Windermere: when to swim (or not)?

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WET
Waterhead E.coli Testing

AMBLESIDE ACTION FOR A FUTURE

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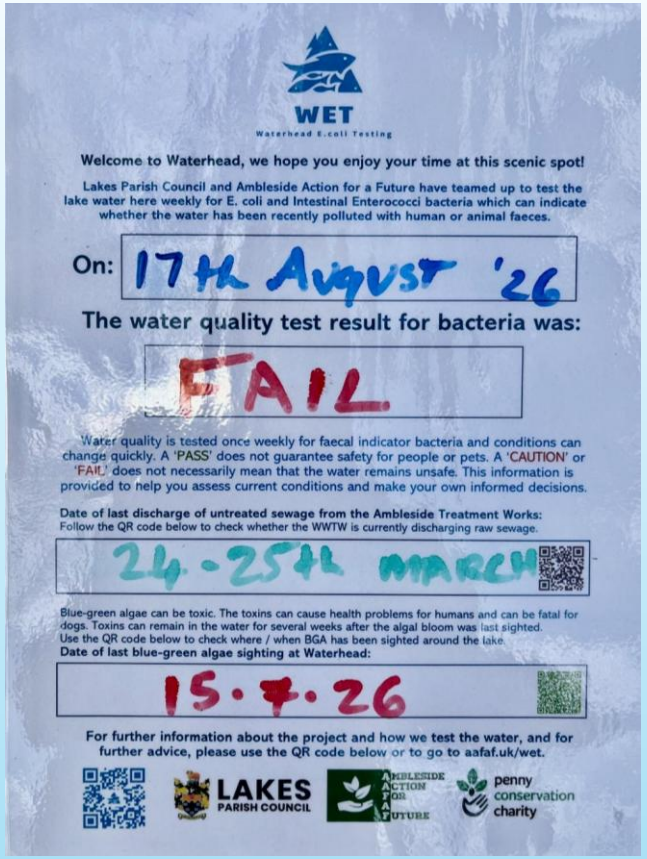
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UK bathing water assessments

- Measure the concentration in water of Faecal Indicator Organisms (FIOs)
  - Thrive in the gut of humans and warm-blooded animals, die off steadily in cold water
  - FIOs are not necessarily harmful, higher concentrations indicate recent faecal contamination
  - Escherichia coli (e.Coli) and Intestinal Enterococcus (IE) used in tests
- UK regulations are aligned to the EU Water Framework Directive
  - FIOs are assessed, roughly weekly, between 15th May and 30th September.
  - Calculations use all valid data from last one to four full years for the site
  - For 2026, using data from 2022-2025, all four Windermere bathing water sites were classified as **EXCELLENT**
- Provide an indication of the typical conditions a bather may expect but no timely information about current (or even this year's) risks.

WET Project, 2026

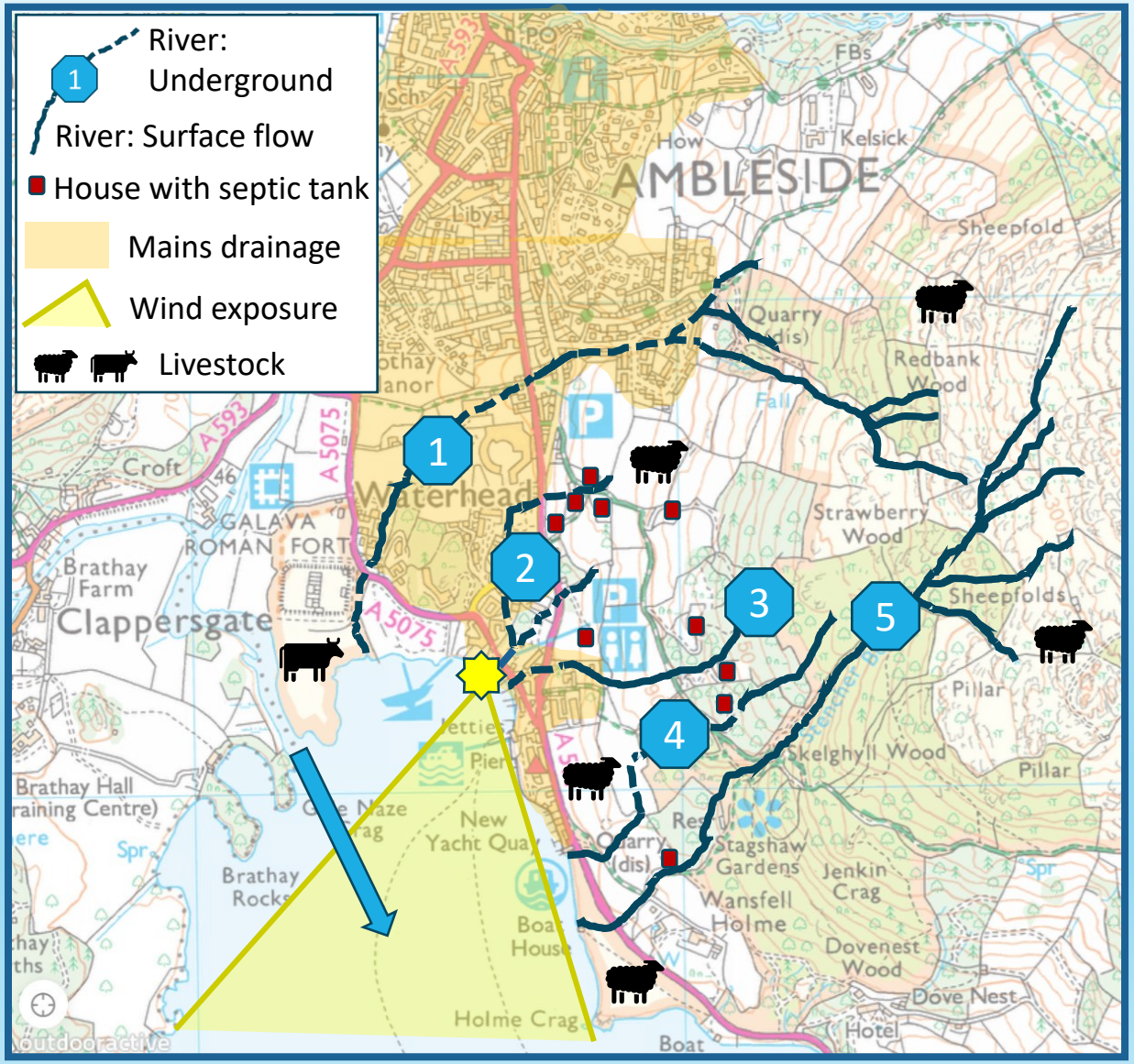
- Aim: Monitor bathing water quality at Waterhead public jetty (not a designated bathing site)
- Duration: Weekly, March-October 2026
- Method: Professional lab testing for FIOs, plus parallel testing with Bactiquick device and R-cards
- Dissemination: Pass/Fail displayed on 2 noticeboards at Waterhead and online with graphs at aafaf.uk/wet.
  - QR code on noticeboard
  - Cards distributed to local businesses: QR codes to scan.
- WET Project Page statistics:
  - 4,844 unique visitors in year to date (2,000 above 2025)
  - Top month July – 1,599 unique visitors





