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System ID:
Introducing the WaterScope Testing System

The WaterScope testing system is refining the membrane filtration method using a simple-to-use cartridge, a disposable insert and a microscope with machine learning to speed up and simplify data collection.

1) Sample filtered through cartridge using filtration system

2) Sample incubated and analyzed in testing kit

3) Machine learning automatically identifies and counts bacterial colonies

E. coli

Coliforms
System contents

Hardcase with:
1) Imaging system
2) Incubator: cartridges are stored in here

Filtration unit with:
3) Collection cup
4) Funnel
5) Filtration cup lid
6) Collection cord
7) Filtration cup
8) Filtration port cap

9) UV steriliser

Checklist
Hardcase
Filtration unit
Electric pump
Water bottle and media powder
Ethanol spray
Power cable
Power bank
Sliders
Cartridges
Steam steriliser
Cartridge guards
Clean water (for steam steriliser)
UV Steriliser

Power cable
Ethanol spray
Water bottle and media powder (p.13)

Cartridge guards

Electric pump

Catridge steriliser

Slider (p. 7)

Cartridge (p. 7)

Power bank
Cartridge instructions

Cartridge top

1) Imaging window  
2) Clamps  
3) Top filtration port

Cartridge (clamped)  
Cartridge (unclamped)

Cartridge bottom

4) Media cap  
5) Bottom filtration port

Slider

6) Plastic housing  
7) Membrane  
8) Absorbent pad

Slider top  
Slider bottom

Slider positions (top side facing up)

First position (for filtration)  
Moving to second position (unclamp, move slider, clamp)  
Second position (for incubation)
The filtration unit contains filtration cup, collection cup, two funnels, filtration cup lid, filtration port cap and the collection cord.

You can easily store the whole unit in the filtration cup (the biggest cup), except for the collection cord. For that you first put the collection cup in the filtration cup. After that you add the two funnels one on top of each other and lastly, the filtration cup lid.

Do not forget to put the filtration port cap either on the filtration ports on the lid or just inside the set.

In general, if you want to run one sample at a time, put the cap on one of the filtration ports. If you want to run two samples at a time, just remove the cap.

The two funnels have different sizes, so that they both fit perfectly next to each other on the filtration cup lid.

On the inside, they both have markings indicating 5 mL, 10 mL, 50 mL and 100 mL.
Preparation before conducting a test
Preparation

Before conducting a test you will first need to prepare the cartridge which includes washing (if used before) and sterilising them (p. 11). Second, you will need to prepare the nutrient media (p. 13).
Cartridge Disinfection

1) Fill steriliser up to maximum line with clean, non-hard water. If the water is hard, use boiled water or bottled water.

2) To prepare the cartridge for sterilisation, first remove the cartridge from the imaging system chamber and lift the clamps to release the slider, if you had used the system before. Properly dispose the slider by generously spraying with ethanol or boiling for a few minutes. Then wash the cartridge with warm water, before rinsing it with clean water. Then loosen the cap of the media chamber slightly.

3) Add the cartridge guard on the bottom filtration port.

4) Place the plug of the cartridge guard into the cartridge side (red circle) and leave the top cap off.

5) Place the unclamped cartridge on its side in the steriliser with the guard plugged on the back side, leaving the middle and top sections open to the steam.
6) Run the steriliser on heat and dry mode (orange circle). This should take 45 minutes. If the cartridges are still wet, just run the dry cycle again (red circle).

7) Once dry **(be careful they may be hot)**, close the cartridge clamps, and tighten the media cap. **Make sure you disinfect your hands** before touching the cartridges to **avoid potential contamination**.

8) Push the remaining plug of the cartridge guard onto the top filtration port. The cartridge is now ready to then be put into the incubator for use in the field.
Media preparation

The aim is to add the powdered medium into the bottle, containing sterile water to activate the media for use. We advise doing this the day before, or the morning of sampling. Wash hands and spray hands and lids of media bottle with ethanol before conducting.

1) Unscrew plastic lid on powdered medium.

2) Open the sterile water bottle placing its lid upside down on a clean surface to avoid potential contamination. Carefully pour media powder into the sterile water bottle.

3) Shake well for 30 seconds before use and store it for up to two weeks in the fridge. Write the date on the bottle for tracking.
Performing a test
Preparation

Connect the power bank and the imaging system with the power cable to turn it on, at least 30 minutes before testing. The incubator will automatically turn on, there is no need to turn it on using the screen buttons. It is automatically set at 36.5 °C.

After booting, the screen will display the incubator temperature (current / target temperature), the time running (“Time X:XX”) and test options (“o – test”).

The **top temperature** reading is the **left incubator**, and the **bottom temperature** reading corresponds to the **right incubator**.

The screen buttons and their function will be further explained on p. 26.

