

Preliminary Research

1. Methods for determining what contaminants/solutes are in a water sample involve heavy, calibrated scientific equipment. Even though portable options do exist, such as the handheld XFR analyzer (<https://www.bruker.com/products/x-ray-diffraction-and-elemental-analysis/handheld-xrf/xrf-analyzer-price.html>) it is still expensive (\$18k-50k) to purchase and must be pre-calibrated to detect certain particles.
2. There are other biotests which have been validated to work for very specific contaminants, (<https://www.sciencedirect.com/science/article/pii/S0925400508001317>) but I was not able to locate any for a general analysis of contaminants present in a sample.
3. For determining water quality, there exists many methods from test strips to satellite imagery which analyzes nearby factors (<https://ieeexplore.ieee.org/abstract/document/1220246>).
4. XRF analyzers work by emitting X-rays and measuring the fluorescence of the sample (<https://www.thermofisher.com/us/en/home/industrial/spectroscopy-elemental-isotope-analysis/spectroscopy-elemental-isotope-analysis-learning-center/elemental-analysis-information/xrf-technology.html>). With energy dispersive XRF, groups, rather than a single element can be determined at a time. EDXRF is also how most handheld XRF devices work.
5. This video demonstrates how a specific handheld XRF analyzer is used and shows its outputs. <https://youtu.be/t5kLwLUYiI>
6. It seems XRF spectrometry can determine elements and basic molecules/compounds since it uses X-rays to knock off outer electrons on an element and measure the energy emitted by it. However, it can't determine bacteria or larger particles. https://en.wikipedia.org/wiki/X-ray_fluorescence
7. An Intel researcher, Peter Ma, has already developed a water contamination detector that uses pattern recognition and machine learning. <https://software.intel.com/en-us/articles/ai-driven-test-system-detects-bacteria-in-water>. His work won numerous awards and the only hardware required is a digital microscope which can be purchased for <\$100 and an intel computestick to run the ML/AI algorithms in real time. Here's a demo video of the product <https://www.youtube.com/watch?v=Df1X1Km9riQ>
8. Other researchers have developed similar systems: this project was able to determine the presence of E. Coli in under an hour, estimate concentration levels, and has a 99% accuracy using TensorFlow <http://ma.ecsdl.org/content/MA2018-02/56/1997.short>
9. Another approach researchers are taking is by using AI/ML and large scale geographic data (similar to the satellite imagery techniques described above in #3) https://www.researchgate.net/publication/266465926_An_application_of_different_artificial_intelligences_techniques_for_water_quality_prediction