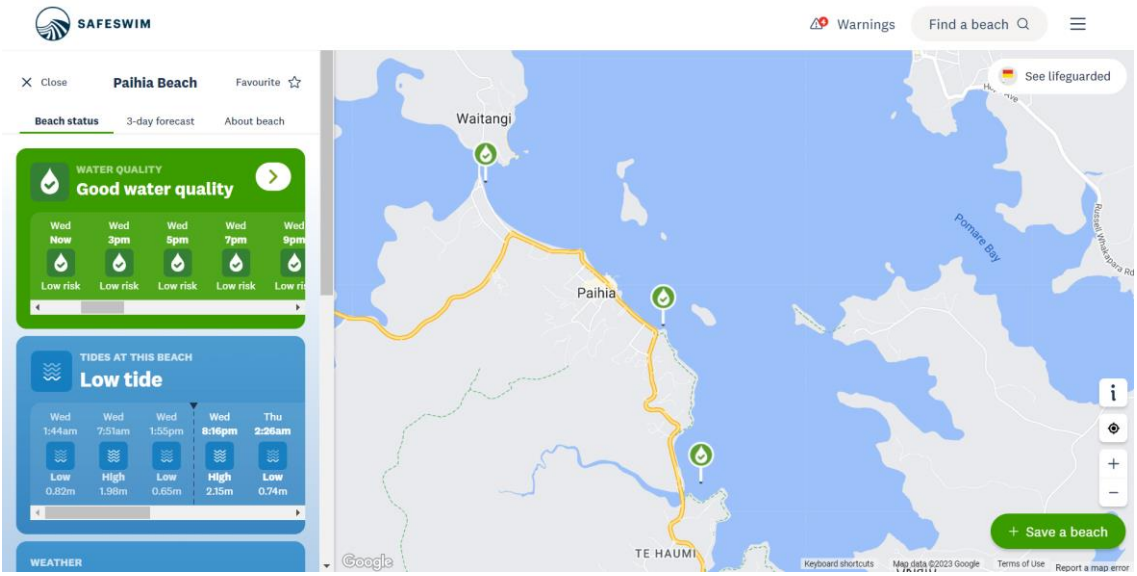


*Figure 2: The real-time and near future Safeswim prediction or one of Northland's popular swimming locations.*

Safeswim has the ability to override site predictions and/or put on temporary warnings if there is something that needs to be communicated to the public. During Cyclone Gabrielle and the other significant flooding events experienced this summer period across Northland and Auckland, Safeswim was used as a means of communicating to the public the risks of swimming when heavy rain and power outages had affected the areas, likely having longer lasting results than what the model would have been able to predict.

Whilst providing the public with a greater understanding of real-time conditions at their popular swimming sites, Safeswim also allows council to better management of resources, such as spreading sampling over the year and still being able to provide water quality information over peak holiday periods when the information is most needed.

## 1.3 Model Development

Safeswim makes use of a number of modelling approaches to predict water quality, including Black box models (most sophisticated), criteria models, and permanent status (both green and red).

Each site's historic data was analysed to determine the best available model to predict water quality. Data had to meet a certain criterion for each approach and each sites model was approved by an expert health panel before display on Safeswim. Some

sites did not meet the model development criteria and as such are not currently on Safeswim.

A Black box model is a regression based 'black box' model that is based on a strong correlation between rainfall and contamination events. It establishes a relationship between input variables (e.g. rainfall, land use) and an output variable (i.e. faecal indicator bacteria (FIB) concentration) based on relatively simple statistical techniques but are data-driven and require relatively large datasets of FIB results to construct effective models (Puhoi Stour, 2020).

Criteria Models are based on a set of criteria that are developed using expert judgement. The development of the criteria should be based on empirical evidence, but the use of professional judgement allows subjectivity to be included in the management framework. This option has similar information requirements and limitations to Blackbox models, but criteria models predict relative risk level (guideline compliance or failure), not concentrations of faecal indicator bacteria. (Puhoi Stour, 2020).