You can reset the timer by holding down the up arrow screen button, this will help you monitor your testing (red circle).
Cartridge and collection cup preparation

1) Disinfection: Spray/wipe the collection cup and both of the funnels with ethanol to sterilise. Wait at least 30 seconds to dry. Spray your hands as well at this step. Then place them in to the UV steriliser for 1 minute each.

2) Collect a water sample using the collection cup and if needed use the collection cord. Rinse the funnel with a small amount of sample water and set aside.

3) Unwrap the cartridge and slider, taking off the cartridge guards. Be careful not to touch the slider’s top inlet with your fingers. Insert the slider into the first position (membrane facing up, p. 7) for filtration. Make sure the slider is located correctly by pulling back on the slider until it is flush against the cartridge.

4) Push the clamps of the cartridge down to lock the slider in position.
Filtration system assembly

Assemble the filtration unit by first putting the lid on the filtration cup. Make sure it is standing on a flat surface. Connect the electric pump to the filtration cup lid as shown on the picture using the pump tubing and the smaller port on the lid. Make sure both tubing connections are tight by pushing firmly.

If you want to run two samples at the same time, check the instructions at page 18. If it is just one sample at time, close the second filtration port with the filtration port cap.

Next, connect the cartridge (imaging window facing up) to one of the ports on the filtration cup lid.

Then, connect the funnel to the cartridge filtration port. The funnel is normally stored in the filtration cup.
Filtration system assembly (for two sample testing)

Our system is designed in a way so that it is possible to **run two water samples at a time**. For that, remove the filtration port cap and assemble the system in the same way like you would do for one sample (p. 17). You will need a second funnel, cartridge and slider. Be sure that you also had **sterilised the additional cartridge** before using.
Sample filtration

Using the collection cup or sample bag, pour the water sample into the funnel. There are markings on the inside of the funnel to indicate 5 ml, 10 ml, 50 ml, 100 ml (red circles).

For clear water (0 NTU), it is recommended to filter 100 ml.

If the water is suspected to have high turbidity, it is recommended to start with 10 ml (black circle). Use the table below as a reference.

<table>
<thead>
<tr>
<th>Turbidity Range (NTU)</th>
<th>Volume filtered (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.5</td>
<td>100</td>
</tr>
<tr>
<td>0.5-1.5</td>
<td>50</td>
</tr>
<tr>
<td>1.5-5</td>
<td>20/10</td>
</tr>
<tr>
<td>&gt;5</td>
<td>10</td>
</tr>
<tr>
<td>&gt;50</td>
<td>1</td>
</tr>
</tbody>
</table>

Funnel with volume markings

Turbid water samples
Sample filtration (continued)

Unplug the power cable from the imaging system. Connect the electric pump to the power bank with its cable to switch it on. You can either leave the power bank in the system kit or place it outside of it.

**Note: the pump is loud and will vibrate.** Wait until all of the sample has been filtered and the membrane is dry without any remaining water. Unplug the pump from the battery to switch it off and disconnect the tubing from the filtration cup lid.

**IMPORTANT:** Only leave the pump running for a maximum of 10 minutes. If the water has not decreased by then, look at the section “troubleshooting guide” for help.
Sample preparation for incubation

Lift the clamps of the cartridge to release the slider. Hold the funnel and push the slider to the second position for incubation. You can also remove the funnel, just make sure it lays on a clean surface. Close the clamps of the cartridge to secure the slider in place. Disassemble the filtration system by removing the funnel (if not already done). The cartridge can be left on the filtration cup for now. Once the slider is in position two and clamped, it is sealed and not prone to contamination so it can be briefly left on the side or on the collection cup.
Media addition and incubation

1) Unscrew the cap on the bottom of the cartridge.

2) Spray the medium from the ampule into the cap until it is approximately full. The precise amount does not matter as long as it is more than half full (5-6 drops). Be careful not to touch the inside of the cap with your fingers.

3) Screw in the media cap tightly into the cartridge from the bottom.

4) Open the incubator and slide the cartridge upside down into the tray with the media cap facing forward.

5) Close the incubator, shut the case securely and place upright. You can now also dispose the water from the filtration cup.

6) Incubate for the desired amount of time:

<table>
<thead>
<tr>
<th>Time</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>8h</td>
<td>Risk level</td>
</tr>
<tr>
<td>&gt;18h</td>
<td>Quantitative</td>
</tr>
</tbody>
</table>
Analysing a sample
Ways to analyse a sample

There are two ways to analyse a sample:

1) Using the screen and buttons on the system (p. 26)

2) Using the WaterScope android app (p. 27)

We recommend using the android app if possible as it provides a more complete experience.
Sample analysis

After desired incubation time (see the table below), remove the cartridge from the incubator. Open the imaging system chamber and slide the cartridge with the clamps into the sample holder with the imaging window (top side) facing the screen on the right. Close the imaging chamber lid.