Waterhead has many, varied pollution sources

- 5 streams drain into Waterhead
  - Number of road drains near jetties
- UU have provided drainage map
  - Both septic tanks and urban drainage
- Drain rough and improved livestock grazing
- Outflow of Rothay/Brathay points away from Waterhead
  - Upstream rural and treated sewage sources are insignificant
- Waterhead is sheltered from wind except between 160° and 230°
  - Storm overflows can be blown in

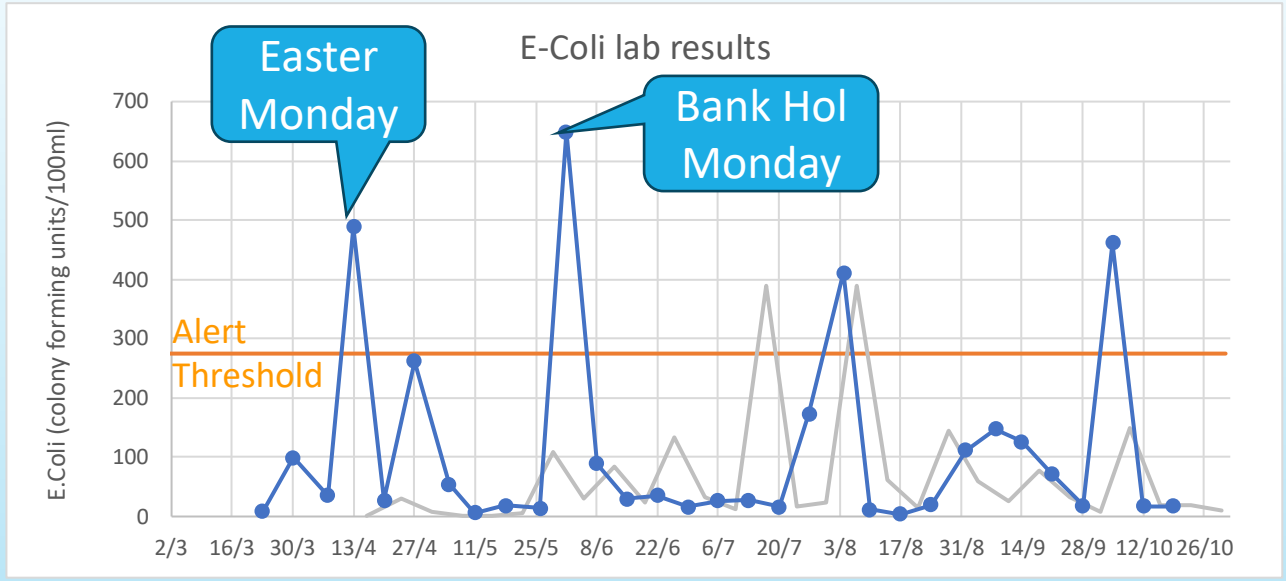


WET project results

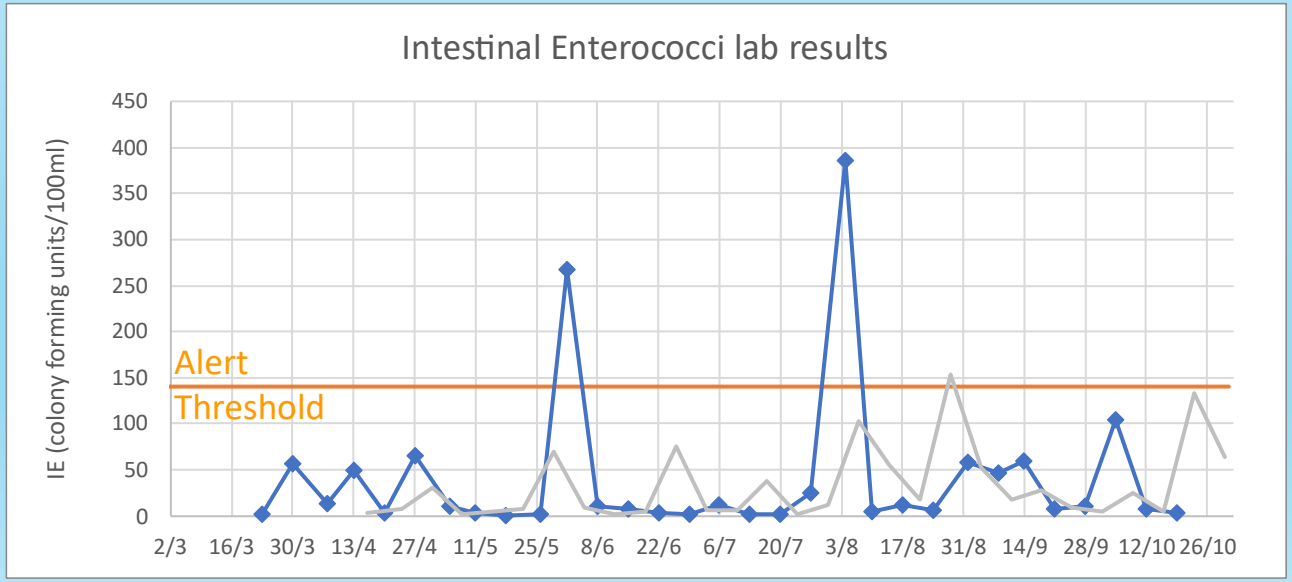
- Testing on Monday not Thursday
- Raw bacterial concentrations :
  - Showed higher peaks than in 2025
  - Lake frontage would have been closed on 1st June and 1st Aug for investigation in NZ
- E.coli levels peaked at 6x regulatory mean (2025: 4x)
- IE levels peaked at 12x regulatory mean (2025: 5x)