There are a few sites in Northland that have been allocated a permanent green status. These sites have very few exceedances over the years of monitoring and therefore remain permanently green as significant rainfall does not statistically affect the water quality of these sites. Conversely there is one site in Northland that has continuously over the years displayed consistently poor water quality, no model was able to be developed and it has met the criteria of a 'permanently red' site.

Each model is underpinned by ongoing sampling, ensuring model accuracy is maintained or improved over time. Each site is compared to a literature-bases accuracy performance standard of 80%, i.e. model prediction agrees with the sampling results at least 80% of the time.

## 1.4 Sampling

Sampling continues to be undertaken across the 'typical' recreational bathing season with freshwater sites collected weekly and coastal sites sampled at least monthly. Throughout the past season, council collected:

- 194 coastal samples across 49 coastal sites with 11 samples within the 'alert level' and 7 samples (4% of the time) exceeding the 'action level' of greater than 280MPN/100mls.

- 182 samples collected across 21 freshwater sites with 42 samples triggering the 'alert level' range and 24 samples (13% of the time) exceeding the 'action level' of greater than 550MPN/100mls.
- Microbial source tracking was also undertaken on samples exceeding the action level (n=24) to identify the source of contamination.

Sampling included sites not currently on Safeswim with data being collected for future model development.

Actual Sample results are not displayed on Safeswim, however can still be accessed from http://www.lawa.org.nz/explore-data/swimming/. Land Air Water Aotearoa (LAWA) reflects the Safeswim predictive model, however the actual sampling results can be viewed in the "Why this status" section.

# 2.0 Results

For the purpose of this analysis, sampling data collected and model predictions from 1 December to 31 March were used, totalling 120 days. To assess whether sample results aligned with the modelled prediction, the sample result was assessed to the closest 15-minute prediction of the sample being collected with each given a value of within or exceeding water quality guidelines (red/green). To calculate the number of swimmable days, daily averages were calculated from each 1-hour prediction across the 24-hour period.

## 2.1 Coastal

A total of 49 coastal sites were displayed on the Safeswim website over this period. 88% of samples aligned with Safeswim prediction.

Samples at 40 sites agreed with the model predictions 100% of time. About 3% of the time coastal sampling results (n=6) exceeded guidelines when the Safeswim prediction didn't indicate unsuitable swimming conditions – model representing swimming risk. Conversely, 9% of the time (n=18), Safeswim advised of unsuitable swimming conditions when the sample results were within the guidelines – model overrepresenting swimming risk.

Sites where the results exceeded but Safeswim advised of suitable swimming conditions were Taurikura Bay, Little Cable Bay, Onerahi at Playground and Matapōuri at Southern Bridge. Sites where Safeswim advised of unsuitable conditions where results showed no exceedances were Wellington Bay, Ngunguru at School, Ngunguru at Motor Camp, Langs Beach, Matapōuri at Northern bridge, Mangawhai Heads at Motor Camp.

*Table 2 Safeswim coastal sites with model type and model analysis.*

| Coastal sites | No. of samples | % of samples aligned with model | No. swimmable days (*of 120 days*) |
|---|---|---|---|
| Mangawhai Heads at Motor Camp | 3 | 33 | 94 |
| Ngunguru Estuary at Motor Camp | 6 | 50 | 86 |
| Langs Beach at Mid Beach | 3 | 67 | 113 |
| Little Cable Bay at SH10 | 3 | 67 | 113 |
| Onerahi at Opposite Playground | 6 | 67 | 106 |
| Wellington Bay | 6 | 67 | 92 |
| Matapōuri Bay at Northern Bridge | 5 | 80 | 94 |
| Matapōuri Bay at Southern Bridge | 5 | 80 | 100 |
| Ngunguru Estuary at School | 6 | 83 | 96 |
| Ahipara at Kaka Street | 3 | 100 | 120* |
| Baylys Beach at Sea View Road | 3 | 100 | 120* |

