

**TECHNICAL ENQUIRY
PRACTICAL EXPERIENCES WITH FIELD WATER QUALITY
TESTING KITS AND EQUIPMENT**



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¹ Consortium comprises Harewelle International Limited, NR International, Practical Action Consulting, Cranfield University and AEA Energy and Environment

Enquiry A0176 – Practical experiences with field water quality testing kits and equipment

Description

The Center for Affordable Water and Sanitation Technology (CAWST) is developing training and support material on field-level 'water quality testing' to support their existing clients and interested CBOs and NGOs.

We are currently looking for:

- 1) Tips and advice from practitioners in the use of the wagtech and delagua kits (particularly on alternatives, consumable/culture media choices, do's and don't's, experience on transferability of testing technology;
- 2) Research and articles of field based studies of basic physical, chemical and microbiological testing which particularly focus on practicality of the aforementioned kits, transferability of testing technology to local organisations.
- 3) Regional availability and true costs for equipment and consumables.

Response

The methodology for the research included:

- i) Literature review and web search (*see appendix for details*)
- ii) Questionnaire sent to international agencies and individual professionals with experience in water supply programmes (*see appendix for details*)
- iii) Informal telephone discussions with key informants

Some people that were sent the questionnaire have not yet responded; if any more responses come in I will forward them to DEW Point.

1) Tips and advice from practitioners in the use of the Wagtech and Delagua kits

Do and don't's when using the Wagtech and Delagua kits

Most respondents said that most dos and don'ts are already included in the instructions with the kit. One respondent reported that he *"learned the handling of the [delagua] kit through the manual."* These manuals are reported to be clear and easy to understand.

However, one key issue is translation of the instruction manual: *"I don't think the instructions come in Arabic though which would be handy as they're too long to translate ourselves"*

Nevertheless, there is a general consensus that membrane filtration field testing kits are relatively difficult to use in the field, especially in an emergency situation. For both the Wagtech and Delagua Oxfam compiled feedback on improvements that should be made to the kits. This information is collated into a report Oxfam did for the Aquatest project - which is a interagency summary of the use of Water Testing kits in emergencies.

On the Wagtech and Hach equipment, one respondent recommended *"the use of optical instruments as the reading are safer and more consistent than the human eye, which also varies between individuals. Optical instruments are sensitive to surrounding light, and I would appreciate some better and easier to use cover or similar to provide shade"*.

Respondents noted the need for an adequate number of samples to ensure economy in use of the Delagua kit (the reagent is normally made for 16 samples/day) as well as to justify the time used to perform the tests. It was suggested that the number of samples could be increased by training specific team members or by offering the testing service to other organisations and the local government etc.

Alternatives to the Wagtech and Delagua kits

On the **Wagtech kit**, respondents thought that

- *It seems more modern than alternatives*

- *More handle-able* (e.g. easier to stack the Petri-dishes, and to insert and remove them from the incubator)
- *It is a little cheaper than alternatives*
- *It is a bit lighter as a complete bacteriological test kit*

On the **Delagua kit**, respondents thought that

- *It is more robust than other variants of the DelAgua kit*
- *Access to the component parts (e.g. the battery) is also easier*

However, the disadvantages of the membrane filtration kits (Delagua/Wagtech) are their cost, weight (which means that accessing water points can be tricky), the time it takes to prepare the broth as well as for sterilization and incubation; moreover the results can be difficult to interpret. Other drawbacks identified include:

- *need for a power supply*
- *easy to get incorrect result-* respondents felt that results from Delagua and Wagtech kits were hard to interpret; or are easy to misinterpret
- it is difficult to maintain
- one respondent thought that *“Delagua is too complicated (the risk to contaminate your sample is too high)”*
- the membrane can become clogged with highly turbid water unless diluted
- samples should ideally be refrigerated below 4°C during transport and until processed

There are a number of alternatives to the Delagua and Wagtech kits. Key alternatives identified are:

