Te Niwha Scholarship Summary for Final Report

Research Title

Roof-Harvested Drinking Water Surveillance Using Metagenomics and qPCR in the Ngāi Tahu Takiwā

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Summary

Systemic failures in drinking water systems can result in significant health risks. In Aotearoa, past outbreaks, which include the largest reported water-borne campylobacteriosis outbreak in the world, in Havelock North in 2016, have highlighted the severe impact of diseases. Current microbial water quality testing relies on monitoring for the faecal indicators of total coliforms (TC) and *Escherichia coli* - 19th century technology that fails to capture the full spectrum of potential pathogens and lacks insight into contamination sources. Metagenomics (DNA-based analysis of all microbes in a sample) and quantitative polymerase chain reaction (qPCR) (a method that measures quantity of specific microbes) will be a paradigm shift for drinking water management. While it is now economically and practically feasible to apply metagenomics, there is a pressing need for fundamental science to underpin this tool's implementation.

Roof-water systems for drinking water are widely used in Aotearoa yet they are largely unmonitored and risks are relatively unknown. Current monitoring approaches rely largely on simple indicator bacteria that do not always reflect true health risk. At the same time, notified cases of water-associated diseases such as legionellosis and enteric infections continue to occur in Aotearoa, and the contribution of burden of disease from roof-water sources is poorly understood. Communities, public health agencies, and policymakers need better evidence to understand where risks occur, how they change over time, and what actions are most effective in reducing illness. There has also been limited application of modern genomic tools to small drinking water systems.

This research aligns closely with Te Niwha's mission to strengthen infectious disease research capability, improve preparedness, and support equitable health outcomes. By focusing on environmental exposure pathways for infectious disease, the project contributes new knowledge that supports prevention, surveillance, and long-term public health protection. This project applied metagenomics and qPCR to roof-water supplies to better understand bacterial communities, pathogen presence, and treatment performance. The aim was to generate new evidence on microbial risks in roof-harvested drinking water and to understand how these risks vary between sites and over time.

This project builds on a larger MBIE Endeavour project and a previous Te Niwha funded project and focused on generating new evidence from repeated testing across multiple roof-water sites. Across two sampling rounds, we used DNA-based methods to describe and compare the bacterial communities present in roof-water supplies and how they varied between sites and over time. We also looked for bacteria of public health

concern, including enteric (gut-related) pathogens and *Legionella*. In addition, we assessed how different treatment types performed in real-world settings and tested for faecal source markers to help indicate whether contamination is likely coming from human or animal sources. Together, these findings provide clearer, practical insights into bacterial communities in roof-water supplies, how risks may change over time, and which management or treatment approaches are most likely to reduce exposure.

This research demonstrates that metagenomics and qPCR can be successfully applied to roof-water systems to provide a much clearer picture of bacterial risks than traditional monitoring alone. Early findings show substantial variation in bacterial communities between sites and over time, highlighting the importance of system maintenance, treatment effectiveness, and local environmental conditions. The research also identified a range of potential pathogenic bacteria including the Legionella and other bacteria associated with enteric (gastrointestinal) illness.

The research was supported through Te Niwha funding and involved collaboration between PHF Science, Ngāi Tahu Research Centre, Te Kura Taka Pini, Rūnanga partners, and public health and water sector stakeholders. These partnerships strengthened interdisciplinary capability across environmental microbiology, infectious disease research, and public health practice while ensuring the research was grounded in community and sector priorities.

The results are relevant to multiple groups, including Rūnanga, households using roof-water supplies, public health units, water sector organisations, and policymakers. Communities can use the findings to better understand risks in their water systems and take informed steps to protect health. Public health agencies and regulators can use the evidence to inform guidance, monitoring approaches, and water safety planning for non-reticulated supplies. By providing locally relevant data on pathogen presence and treatment performance, the research supports safer drinking water and helps reduce preventable illness. It also contributes to more equitable health outcomes by addressing risks in communities that are often under-served by existing water regulations.

This project provides a strong foundation for the next phase of research, including planned PhD work. Future research will quantify how many people across Aotearoa rely on roof-water supplies, examine national patterns in bacterial risk, and assess associations between roof-water exposure and notified cases of infectious disease. Targeted sampling will be used to validate assumptions and strengthen understanding of how environmental exposure contributes to illness.