Had Waterhead been a designated bathing water, still assessed as EXCELLENT under the UK rules combining 2025 & 2026

- E.coli: 379 cfu/100ml (target <500)
- IE: 168 cfu/100ml (target <200)
- Both similar to 2025



Grey plot is 2025 data



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Waterhead Pass/Fail results using US EPA method

- WET project used US Environmental Protection Agency method: results calculated immediately based on weekly tests in a rolling 30-day window
- Mean identifies the typical value, STV-90 measures the value exceeded 10% of the time
- This year brought in CAUTION band - result in between the two alternative levels in the US EPA system. In 2025, both were marked as FAIL.
- Significantly more weeks where CAUTION/FAIL advised than in 2025 (17 vs 12)
  - Result of severe failures affecting results for following 4 weeks, despite better quality
  - Either use weighted system or more tests

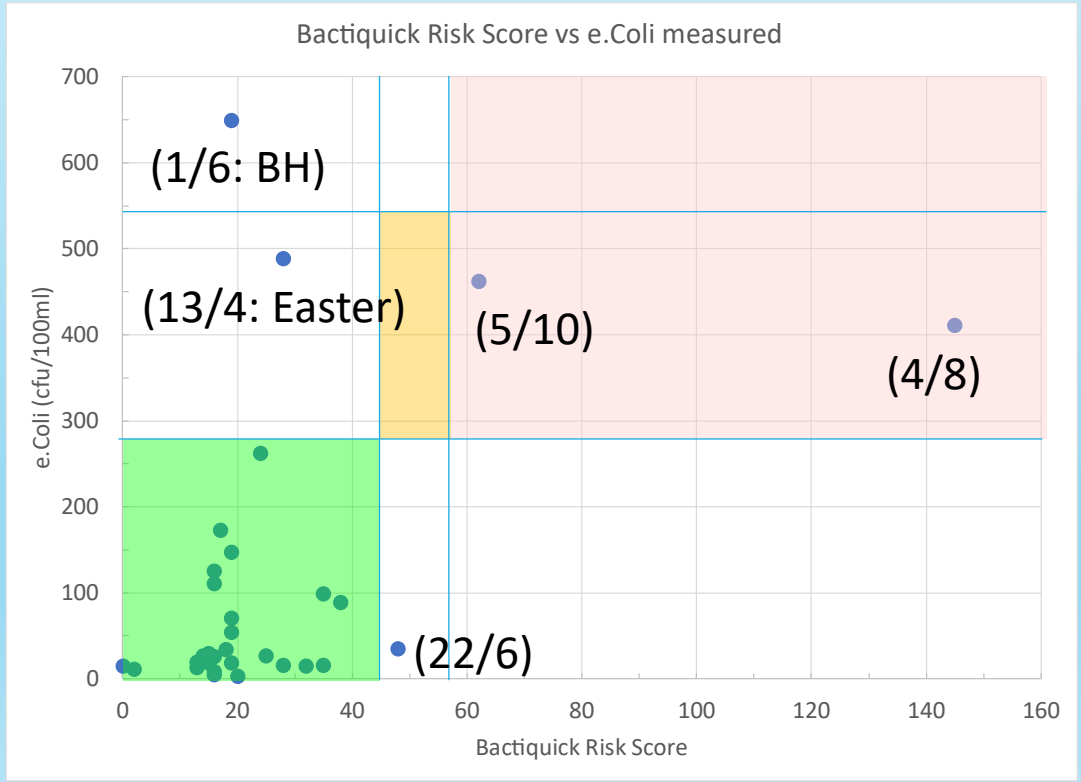
Date	Weekly Status	eColi Mean	Intestinal Enterococci Mean	eColi STV-90	Intestinal Enterococci STV-90
23-Mar-26	PASS	PASS	PASS	PASS	PASS
30-Mar-26	FAIL	PASS	PASS	PASS	FAIL
7-Apr-26	PASS	PASS	PASS	PASS	PASS
13-Apr-26	FAIL	PASS	PASS	FAIL	CAUTION
20-Apr-26	CAUTION	PASS	PASS	CAUTION	PASS
27-Apr-26	FAIL	CAUTION	PASS	FAIL	CAUTION
5-May-26	FAIL	PASS	PASS	FAIL	PASS
11-May-26	FAIL	PASS	PASS	FAIL	PASS
18-May-26	PASS	PASS	PASS	PASS	PASS
26-May-26	PASS	PASS	PASS	PASS	PASS
1-Jun-26	CAUTION	PASS	PASS	CAUTION	CAUTION
8-Jun-26	FAIL	PASS	PASS	FAIL	CAUTION
15-Jun-26	FAIL	PASS	PASS	CAUTION	FAIL
22-Jun-26	FAIL	PASS	PASS	CAUTION	FAIL
29-Jun-26	FAIL	PASS	PASS	CAUTION	FAIL
6-Jul-26	PASS	PASS	PASS	PASS	PASS
13-Jul-26	PASS	PASS	PASS	PASS	PASS
20-Jul-26	PASS	PASS	PASS	PASS	PASS
27-Jul-26	PASS	PASS	PASS	PASS	PASS
4-Aug-26	FAIL	PASS	PASS	CAUTION	FAIL
10-Aug-26	FAIL	PASS	PASS	CAUTION	FAIL
17-Aug-26	FAIL	PASS	PASS	FAIL	FAIL
24-Aug-26	FAIL	PASS	PASS	FAIL	FAIL
1-Sep-26	FAIL	PASS	PASS	CAUTION	FAIL
8-Sep-26	PASS	PASS	PASS	PASS	PASS
14-Sep-26	CAUTION	PASS	PASS	CAUTION	PASS
21-Sep-26	PASS	PASS	PASS	PASS	PASS
28-Sep-26	PASS	PASS	PASS	PASS	PASS
5-Oct-26	FAIL	CAUTION	PASS	FAIL	CAUTION
12-Oct-26	CAUTION	PASS	PASS	CAUTION	PASS
19-Oct-26	PASS	PASS	PASS	PASS	PASS