| Coastal sites | No. of samples | % of samples aligned with model | No. swimmable days (*of 120 days*) |
|---|---|---|---|
| Cable Bay at East Beach | 3 | 100 | 120* |
| Church Bay at Mid Bay | 6 | 100 | 101 |
| Coopers Beach Foreshore | 3 | 100 | 118 |
| Glinks Gully at Marine Drive | 3 | 100 | 120* |
| Houhora at Houhora Heads Road | 3 | 100 | 108 |
| Kowharewa Bay | 1 | 100 | 95 |
| Maitai Bay at South End | 3 | 100 | 120* |
| Mangawhai Heads at Open Coast | 3 | 100 | 120* |
| Matauri Bay at Campground | 3 | 100 | 120* |
| McLeod Bay at Playground | 5 | 100 | 113 |
| Ōākura Bay at North End | 3 | 100 | 120* |
| Ocean Beach at Mid Beach | 6 | 100 | 120* |
| Ohawini Bay | 3 | 100 | 120 |
| Ōmāmari Beach | 4 | 100 | 120* |
| Ōmāpere at Old Wharf Road | 2 | 100 | 120* |
| One Tree Point at Intertidal Beach | 2 | 100 | 120* |
| Opononi at Hokianga Harbour | 2 | 100 | 120* |
| Otamure Bay | 4 | 100 | 101 |
| Pacific Bay | 6 | 100 | 100 |
| Pahi at Jetty | 2 | 100 | 96 |
| Paihia at Seaview Road | 3 | 100 | 116 |
| Paihia at Te Haumi | 3 | 100 | 116 |
| Paihia at Waitangi Bridge | 3 | 100 | 115 |
| Pataua South at East End | 5 | 100 | 118 |
| Rangiputa at Rangiputa Road | 3 | 100 | 108 |
| Rāwene at Past Ramp | 2 | 100 | 104 |
| Ruakākā Beach at Surf Club | 2 | 100 | 120* |
| Ruakākā River at Below Motor Camp | 2 | 100 | 101 |
| Sandy Bay at Mid Beach | 5 | 100 | 120* |
| Taipā Estuary at Boat Ramp | 3 | 100 | 111 |
| Tamaterau Bay at Whangārei Heads Road | 6 | 100 | 102 |
| Taupō Bay at Mid Beach | 3 | 100 | 108 |
| Taurikura Bay | 6 | 100 | 102 |
| Teal Bay | 3 | 100 | 120 |
| Tokerau Beach at Melissa Road | 3 | 100 | 107 |
| Waipū Cove at Beach | 3 | 100 | 120* |
| Whananaki at East Beach | 4 | 100 | 103 |
| Whatuwhiwhi at Holiday Park | 3 | 100 | 107 |

**Refers to sites that are 'permanent green'.*

## 2.2 Freshwater

There were 20 freshwater sites live on Safeswim this season. Over 90% of samples aligned with Safeswim prediction.

Samples at 10 sites aligned with the model prediction 100% of the time. About 5% of freshwater sample results (n=9) identified unsuitable swimming conditions when Safeswim indicated suitable conditions – model underrepresenting swimming risk. Conversely, 5% of sample results (n=9) indicated suitable swimming conditions when Safeswim predicted unsuitable swimming conditions – model overrepresenting swimming risk.

Sites where sample results exceeded guidelines, but Safeswim advised of suitable swimming conditions were Whangārei Falls, Kaihū Swimming Hole, Piroa Falls, Raumanga Falls and Kerikeri Rainbow Falls. Sites where Safeswim advised of unsuitable conditions, but sample results showed no exceedances was Tauranga Bay, Kerikeri at Stone Store, Kerikeri Rainbow Falls, Waitangi at Lily Pond Lane, Waitangi at Wakelins and Lake Rotopokaka.

