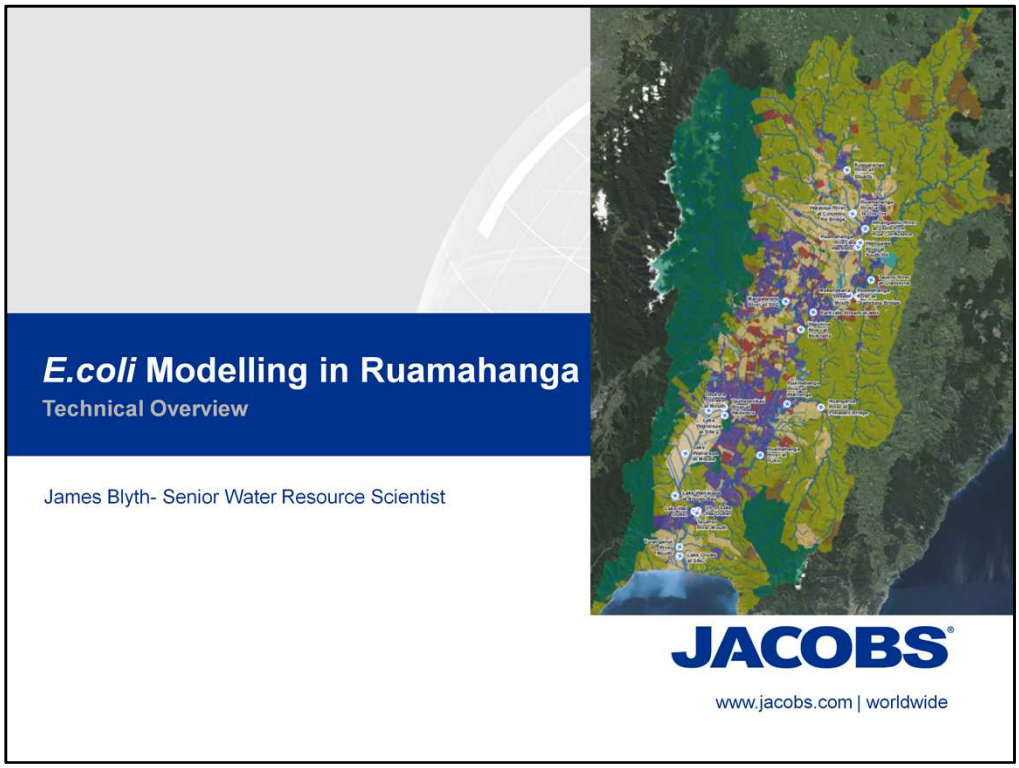

This presentation aims to summarise the *E.coli* modelling undertaken as part of the Ruamāhanga Whaitua Process. The high level overview is supported by a number of technical reports, primarily the E.coli Human Health Report titled "IZ090000_RP_Rua_Scenarios_Human_Health_E.coli_Rev2_Final".

What should you consider from the modelling results?

- These are a guide to help inform your decisions
- The results will not always be a perfect match to the observed data
- The model is calibrated as close as possible to observed data, with the aim of replicating the natural system
- The relative changes (i.e. percentage reductions and swimming categories) provide the most useful information about how a catchments concentrations may change, depending on its landuse and the mitigations applied

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Background to catchment modelling

- Landuse/soil classes defined in the catchment
- Apply input data to these landuses
  - EMC - Event Mean Concentrations.
    - Applied to the quickflow/runoff during storm events
  - DWC – Dry Weather Concentrations
    - Applied to the baseflow that occurs as regular inputs to a stream

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This slide summarises the approach undertaken to assign input concentrations in the model for E.coli to certain landuse types. There are 48 landuse/soil drainage combinations in the model, each with variations of E.coli EMC and DWC inputs.