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Alternative method 1: Bactiquick device

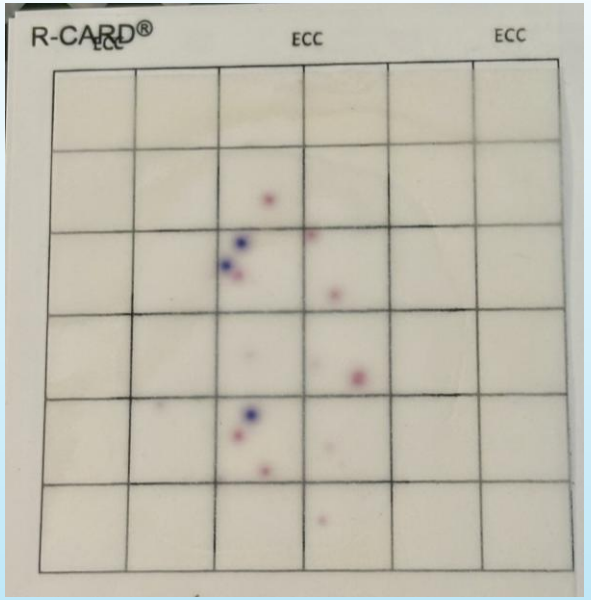


- Bactiquick device provides a risk score in 15 minutes – level of gram-negative bacteria
- Measuring directly the safety of the water rather than using FIOs as indicators
- 90% (28/31) aligned to the NZ e.Coli quality ranges
  - 1 false positive (22/6)
- 50% (2/4) success in identifying poor quality
  - 2 false negatives (Easter & BHM)
- Limited granularity in results:
  - Over 50% scores in range 15-23 whilst e.Coli ranged from 3 to 649 cfu/100ml

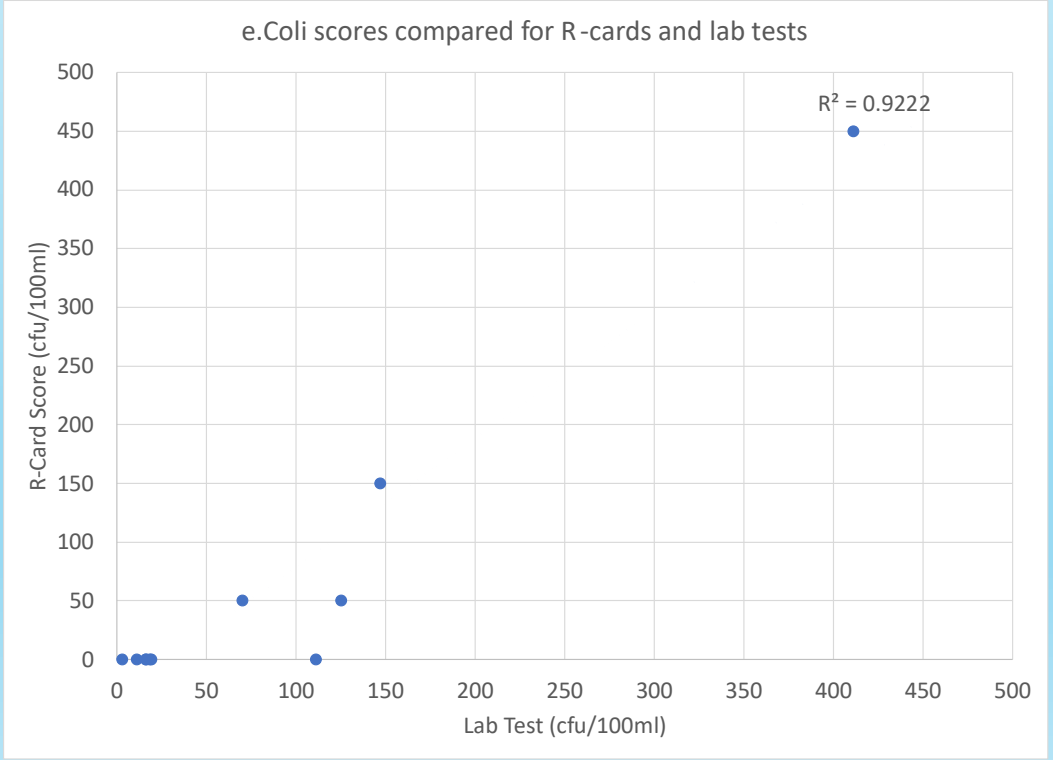


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Alternative method 2: R-card