*Table 3 Safeswim freshwater sites with model type and model analysis.*

| Freshwater sites | No of samples | % of samples aligned with model | No. swimmable days (*of 120 days*) |
|---|---|---|---|
| Tauranga Stream at Tauranga Bay | 9 | 67 | 0** |
| Kerikeri at Rainbow Falls | 8 | 75 | 86 |
| Kerikeri at Stone Store | 9 | 78 | 69 |
| Raumanga at Raumanga Valley Park | 9 | 78 | 88 |
| Hātea at Whangārei Falls | 9 | 80 | 33 |
| Ahuroa at Piroa Falls | 6 | 83 | 78 |
| Waitangi at Wakelins | 9 | 86 | 103 |
| Kaihū at Swimming Hole | 9 | 89 | 103 |
| Mangakāhia at Swimming Hole | 9 | 89 | 93 |
| Waitangi at Lily Pond | 9 | 89 | 103 |
| Lake Manuwai at Boat Ramp | 9 | 100 | 108 |
| Lake Ngatu at South End | 9 | 100 | 120* |
| Lake Rotopokaka (Coca-Cola) at Picnic Area | 9 | 100 | 101 |
| Lake Taharoa at Pump House | 8 | 100 | 120* |
| Lake Waro at Launch Site | 9 | 100 | 117 |
| Tirohanga at Tirohanga Road | 9 | 100 | 94 |

| Freshwater sites | No of samples | % of samples aligned with model | No. swimmable days (*of 120 days*) |
|---|---|---|---|
| Victoria at DOC Reserve Crossing | 9 | 100 | 120 |
| Waipapa at Charlies Rock (stream) | 6 | 100 | 102 |
| Waipapa at Waihou Valley (river) | 9 | 100 | 106 |
| Waipoua at Swimming Hole | 9 | 100 | 104 |

**Refers to sites that are 'permanent green'. **Refers to permanent red.*

When looking at the 120 days for the period of this analysis, averaging each 24-hour period in a day to get a daily result for whether the site was considered suitable for swimming or not, only one freshwater site was considered suitable for swimming 100% of the time. Across the freshwater sites there is one site that is a permanent red meaning its deemed unsuitable for swimming 100% of the time (Tauranga Bay estuary) and one site is considered suitable for swimming 100% of the time (Lake Taharoa).

## 2.3 Microbial Source Tracking

Some samples that returned alert or action level results were further analysed for microbial source tracking using PCR analysis – analysing DNA to identify source animals. PCR analysis was undertaken for two human markers (HR183 and HumM2) ruminant (e.g. cattle, sheep) and avian (e.g. wildfowl).

Over the 2022/23 **season** 24 samples were analysed for source tracking across 13 different sites. Avian and ruminant were the dominant sources across the majority of the sites. Two sites identified human sources on more than one occasion and as a dominant source on each occasion (Ahuroa at Piroa Falls and Whangārei Falls). These results help inform regulatory and non-regulatory actions to improve water quality.