Background to catchment modelling

- Flows generated off each landuse are partitioned into baseflow and quickflow.
  - The partitioned flow has either EMC's or DWC's applied to generate load
- Point source inputs (i.e. WWTP) added as a daily concentration
- Model is calibrated at various river sites to observed data, by incorporating 'attenuation factors' and stream decays (die off)

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This is a continuation of the previous slide, explaining how flow is generated off each landuse in the model. This is then partitioned into baseflow and quickflow (i.e. a baseflow separation analysis). The EMC's are applied to quickflow, the DWC's to baseflow. This is important as it links back to mitigations at a later stage where if you change the landuse due to retirement, you change the EMC/DWC inputs for that area, or if you apply reductions to DWC's, this effects loads through baseflows, which are generally smaller than the EMC's. EMC's primarily influence the 95th percentiles and also the medians.

Assumptions/Limitations to *E.coli* modelling

- Most input concentrations are off literature data, not always from the study area
- Model is daily timestep and 'lumped' loads, where *E.coli* is best modelled sub-daily (i.e. 2 hourly)
- Flows (not modelled by Jacobs) have a significant impact on concentrations. Poor flow calibrations mean *E.coli* calibrations may be poor.
- Water quality data to calibrate was from 2000-2014 (same as flow data), and was not calibrated for 'swimmability' criteria brought out in mid 2017.

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Discuss the last two points as these hold the most importance. The model at a number of locations oversimulated the flows, which has led to a greater load than the observed at some sites. Governmental regulation changes in E.coli swimmability were implemented mid 2017, and were not calibrated for in the baseline model. Important as the swimmability criteria is based off the last 5 years of WQ data, not the 14 year record we have used for calibration.

Mitigations applied

- Tier 1 BAU- Stock exclusion and dairy effluent management, lowers Dry Weather *E.coli* Concentrations (DWC) by 44-69%
- Tier 3 SILVER/GOLD- Riparian planting, lowers Event Mean *E.coli* Concentrations (EMC) by 10%
- WWTP land treatment- decrease *E.coli* concentrations by 95%
- Land Retirement- changes input concentrations to 'Native Bush' values (very low in *E.coli*)

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These are the key mitigations applied in modelling that effect E.coli. Driven primarily from MPI/Agresearch farm mitigation modelling. Richard Muirhead helped advise the DWC and EMC reductions to apply to baseflows and quickflows. WWTP 95% reductions were based off a single study for the region, and in reality may have less removal than this, however in the absence of data this was applied to all sites.

Amended NPS Swimming Guidelines

Category	Percentage of Exceedances over 540 cfu/100 mL	Median E.coli per 100 mL	95th percentile E.coli per 100 mL	Percentage of exceedances above 260 cfu/100 mL
Blue (Excellent)	< 5 percent	≤ 130	≤ 540	< 20 percent
Green (Good)	5–10 percent	≤ 130	≤ 1,000	20–30 percent
Yellow (Fair)	10–20 percent	≤ 130	≤ 1,200	20–34 percent
Orange (Intermittent)	20–30 percent	> 130	> 1,200	> 34 percent
Red (Poor)	> 30 percent	> 260	> 1,200	>50 percent

- Blue to Yellow- Suitable for primary contact recreation (swimming)
- Red and Orange- Generally unsuitable for swimming

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NPS 2017 amended E.coli swimmability criteria

Modelling swimmability results

Site	Base-line	BAU 2025	BAU 2040	BAU 2080	Silver 2025	Silver 2040	Silver 2080	Gold 2025	Gold 2040	Gold 2080
Kopuaranga at Stuarts										
Waipoua at Colombo										
Rua at Te Ore Ore										
Whangaehu 250m Confluence										
Rua at Wardells										
Waingawa at South Rd										
Taueru Gladstone Te Whiti										
Makahakaha Stream Mouth										
Rua at Gladstone										
Parkvale Weir										
Mangatarere at SH2										
Waiohine at Bicknells										
Huangarua Ponatahi Bridge										
Rua at Waihenga										
Rua at Pukio										
Rua US LWai Outlet										
Tauanui River Mouth										
Turanganui R Mouth										
Otukura Stream Mouth										
Tauherenikau at Websters										

Summary of the E.coli scenario results showing how the sites change (or don't) from the baseline model. Note that these are simulated results only, the baseline may vary in swimmability category compared to the observed. The technical report goes into more detail about the sites, how they compare to observed data and the relative changes that could be expected due to mitigations and land use change in the catchment.

