



University  
of Victoria

Graduate Studies

Notice of the Final Oral Examination  
for the Degree of Master of Applied Science

of

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BSc (University of Calgary, 2016)

**“Innovative Techniques for the Quantification of Waterborne Microbial  
Risks in Field Studies”**

Department of Civil Engineering

Thursday, August 15, 2019

9:00 A.M.

Engineering/Computer Science Building  
Room 128

Supervisory Committee:

Dr. Caetano Dorea, Department of Civil Engineering, University of Victoria (Supervisor)  
Dr. Heather Buckley, Department of Civil Engineering, UVic (Member)

External Examiner:

Dr. Natalie Linklater, Department of Environmental Engineering, University of Northern British  
Columbia

Chair of Oral Examination:

Dr. Wanda Boyer, Department of Educational Psychology & Leadership Studies, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

## Abstract

In low-resource contexts, household-level point-of-use water treatment (POUWT) methods are the final, and sometimes only, barrier against waterborne illnesses, and in these and other water-related applications, health risks can be quantified using one of two methods. Firstly, *Escherichia coli* (or other indicator organism) counts can be used to monitor water and determine adherence to a health-based limit (i.e. compliance monitoring). Secondly, *E. coli* can be used to conduct a quantitative microbial risk assessment (QMRA), indicating the level of protection conferred by a given POUWT device by spiking test water with *E. coli* to ascertain a reduction efficacy relative to that target organism; a process referred to as *challenge testing*, which is typically carried out in a laboratory context. Although both methods are well established, both have scope for improvement for effective field application in low-resource contexts. Regarding compliance monitoring, the performance of a new low-cost field kit for *E. coli* enumeration was assessed, and the feasibility of re-using some disposable materials was assessed for sterility and mechanical wear. The use of the new low-cost field kit was successful during the fieldwork campaign; however, re-using disposable materials introduced a relatively high occurrence of false positive results during *E. coli* enumeration. Use of the new low-cost field kit can reduce financial barriers, thus enabling greater water quality testing coverage. Regarding challenge testing, objective of this study was to adapt current protocols to assess the *household* performance (as opposed to *laboratory* performance) of POUWT methods. A conceptual framework was developed to conduct Field Challenge Tests (FCT's) on POUWT methods, and a pilot FCT was successfully carried out in Malawi with limited resources, verifying FCT viability. Applications of such FCT's include quality control practices for manufactured devices, guiding QMRA and recommendations by public health organizations regarding POU device selection, and assessing the impact of user training programmes regarding POUWT methods.