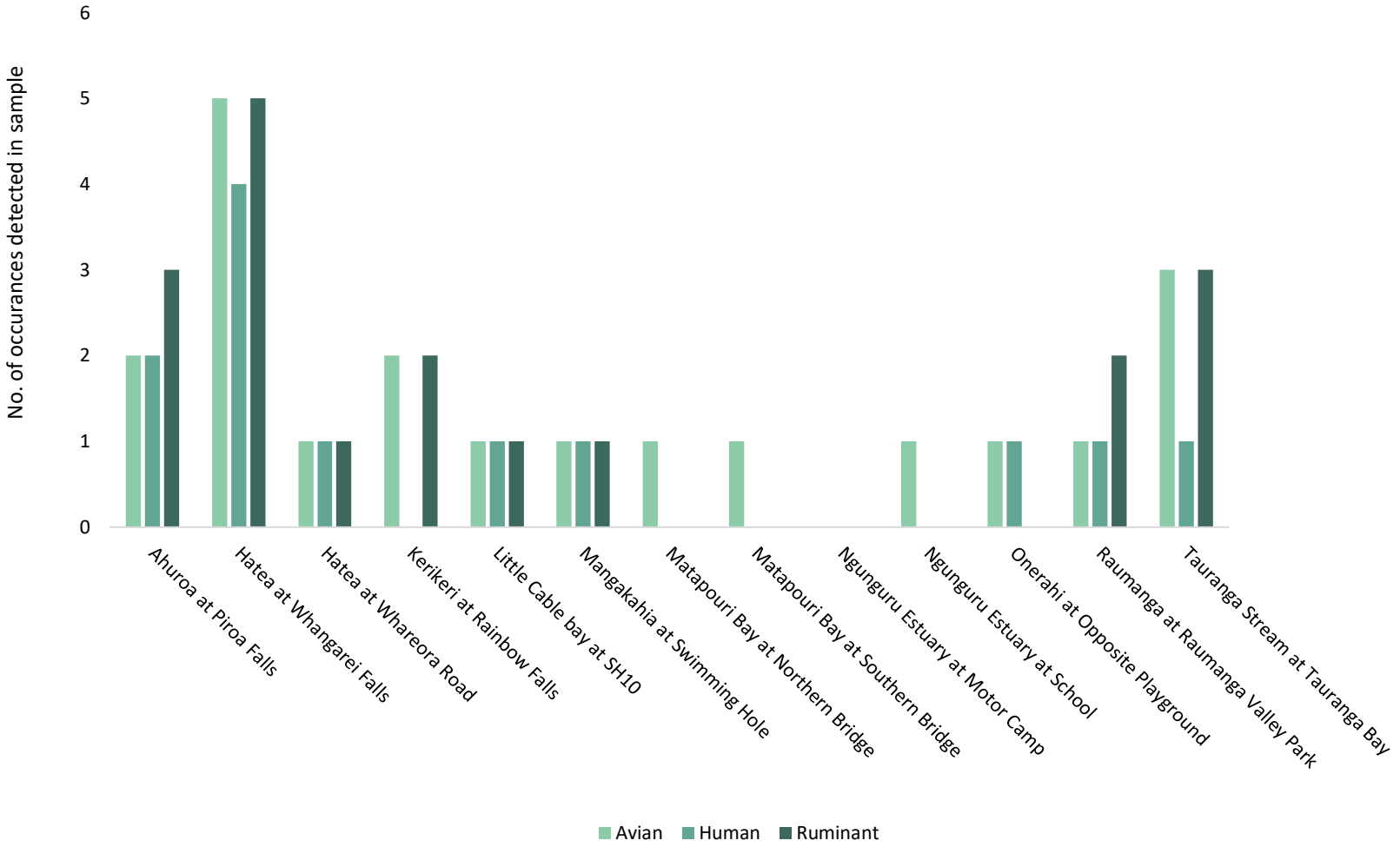


*Figure 3. Number of occurrences of avian, human, and ruminant markers in PCR results*

# 3.0 Further Model Developments

A minimum of four samples per year will be collected at all sites with black box models to underpin the predictive models. More frequent sampling will be undertaken at the criteria modelled sites to develop better correlations with environmental conditions, with a view of developing black box models at these sites. Permanent green and red sites will also be monitored at least four times a year.

There is a number of sites where we have a large historical data set that haven't been sampled in recent years or new sites that only have a few years of sample collection but there is insufficient data to develop a model. These sites will be the focus over the coming years to collect more samples throughout a wide range of environmental conditions to develop models and to provide water quality predictions on Safeswim.

# 4.0 Summary

The first season of Safeswim being live across all sites was considered a success. The analysis of agreement between samples and predictions indicated an overall accuracy of 88%, and more often where there was a difference the model was conservative, overrepresenting the health risk associated with swimming. The analysis of accuracy of the Safeswim model predictions will be more meaningful in time as the number of samples increases and will allow further improvements.

This report concludes the Safeswim approach is an effective tool to communicate to the public the current health risks associated with swimming at Northland recreational bathing sites, allowing the public to make an informed decision on where to swim based on real-time conditions.

# 5.0 References

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