2) Select ‘Test’ using the ‘O’ button on the screen of the imaging system. Follow the instructions on the screen to obtain results.

3) Select ‘App’ using the ‘X’ button on the screen of the imaging system. Follow the instructions on the app on your mobile device to obtain result.

<table>
<thead>
<tr>
<th>Incubation time</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>8h</td>
<td>Risk level</td>
</tr>
<tr>
<td>&gt;18h</td>
<td>Quantitative</td>
</tr>
</tbody>
</table>
Using the screen

1) Select ‘DONE’ using the ‘O’ button.

2) Select ‘DONE’ using the ‘O’ button.

3) Select ‘Analyse Sample’ using the ‘X’ button.

4) Use the arrow buttons to change sample ID as desired. Then select ‘DONE’ using the ‘O’ button.

5) Wait approximately 3 minutes for imaging and analysis.

6) The results will be displayed on the screen.
Using the WaterScope App

1) Download the App from Google Play:

2) If using the system for the first time, go to the Bluetooth settings, enable Bluetooth and search for the WaterScope system. Once you find it, click on it to pair. The number of the WaterScope system is written on the inside of the hardcase lid.
Using the WaterScope App

3) Open the WaterScope App and click on “Connect to a WaterScope device” and then click on the WaterScope system with the number which you just paired to.
Using the WaterScope App

4) Once the device is connected, there will be a green tick at the bottom left. Afterwards click on “Sample submission”, then enter the sample details and click “Submit sample”. The sample ID can only be numerical.
Using the WaterScope App

5) Wait for the analysis. This normally takes around 2-3 minutes.
Using the WaterScope App

6) Once the results are ready, they will be transferred over Bluetooth and shown in the app. The first image is the analysed result, if you swipe left you will see the second image, which is the raw data. You can click on the top right button to share the image to WhatsApp or email.
Using the WaterScope Dashboard
The WaterScope Dashboard

The WaterScope Dashboard allows you to see all tests conducted by registered devices. It also allows you to manually count colonies, download the raw data, as well as share testing results.
Using the WaterScope Dashboard

1) Create an account here: https://dashboard.waterscope.org/auth?mode=sign-up

2) After you login with your account details, you should see this:

3) Click on “Linked Devices” and a “Link new device” button will appear at the bottom right.

4) Add your WaterScope device identifier.
Using the WaterScope Dashboard

5) The dashboard should find the device and its latest location. Click on “Link this device”.

6) On the next window, you can change the operator name and location of your device.
Using the WaterScope Dashboard

7) After the device is linked, you can see all samples by clicking the “Sample history” button. You can filter samples by location, time, sample ID and contamination.
Using the WaterScope Dashboard

8) You can correct the machine learning count by clicking on the “Count Colonies” button.

9) Adjust the labels as appropriate and upload back to the database by clicking “Annotation” and “Upload annotations to Firebase”.

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Image of the WaterScope Dashboard with sample ID details and count options.

Image of the annotation tool with labeled regions on a sample image.

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Troubleshooting guide

Problems regarding the filtration of a water sample

If the water in the funnel is not decreasing while the electric pump is running, stop the filtration process by unplugging the electric pump.

Now pour out the water sample. For that, remove the cartridge and the funnel from the filtration cup lid while they remain assembled together, as it is shown in the pictures. The water sample can easily be poured out in an other cup, in the sink or just outside.

Now replace the wet slider with a fresh, dry slider. Reassemble the slider in position 1 and place it back onto the filtration manifold with the funnel in place. From here you can restart the filtration process with a new water sample.

Take extra care to align the slider carefully into the cartridge (see page 16). If you suspect filtration was slow due to high turbidity, you may consider using a lower volume of water (see page 19).
Troubleshooting guide

Problems regarding consumables

If your slider, slider lid or membrane pad seems to be damaged, do not use the slider for your water testing. Otherwise your results might be adulterated and not precise. Depending on which step you notice this, sterilise and then dispose the slider.

If you accidentally drop any parts of the system contents, e.g. the media cap while adding the media or the sliders, be sure that you will not continue using them for your testing. This provides adulterated results.

After having sterilised the parts with the steriliser (for cartridges) and the ethanol spray (for filtration unit parts), they are then ready to be used again. Sliders which have been dropped can not be used again, dispose them and use a new one.
Contact

Want to learn more about WaterScope and our work?
Visit us on [www.waterscope.org](http://www.waterscope.org) and follow us on Social Media:

- Twitter: @WaterScope_org
- Facebook: @WaterScope
- Instagram: @waterscope
- LinkedIn: @WaterScope

If you have any questions or want to reach out to us, contact us via email [info@waterscope.org](mailto:info@waterscope.org).

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