- **Colilert:** some respondents use the kit Colilert (MPN) which is reported to be easier to use (with ready to use culture media) and meets WHO recommendations.
- **The Presence/Absence** test for hydrogen-sulphide (H₂S) producing bacteria-based fecal. These are easy to use (no media preparation is needed); do not need an incubator (samples can be incubated on the human body); can detect presence/absence rapidly; are highly portable and durable; are relatively inexpensive. There seems to be some consensus that these are often more appropriate for use in the field. However, one respondent said: *“With regard to microbiological tests, I would appreciate simpler field equipment”*. Some respondents use pathoscreen test kits, which cost about USD 40 per 50 tests and about another USD 20 for 100 sampling bags. Further information on the hydrogen sulphide paper strip test can be found here: <http://www.sopac.org/Community-based+Tool+for+Water+Quality+Monitoring>. H₂S tests have their limitations (e.g. specificity of the test).
- University of Brighton has undertaken work on coliphages. This has been developed further in India by NEERI (contact Pawan Labhsetwar pk_labhsetwar@neeri.res.in) for more information on the coliphage work. Mark Sobsey of the University of North Carolina has completed an extensive review of the current research on this method. The full report is available at http://www.who.int/water_sanitation_health/Documents/H2S/h2s5.htm.

- Research project at WEDC on **Water Safety Kit (WSK)**, which is now in the prototype stage and resolves some of the most critical limitations of the Potatest and DelAgua kits (i.e.)
 - ⇒ Battery capacity - the WSK has a solar panel system with a light weight lithium battery,
 - ⇒ Water testing and Water Safety Plans - the kit contains the tools required to undertake Water Safety Plans.
- **The Aquatest Project**, developments by Barry Lloyd and Brian Clarke at Surrey University and recent developments at Glasgow University by Caetano. *“The new Aquatest project <http://www.bristol.ac.uk/aquatest/> is my hope for a genuine alternative and real step forward in field based water quality testing although this is not much help for now”*
- **Hach DR 820 or DR 850**: These do not, however, cover bacteriological testing and therefore have a different application to the Wagtech and Del Agua kits which are focused on the 4 key parameters.

A few respondents mentioned that a study by Action Contre la Faim, comparing a number of different testing alternatives, influenced their decision-making when selecting a water quality testing kit.

However, it seems that practices are changing. Many analyses are not performed in the field but recommended to be done always in mini labs. Alternatively, there may be cases where it is more appropriate to use the (DelAgua) kit as a “lab” kit, rather than a field kit. This is because the apparatus is quite complicated in appearance to someone who has no idea what the entire sampling procedure is “doing to their water supplies”. In such situations it is preferable to take only a set of sterilised sample bottle to the field, and to process the samples back at the team base.

2) Research and articles of field based studies of basic physical, chemical and microbiological testing

1. Sophie Thomasset (2007) Water analysis kits: Comparison and Recommendations Research report. ACF-IN
2. UNICEF (2005) Water Quality Testing Kits for Field Use:
<http://www.indiawaterportal.org/data/kits/> India Water Portal has published a [list of field kits](#) for water quality testing available in India. Included are the water quality parameters each kit can test for, the price (if available) and the supplier's address
http://www.indiawaterportal.org/data/kits/Field%20Test%20Kits_2nd%20Feb%2006_P RINT.PDF
3. WEDC developed a new lightweight kit with WAGTECH called the Water Safety Kit (WSK). The kit contains the tools required to undertake Water Safety Plans at the field level. The kit was trailed in Mozambique: see
http://wedc.lboro.ac.uk/projects/new_projects3.php?id=168
4. Research on different microbial medias including development of the Nutri Azide discs for Enterococci analysis using the simple Membrane Filtration technique in the Wagtech Potatest. See the following publication in the Water Science and Technology journal
<http://www.iwaponline.com/wst/05403/wst054030127.htm>
5. OXFAM (2004). *Oxfam-DelAgua Water Testing Kit-Users Manual, Version 4.1*. Prepared by Robens Centre for Public and Environmental Health, University of Surrey Guilford, UK.
6. M. Abbas, D.I. Wilfried Schlosser (2005) Water quality monitoring of improved water delivery systems in Northern Pakistan. 31st WEDC International Conference, Kampala, Uganda, 2005 <http://wedc.lboro.ac.uk/conferences/pdfs/31/Abbas.pdf>
7. OXFAM Technical Brief: Water quality analysis in emergency situations.
http://www.oxfam.org.uk/resources/downloads/emerg_manuals/draft_oxfam_tech_brief_watertest.pdf
8. Presentation: Water quality monitoring in developing countries: New initiatives Thursday 14 September 11:30 –13:00 IWA World Water Congress 10 -14 September 2006
9. Project Proposal: Water Testing:
<http://home.btconnect.com/engindia/watertesting.htm>
10. IRC Source Bulletin Making water quality visible: for women as well as men
<http://www.irc.nl/page/40485> Stephany Kersten, Ammatilla Ahmed from CARE International Yemen & Kaid Al Sidrayh from Water and Environment Centre, Sana'a University, Yemen - case study of the use of the DelAgua kit by CARE in Yemen
11. Sandy Cairncross Bacteriological testing of water WELL Factsheet adapted from Cairncross & Feachem (1993) *Environmental Health Engineering in the Tropics: an Introductory Text* 2nd edition. London: John Wiley & Sons.
<http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/btw.htm>
12. Peter Harvey, January 2007. Field Water Quality Testing in Emergencies WELL Factsheet:
<http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/WQ%20in%20emergencies.htm>
13. Jamie Bartram and Richard Balance (eds.) (1996) Water Quality Monitoring - A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring

Programmes. United Nations Environment Programme and the World Health Organization. Appendix 1 – Portable Field Kits

14. Sri Lanka: UNICEF helps residents check water safety in tsunami aftermath
<http://www.irc.nl/page/38743> UNICEF has used simple water testing field kit for bacteriological quality only in post-tsunami programme in Sri Lanka
15. Toop Katie E MSc (2004) project “*Evolution of field water quality testing. (Analysis of enterococci for developing countries, using portable test equipment)*”. WEDC. Supervised by Sam Godfrey with Mike Smith
16. All India Institute of Hygiene & Public Health; UNICEF (1996). Clean water is great. A manual on water quality field test kit.
17. Robert Youlten September 2008. An Investigation into the Quality of Harvested Rainwater and Open Water Sources in a Region of North East Uganda. Cranfield University School of Applied Science. MSc Thesis
18. Maria Dillon August 2008 Comparative Testing of Microbial Water Quality from different Water Source Types. MSc in Water Management (Community Water Supply) Cranfield University School of Applied Science
19. Thomas Nussbaumer August 2008. *A study into the variation in microbiological water quality between different water source types*. Cranfield University School of Applied Sciences Water Management Master of Science Thesis

3) Regional availability and true costs for equipment and consumables

For Delagua (and possibly Wagtech as well) kits the following items need to be purchased locally in order for the kits to be used:

- methanol,
- wax pencils,
- distilled water,
- portable sterilizer (autoclave, pressure cooker),
- lighter, and
- cold box(es) for collected samples.

While in storage, test kit batteries need to be recharged at least once per month.

The majority of respondents said that they brought their Delagua test kits with them from Europe and ordered spare parts and consumables internationally. Most said that they had never tried to get the equipment and/or consumables in the field, although some thought that national laboratories would either have the consumables available or else would be able to do such analyses.

Wagtech's consumables are available from the UK and the company's regional supply offices in Ethiopia, Uganda, South Africa, Bangladesh and Nepal from where they are able to supply consumables, facilitate the purchase of the kit from UK and provide training to local staff on the use of the kit. Whilst consumables for Wagtech are often found locally, it was reported that stocks are variable and unreliable in many countries (e.g. Ethiopia, Ivory Coast), with more reliable stocks expected in Nairobi for example. However, others thought that Wagtech need to greater publicize where their global outlets are.

Most respondents thought that the consumables for the kits are far too expensive. In some countries, such as India and Pakistan, cheaper consumables are available locally. One respondent said that *"In Pakistan I find that all the culture media are available but are as or more expensive than US prices."* In Africa respondents bought them from UK. One respondent said *"There is no source in Sudan for the consumables. It is actually a huge issue, sometimes water points are not tested for 6 months as we await consumables."* Where culture medium is not easily available, enough stock has to be in place beforehand.

Respondents said that it is the lack of consumables for the sterilisation process that causes most problems in the field – it is hard to get filtered /sterilised water to prepare the broth and to clean the filtration unit between tests, need for autoclaving etc.