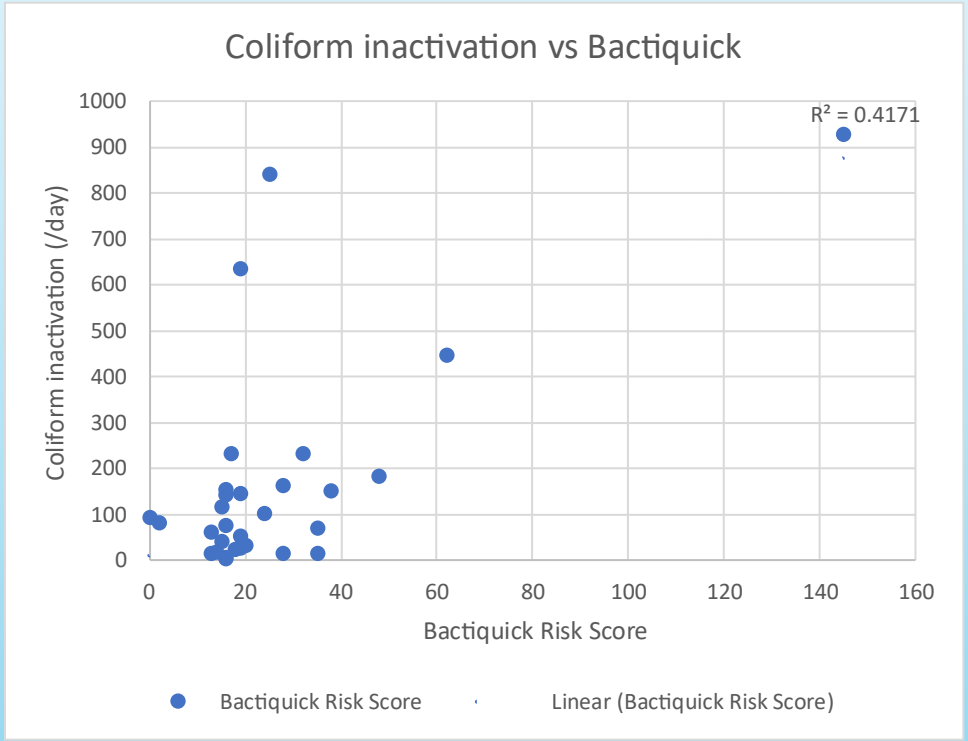


- R-cards are stored in a freezer, place sample on card, then incubate at 35°C for 24 hrs.
- Only tested for e.Coli, but Enterococcus available
- Count Blue dots (e.Coli) and Pink dots (coliforms). Average across 2 cards and multiply by 100 for score.
- 11 tests so far, correlation is very high to lab tests (R^2=0.92), remarkable given that by using 2 cards, results are ±70 cfu/100ml
- Used 1ml cards but 3ml available in which case error ±24 cfu/100ml



Why does Bactiquick produce different results?

- All coliforms are gram-negative and therefore will generate a response:
  - Better fit between total coliforms and Bactiquick risk score (R^2 = 0.36 vs 0.2)
  - Includes non-sewage related, “non-harmful” environmental bacteria
- Sampling for the presence of free endotoxins in the water:
  - Shed by bacteria during cell damage, death and division
- Measure of coliform inactivation (both e.Coli and Total) not concentration

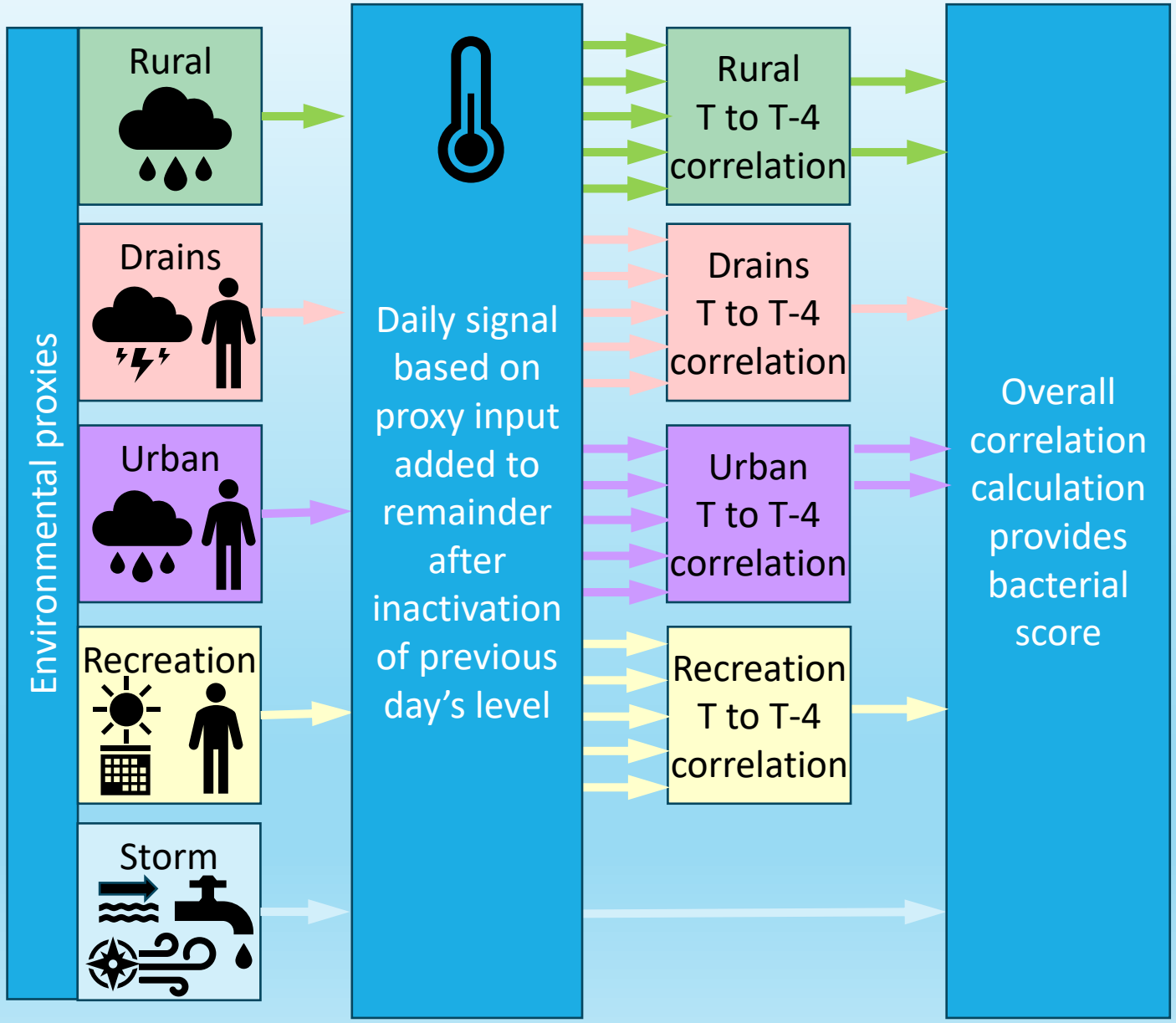


e.Coli samples inactivate at 2.3 times the rate of total coliforms at summer ambient river temperatures

