

# The Design and Usage of a Portable Incubator for Inexpensive In-Field Water Analysis

## Summary Paper

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## 1. TARGET AUDIENCE

The audience for this paper is humanitarian workers or others who may benefit from a two-day turnaround of bacterial water quality analysis achieved using a portable, rugged, and battery-powered method, ideal for field use in remote developing communities (Figure 1)



Figure 1: The Armadillo incubator

## 2. BACKGROUND

3M Petrifilm Count Plates (Petrifilms) can quantify bacterial contamination (Figure 2). Petrifilms are easily understood by local community leaders, despite potential language barriers, due to their visual nature. Petrifilms need to be incubated at close to body

temperature (35°C). They are sometimes incubated using the body heat of field workers, which is another viable approach to incubation that addresses challenges frequently encountered in field settings where grid electricity is unavailable. An inexpensive, application-specific battery-powered incubator would complement the existing incubation options and would significantly improve one's ability to do water analysis testing in a wider variety of settings, especially low resource and off-grid settings.

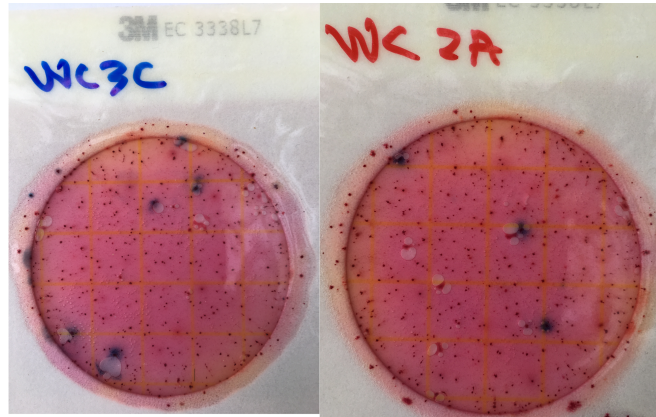


Figure 2: Petrifilms from the same source incubated in the laboratory incubator (left) and the Armadillo (right) showing purple *E. coli* colony-forming units (CFUs)

### 3. PURPOSE

The portable Armadillo Petrifilm incubator (the Armadillo, Figure 1) described herein is a robust, reliable, and convenient incubation method that has been tested in laboratory and field environments. Free, open-source construction plans for the Armadillo are published to encourage independent replication and co-development (EWB-USA-Austin 2017). The Armadillo is easily constructed from commercially available components. The total cost of one unit is less than USD \$200.00.

### 4. METHOD

The Armadillo was compared to an industrial laboratory incubator by enumerating bacterial counts in identical water samples. The temperature holding performance was measured at ambient temperatures of 25°C (65 hours) and 4°C (40 hours).

### 5. RESULTS

The Armadillo can incubate for the full period of 48 hours on one battery charge in most ambient temperatures. Bacterial counts from water samples enumerated with the Armadillo were benchmarked against those with an industrial 110 V AC laboratory incubator (estimated cost: USD \$1,500.00), which produced comparable results.

### 6. IMPLICATIONS FOR TARGET AUDIENCES

The Armadillo provides a reliable, inexpensive method to measure bacterial water quality in poorly electrified locations with a turnaround time of 48 hours. The Armadillo is designed specifically for incubating Petrifilms, which provide intuitive, visually quantitative results of bacterial contamination that is understandable with minimal language dependence.