Kopuaranga at Stuarts

- Example of a site that did not change swimmability category
- Catchment is 93% sheep and beef, dairy and dairy support
- Flow calibration at this site resulted in higher simulated flow than observed, led to a higher *E.coli* concentration (cfu/100 mL).
  - High simulated concentrations decreased in scenarios, but not enough to change category

Scenario	Median (50th) percentile	95th percentile	Category
Observed	180	1,800	D
Baseline Model	481	2,377	E

- No retirement in BAU, 1068 ha in Silver and Gold (6.4% of area)
- Applying the 8.5 – 19.4% reductions in 95th percentiles in Gold and Silver scenarios to observed 95th would not be sufficient to change this site to 'yellow' (<1200 cfu/100 mL)

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This is a summary of one of the 'red band' sites which do not change, with explanations as to why. This detail is covered further in the E.coli Human Health Technical Report. Primarily this is showing that while the scenario modelling is significantly different to the observed for the median results, the mitigations applied in modelling can be used to approximate % changes from the baseline. These % changes (i.e. 19.4% reduction in the 95th percentiles) can be applied to the observed to see if a change would occur that may not have been evident in the scenarios.

Key changes between scenarios- BAU

Site	Base-line	BAU 2025	BAU 2040	BAU 2080
Taueru Gladstone Te Whiti				
Waiohine at Bicknells				

- Only 2x sites change category from the baseline
- Minimal land retirement
- Stock exclusion and dairy effluent management is effective on the base load of *E.coli*, BUT
  - what drives the swimming categories the most is the 'event loads' which cause high median and 95th percentiles

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Discuss the results for BAU, changing at only two sites. While medians have decreased significantly in a number of sites, this is often not the cause for a site being in yellow, orange or red category. Usually these are driven by higher 95th percentiles >1000 cfu/100 mL, which means any stock exclusion (Tier 1 mitigation) effecting baseflow loads only will have limited reductions in the 95th.

Key changes between scenarios- SILVER

Site	Base-line	Silver 2025	Silver 2040	Silver 2080
Huangarua Ponatahi Bridge				
Mangatarere at SH2				
Parkvale Weir				
Rua at Te Ore Ore				
Tauanui River Mouth				
Taueru Gladstone Te Whiti				
Waiohine at Bicknells				
Waipoua at Colombo				

- 8x sites change category from the baseline
- Significant land retirement (up to 10,000 ha)
- Riparian planting (Tier 3) lowers event loads by up to 10%, decreasing 50th and 95th percentiles
- WWTP land treatment lowers point source inputs significantly

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Silver has greater changes, as it incorporates riparian planting/buffer strips removing some E.coli. In addition there is greater WWTP land treatment, more retirement (changing E.coli input concentrations). The 10% reduction is staged depending on the amount of riparian planting occurring, i.e. 100% by 2080 would be a 10% reduction, however 66% by 2040 would be 6.6% reduction. Width/thickness of buffer strip has been assumed to be equal in effectiveness in Gold and Silver.

Key changes between scenarios- GOLD

Site	Base-line	Gold 2025	Gold 2040	Gold 2080
Huangarua Ponatahi Bridge				
Mangatarere at SH2				
Parkvale Weir				
Rua at Te Ore Ore				
Tauanui River Mouth				
Taueru Gladstone Te Whiti				
Waiohine at Bicknells				
Waipoua at Colombo				

- 8x sites change category from the baseline
- Same sites as Silver
- Difference- This all occurs in a faster timeframe (i.e. by 2025 or 2040)

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Key changes in Gold is primarily due to a faster adoption of mitigation practices.

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