Faecal indicator Organism die-off rates in UK rivers, O’Brien et al, UK CEH for UK Water Industry Research, 2026

Modelling bacterial inputs

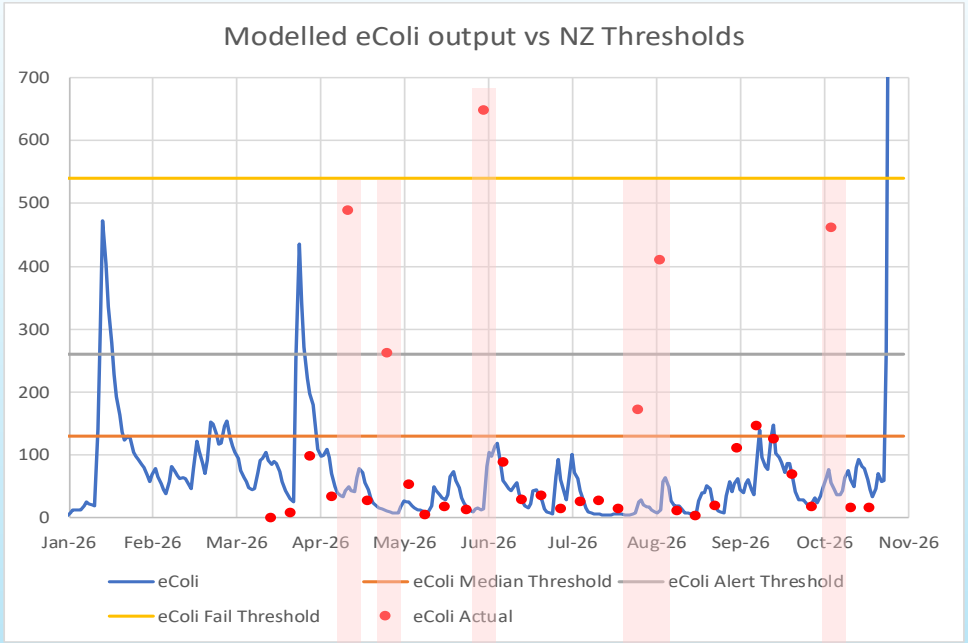
- 2025 analysis led to the development of a model using environmental inputs to predict eColi and Enterococcus levels
- Environmental proxies used to simulate different types of pollution