Consumables such as methanol for disinfection of probing equipment can be used up relatively rapidly. It is extremely difficult to obtain methanol for sterilisation of all equipment that comes into contact with the sample (apart from in major pharmacies in the capital but when you live in an area of an permanent conflict, you will not find methanol in the pharmacies), which means it has to be transported over land from neighbouring countries as it is classed as hazardous freight. This presents staff with the dilemma of whether to break air transport regulations or to do an overland journey to get it.

Instead, some respondents reported relying on sterilising the apparatus using a pressure cooker. *“ But when the seal became perished, and wasn’t doing its job any longer, the whole water testing regime was held up for a considerable period. Thus, the crux of the matter seems to be the supply chain for consumables: it isn’t just about the lauryl sulphate broth, DPD tablets, or methanol, etc., but it might involve, say, the rubber sealing ring for a pressure cooker.”*

Another key issue is obtaining make-up water for the broth which has the right range of pH (mainly Honduras and Turkmenistan). Rainwater sources didn’t always match up.

Some respondents said that they hoped the Aquatest project might result in low cost alternative to these filtration /culture medium based tests.

Experience on transferability of testing technology to local organisations

Most respondents said that they do not transfer the technology to local organisations. However, one respondent thought *“There might be a need for better trained operators for a Delagua kit, as the technique is more sophisticated than the use of Petrifilm, which should be possible to use after rudimentary training.”* Another respondent said: *“the best thing about the Delagua kit is how easy it is to use and teach others to use”*: in North Sudan one NGO *“has trained technicians and local government departments with great success”*.

Where they have done local training, some respondents were sceptical as to whether the local counterparts have been able to keep up the testing program due to the cost and availability of the culture media. There seems to be a general lack of follow-up where NGOs have transferred Wagtech and Delagua water quality testing kits to local government water and health offices i.e. whether officials still conduct testing and if so on what basis and what constraints prevent them from testing (e.g. the consumables have to be imported and paid for with foreign currency).

Good training and refresher training was also reported to be key for NGO staff in the field. One respondent thought that training is necessary to ensure staff make full use of their equipment as well as to ensure staff work to the WHO standards for safe drinking water (i.e. no coliform bacteria per 100 ml sample of water).

Regarding the training of local counterparts:

- One respondent thought that it is easy to train people on the use of the water quality testing kits; the thing which prevents sustainability is purchasing consumables.
- In Myanmar one NGO has 2 Wagtech kits in use. They found Wagtech very cooperative and helpful in training the national staff of Myanmar.
- Training of local partner staff should cover:
 - *why water quality monitoring is important.*
 - *sample handling* - field sterility and aseptic handling (for example, in refugee camps respondents used refugees to help with water testing but had to reassure them that if they break sterility (e.g. putting a finger in the sample) it is better to say so than to hide it.
 - *information about the testing regimes.*

- *Where to test* - some respondents were of the opinion that testing should normally be done at the household level rather than at the water source, distribution point, or tap.
- *sampling methodology* (e.g. deciding where and when to take samples)
- *sample collection, transport, storage and handling.*
- *use of testing equipment.*
- *the use of quality assurance methods* (blank, duplicate and triplicate samples etc...).