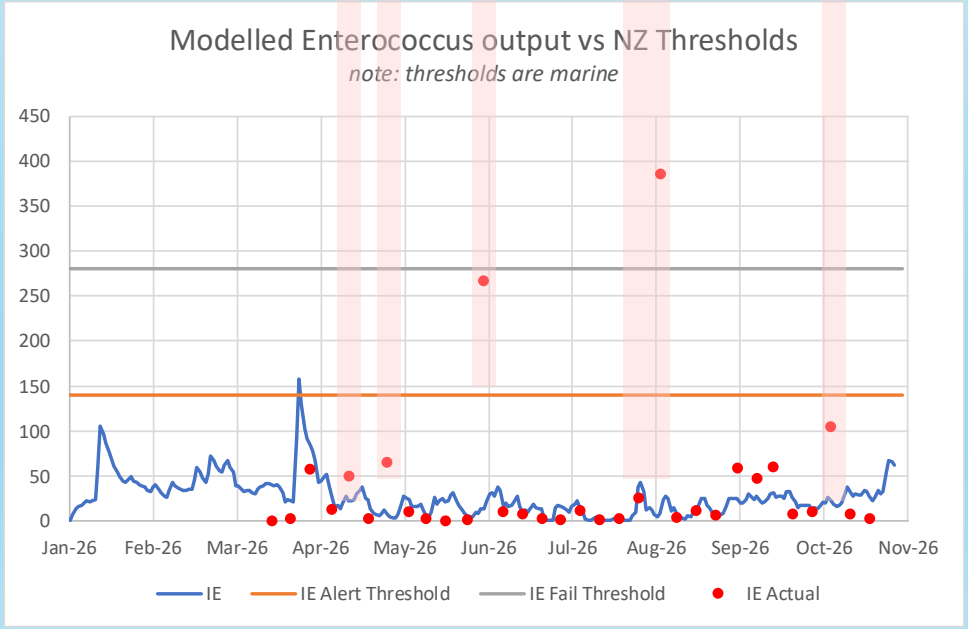


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Model performance

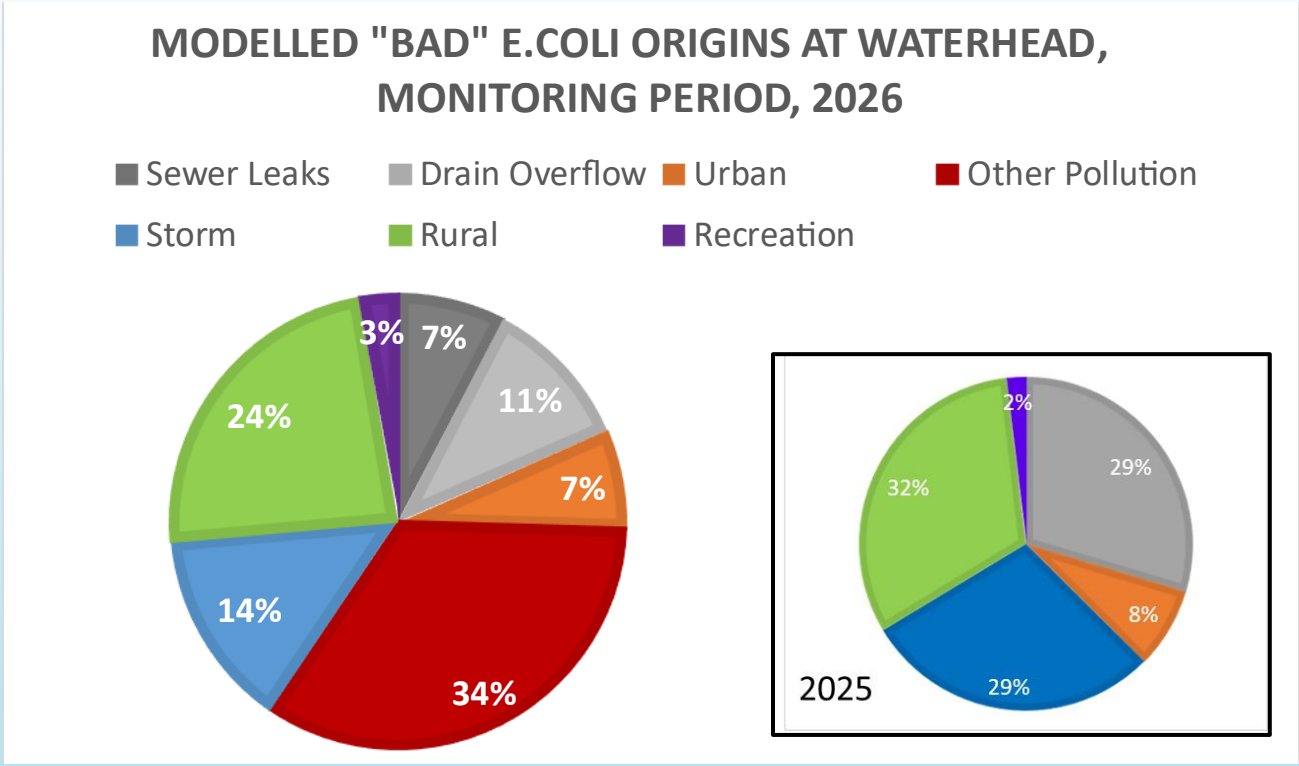
- Graphs show performance of the model using the 2026 environmental data
- E.Coli predictions follow trends with the exception of five pollution events that have no obvious environmental driver
  - No unexplained pollution events in 2025 due to wetter summer
- Enteroccus predictions similarly show a fair fit to reality with the exception of same pollution events
- Ignoring pollution events, correlation factors: e.Coli: 0.78, Enterococcus 0.65

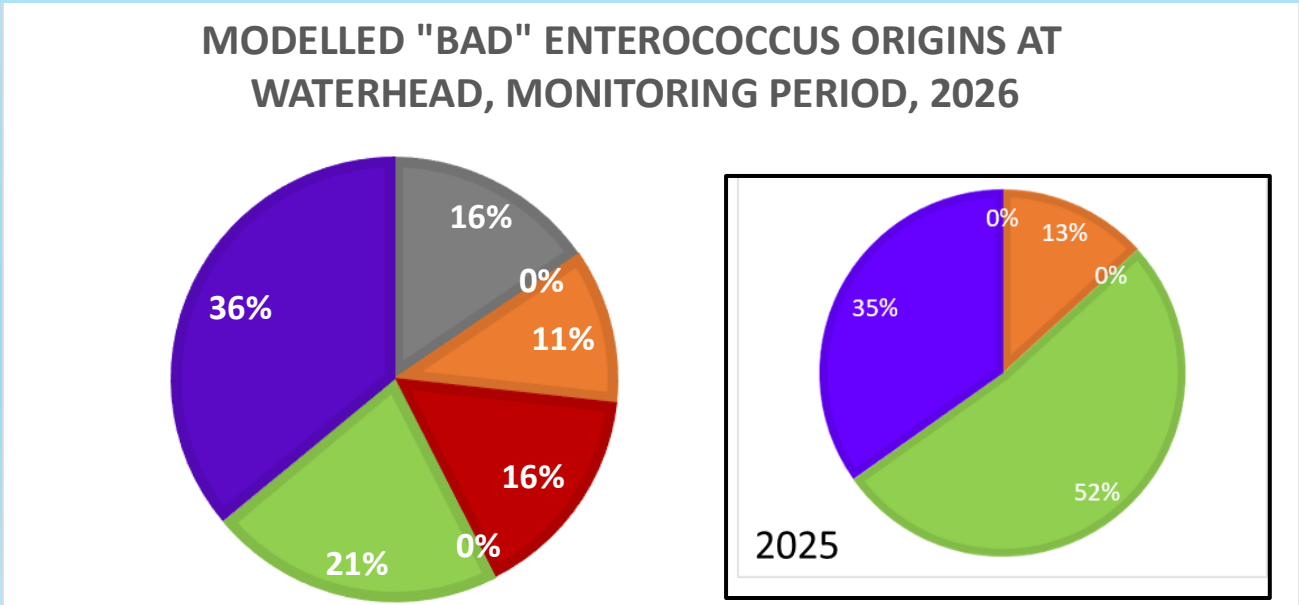




Modelling bacterial origins

- Model can identify which contribute most to bad quality:
  - Layer pollution incidents on top of model
  - Sum origins on days where e.Coli levels over the median threshold
- E.Coli – 96% increase vs 2025
  - Urban, storm and drains similar
  - Rural higher but smaller proportion
- Enterococcus – 57% increase vs 2025
  - Recreation nearly doubled to become the most important – dogs / swimmers
  - Rural input halved
- Pollution episodes 85% of increase





What does WET tell us about helping the public to swim safely?

- Windermere at Waterhead is mostly safe to swim in during the bathing period
  - Not the blanket “Excellent” that UK rules suggest
  - In 60 weeks of testing, there have been 8 occasions where Alerts would have been issued had Waterhead been in New Zealand, 2 closures
    - In 2025, linked to Storm Overflows and lengthy and/or intense rainfall
    - In 2026, rainfall still a key factor, but also individual pollution events that can’t be predicted from environmental factors
  - In other seasons, rainfall is biggest driver of quality
- Effective communication is critical
  - WET reached nearly 5,000 unique Internet users, plus noticeboards
  - A system that takes over a week to publicise issues can’t fulfil its purpose
  - Has to be both cost-effective and not time-consuming for volunteers
  - Requires a combination of environmental monitoring and physical testing to allow for random pollution events

Moving forward – Combine model and tests

- Manual testing to validate model and identify pollution incidents:
  - Laboratory testing – not timely (7 days+) and expensive (£100/test)
  - Bactiquick – identifies broad quality, results 15 mins, modelling accuracy? (£30/test)
  - R-cards – the best option, results in 24 hours (£10/test @ 2 cards each for 2 bacteria)
- Modelling Methodology:
  - Import environment data
  - US EPA method, daily values with 7 day windows
  - Overlay pollution

2025

		April				May				June				July					August				September					October			
S		P	P	F	C	P	P	P	P	F	F	B	C	B	P	P	F	P	P	F	P	P	F	F	P	B	P	B	F	P	F
M		P	P	F	P	P	P	P	P	F	F	B	C	P	P	P	F	P	P	F	P	P	F	F	P	B	P	B	F	P	F
T		P	P	F	P	P	P	P	C	F	C	P	P	P	P	P	F	P	P	F	P	P	F	F	B	F	P	F	C	P	F
W		P	P	F	P	P	P	P	F	F	C	C	P	P	P	B	F	P	P	F	P	P	F	F	B	F	P	F	P	P	F
T		P	P	F	P	P	P	P	F	F	C	C	P	P	P	B	F	P	F	F	P	P	F	C	B	C	P	F	P	P	F
F		P	P	F	P	P	P	P	F	F	C	C	P	P	P	F	F	P	F	P	P	P	F	P	B	P	P	F	P	C	F
S	P	P	C	F	P	P	P	P	F	F	P	C	P	P	P	F	P	P	F	P	P	F	F	P	B	P	B	F	P	F	F

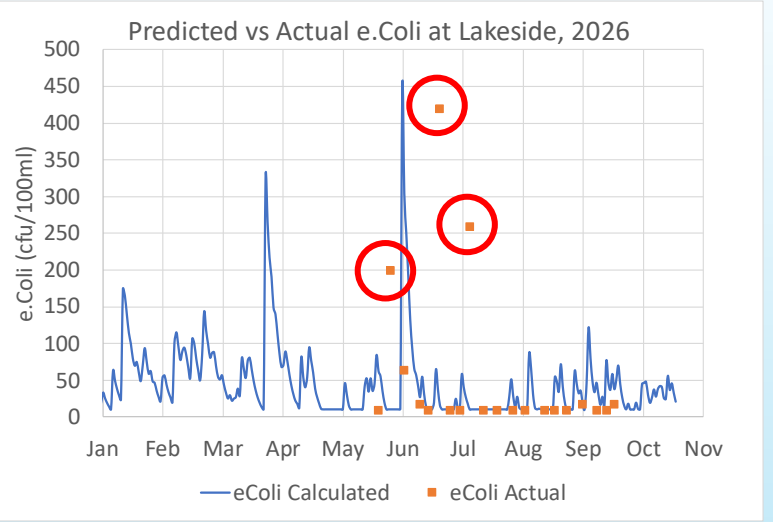
2026

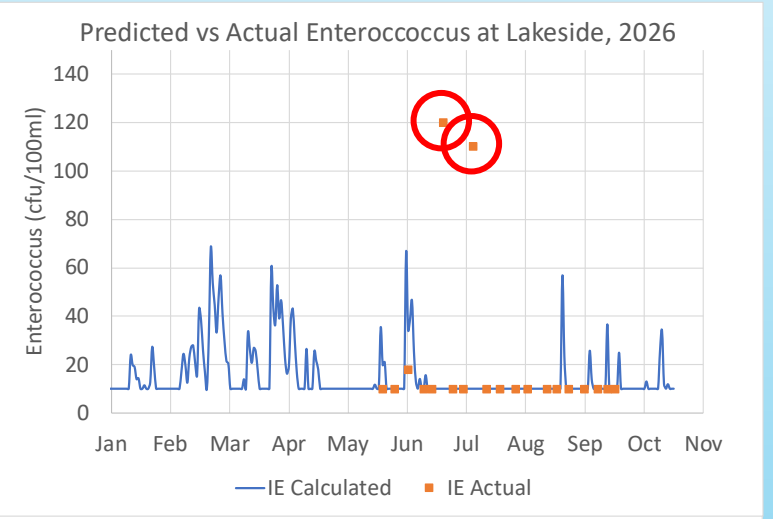
	January					February				March					April				May				June				July				August				September					October			
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Summary

- Lakes difficult to model: slow-moving water, public access and shoreline land-use create unpredictable pollution events
- WET shows that modelling is possible where sources can be defined and environmental proxies used for inputs
  - E.coli is easier to predict than Enterococcus
  - Even then, low rainfall and pollution events can break the model
- Models require on-site testing to validate conditions
- Principles extended to other Windermere bathing sites, e.g. Lakeside using 2024-25 data to predict 2026 results





2026

	January	February	March	April	May	June	July	August	September	October
S	P P P P	P P P P	F P P P F	C P P P	P P P P	P F P P	C P P P P	P P P P	P P P P P	P P
M	P P C P	P P P C	F P P P F	P P P P	P P P P	P F P P	P P P P P	P P P P	P P P P P	P P
T	P P P P	P P P C	C P P P F	P P P P	P P P P	P F P C	P P P P P	P P P P	P P P P P	P P
W	P P P P	P P P C	P P P P F	P P P P	P P P P	C C P C	P P P P P	P P P P	P P P P P	P P
T	P P P P P	P P P C	P P P P F	P P P P	P P P P	F P P P	P P P P P	P P P P	P P P P P	P P
F	P P P P P	P P P F	P P P P C	P P P P	P P P P	F P P C	P P P P P	P P P P	P P P P P	P P
S	P P P P P	P P P F	P P P F C	P P P P	P P P P	F P P C	P P P P P	P P P P	P P P P P	P P

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Questions?



Thanks to the Water Group team: Clare Humphry, Iain and Sandra Blackburn, Juliet Cunningham, Jane Mathieson, Julia May, Ursula Brendling and Barbara Stothard without whom none of this would have been discovered!

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Thanks also to our sponsors, the Lakes Parish Council, who supported the majority of the testing, and the Penny Conservation Trust, who funded the last few weeks of testing.

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