Record of search

Search strategy	Search tool
Search Engines	Google, Yahoo!, and Dogpile
Water and Sanitation Portals or Subject Gateways	<p>Development Gateway - Water Resources Management: http://topics.developmentgateway.org/water</p> <p>FAO Water Portals: http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/prtwat.htm</p> <p>ID21 Research Reporting Service: http://www.id21.org/</p> <p>IRC International Water and Sanitation Centre: http://www.irc.nl</p> <p>The Global Water Partnership (GWP): http://www.gwpforum.org/</p> <p>The Water Page: http://www.thewaterpage.com</p> <p>UNEP.Net Freshwater Portal: http://freshwater.unep.net</p> <p>UNESCO Water Portal: http://www.unesco.org/water/</p> <p>WatsanWeb: http://www.skat.ch/watsanweb/</p>
Specialised Water and Sanitation Databases	<p>African Medical and Research Foundation (UK) (AMREF): http://www.amref.org/</p> <p>ELDIS: http://www.eldis.org/index.htm</p> <p>IRCDoc: http://www.irc.nl/ircdoc</p> <p>Lifewater International technical: http://www.lifewater.org/resources/tech_library.html</p> <p>Source Water and Sanitation News Service: http://www.irc.nl/page/168</p> <p>Technologies World Bank Group: http://www.worldbank.org/html/fpd/water/topics/tech_sanitation.html#latrines</p> <p>Universities Water Information Network (UNWIN) Research Abstract Database: http://www.uwin.siu.edu/dir_database/wrsic/wrsic.htm</p> <p>Water Research Commission (South Africa) Research Projects Database: http://www.fwr.org/sawrcomm.htm?path=wrrp.txt&id=webber&pass=webfree&OK=OK</p> <p>Akvo.org: http://www.akvo.org/</p> <p>Appropedia – water portal: http://www.appropedia.org/Portal:Water</p> <p>Wikipedia – water portal: http://en.wikipedia.org/wiki/Portal:Water</p> <p>Waterwiki: http://water.wikia.com/wiki/Main_Page</p> <p>WatSan.org: http://www.watsan.org/</p> <p>WatsanWeb: http://www.watsanweb.ch/</p> <p>Lifewater/: http://www.lifewater.ca/</p> <p>Water-e: http://www.lifewater.ca/</p> <p>CD3WD, an offline wiki for the third world: http://www.irc.nl/page/30906</p>
Fact sheets, technical briefs, and thematic overviews	<p>GATE watsan technical briefs: http://www.gate-international.org/publications.htm</p> <p>IRC Thematic Overview Papers (TOPs): http://www.irc.nl/content/view/full/3271</p> <p>IRC FAQ sheets: http://www.irc.nl/content/view/full/8027</p> <p>ITDG Technical Briefs: http://www.itdg.org/index.html?html/technical_enquiries/technical_briefs.htm-mainFrame</p> <p>Lenntech Water FAQ Frequently Asked Questions: http://www.lenntech.com/Water-FAQ.htm</p> <p>LifeWater technical bulletins: http://www.lifewater.org/resources/tech_library.html</p> <p>One World Water and Sanitation Topic Guide: http://www.oneworld.net</p> <p>WaterAid Technology Notes: http://www.wateraid.org.uk/international/what_we_do/how_we_work/sustainable_technologies/technology_notes/default.asp</p> <p>WEDC Technical Notes for Emergencies http://wedc.lboro.ac.uk/who_Technical_notes_for_emergencies/</p> <p>WELL Fact Sheets: http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets.htm</p> <p>WELL Technical Briefs: http://www.lboro.ac.uk/well/resources/technical-briefs/technical-briefs.htm</p> <p>WHO water-related diseases fact sheets: http://www.who.int/water_sanitation_health/diseases/diseasefact/en/</p> <p>http://www.who.int/water_sanitation_health/hygiene/emergencies/envsanfactsheets/en/index2.html</p> <p>Appropedia: http://www.appropedia.org/Welcome_to_Appropedia</p> <p>Howtopedia: http://www.nrsp.org.uk/index.aspx</p> <p>OXFAM: Emergency manuals and guidelines: http://www.oxfam.org.uk/resources/papers/emergency.html</p> <p>C@TAS Appropriate & Alternative Technology: http://www.catas1.org/eng/home.htm</p>
Discussion lists	<p>Dialog-agua-l: http://altair.ces.fau.edu/pipermail/dialog-agua-l/</p> <p>Aid Workers Forum - Water and Sanitation: http://www.aidworkers.net/?q=node/602</p> <p>http://www.reliefweb.int/rw/dbc.nsf/doc100?OpenForm</p> <p>Water-and-san-applied-research: http://www.jiscmail.ac.uk/archives/water-and-san-applied-research.html</p> <p>Water-L listserve: http://www.iisd.ca/email/water-L.htm</p> <p>WaterForum: http://tech.groups.yahoo.com/group/waterforum/</p> <p>http://www.firstwater.info/noflash/ab_people.html</p> <p>http://tech.groups.yahoo.com/group/waterforum/message/6609</p> <p>Humanitarian Distance Learning Centre - HDLC Discussion Forum: http://www.contingencyonline.com/forum.html</p> <p>Dialog-Agua-L: http://www.waterweb.org/subscribe/</p> <p>Water Forum: http://groups.yahoo.com/group/waterforum</p> <p>Community of Practice in Environmental Health: http://ehupdates.blogspot.com/</p> <p>http://home.btconnect.com/engindia/watertesting.htm</p>

Of the 150 sent out, 61 people responded:

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