Field Level Arsenic Testing Guideline
December 2015

CDI 2 WASH Program
Bangladesh Red Crescent Society

Australian Aid
International Federation of Red Cross and Red Crescent Societies
NGO FORUM FOR PUBLIC HEALTH

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Table of Content

Abbreviation

AAS	Atomic Absorption Spectrometry
APSU	Arsenic Policy Support Unit
BDRCS	Bangladesh Red Crescent Society
DPHE	Department of Public Health Engineering
GPL	General Pharmaceutical Limited
ICP-MS	Inductively coupled plasma mass spectrometry
ml	milliliter
NGOF	NGO Forum for Public Health
NIPSOM	National Institute of Preventive and Social Medicine
NPV	negative predictive value
ppb	parts per billion
ppm	parts per million
PPV	positive predictive value
SOES	School of Environmental Studies
SOP	Standard Operating Procedure
VCDK	Visual Colour Detection Kit
WQTL	Water Quality Testing Laboratory

Message

Arsenic in groundwater shows no color, no taste but has adverse human health effects ranging from skin lesions to internal cancers as well as widespread social and psychological problems caused by arsenic contaminated drinking water. The contamination of groundwater with arsenic has turned into the single largest problem of groundwater based water supply system in Bangladesh. A large number of tubewells in Bangladesh was identified with the presence of arsenic exceeding the acceptable limit. Massive assessment test has been done using arsenic test kit and in some cases, by laboratory. After taking initiatives by Govt, NGOs and development partners, the arsenic contamintion ratio has been reduced from 22% to 12%. However, arsenic contamination is still the main barrier to achieve the safe water supply target for all. In this context coordinated effort will be required to mitigate arsenic for water supply. Detection of arsenic content is the prime task to take any mitigation intervention.

In this regard, I want to thank and appreciate Bangladesh Red Crescent Society for their effort in developing these guidelines for arsenic testing of groundwater at field level in rural areas. DPHE reviewed this guideline and felt that it would be useful for field workers to test arsenic in tube-well water. Sharing the data and field findings with DPHE counterparts will help DPHE towards safe drinking water supply for the affected people in Bangladesh.

Md. Wali Ullah
Chief Engineer
Department of Public Health Engineering

Preface

Bangladesh Red crescent Society (BDRCS), being auxiliary to Public Authority, has been providing humanitarian service throughout the country since its inception in 1971. Among different initiatives of the organization, the Community Development Initiative (CDI) program is designed to enhance the overall resilience capacities of targeted communities through an integrated intervention comprising disaster risk reduction, poverty alleviation, health and hygiene and multiple socio-economic development. The aim of the ongoing CDI programme activities is to increase the community resilience to disasters and improve the basic living condition of over 40,000 people in 16 impoverished communities of Bangladesh by 2017.

Fresh water is increasingly becoming scarce in many parts of the globe because of both anthropogenic and environmental factors. Bangladesh experiences sharp seasonal variations in water flows due to climate phenomena which add to the difficulty of finding equitable and sustainable water supply. The problem has been further intensified due to groundwater arsenic contamination. Rapid population growth, expanding urbanization and fast growing needs for irrigation are increasing strains on the available water resources. The Bangladesh Red Crescent Society (BDRCS) encapsulates a wide panorama of focus areas including economic security, women empowerment, capacity building which also covers increasing arsenic free safe water supply and adequacy of sanitary latrines in household and communities.

For effective and efficient implementation of the arsenic free safe water supply programme, a 'Field Level Arsenic Testing Guideline' has been developed with the technical support of NGO Forum for Public Health which is endorsed by Department of Public Health Engineering (DPHE). I believe, this guideline will help in testing arsenic level of ground water in a very simple and cost effective way. I am confident that the guideline will contribute significantly to ensure safe drinking water supply in the deserved communities.

BMM Mozharul Huq, ndc
Secretary General
Bangladesh Red Crescent Society

Acknowledgement

The promotion of arsenic free safe water supply in combination with enhancing the overall resilience capacities of targeted communities can have a major impact on reducing vulnerability and improving public health situation. We hope that the readers and users, who are involve in promoting arsenic free safe water supply, will find 'Field Level Arsenic Testing Guideline' useful for all practical purpose related to arsenic test. We, therefore, acknowledge the contribution of concerned government officials of Department of Public Health Engineering to finalize the guideline.

I take this opportunity to express my profound gratitude and deep regards to Md. Wali Ullah, Chief Engineer, DPHE for his enthusiastic cooperation for accomplishing this guideline.

I thankfully acknowledge the contribution provided by Mr. Md. Delwar Hossain, Additional Chief Engineer (Water Resources), Mr. Shaheed Iqbal, Additional Chief Engineer (Works), Mr. Sudhir Kumar Ghosh, Superintending Engineer (Ground Water Circle), Mr. Tushar Mohon Sadhu Khan, Superintending Engineer (Planning Circle), Mr. Md. Saifur Rahman, Executive Engineer (R & D Division), DPHE Bhaban Dhaka among others.

My appreciation also goes to Mr. Mohammad Al Amin, Executive Engineer, DPHE, Rangpur, Mr. Dipak Chandra, Executive Engineer, DPHE, Gopalganj and Mr. Badsha Alamgir, Sub Assistant Engineer, DPHE, Pirganj, Rangpur for their all-out contribution.

The Community Development (CD) Department on behalf of Bangladesh Red crescent Society (BDRCS) would like to thank each and every one who has contributed to bring this guideline into its current form. Feedback based on practical application is welcome to be accommodated in subsequent revisions.

Nazmul Azam Khan
Director
Community Development Department
Bangladesh Red Crescent Society

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Decades in Development

Forward

Field Level Arsenic Testing Guideline for testing arsenic of groundwater by the Community Development Initiative (CDI) program of the Bangladesh Red Crescent Society (BDRCS) is first of its kind so far we remember. This document provides a simple guidance for testing arsenic of groundwater specifically the tube wells which include some other issues related to operate a small scale testing programme. The guideline will cover different aspects like costing involved in a testing programme, justification of selecting field kits, sample collection procedure, interferences, data management, quality control, safety, waste management issues along with the testing procedure. Though the guideline has been developed targeting the district level concerned authority as a primary stakeholder but we believe this document will prove to be useful for all level.

I express my sincere gratitude to the concerned officials of DPHE, expert from BDRCS, NGO Forum's regional colleagues and the team involving in developing the document for their sincere support, expert input and cooperation.

I would like to convey my deep appreciation to the Bangladesh Red Crescent Society (BDRCS) for initiating and its consistent support to prepare the document.

S M A Rashid
Executive Director
NGO Forum for Public Health

Field Level Arsenic Testing Guideline

(Main Volume)

Background

The importance of safe drinking water supply and environmental sanitation was recognized for more than couple of decades ago because of their high significance in the human health. Access to potable water, good sanitation and personal hygiene are prerequisites for the human being keeping healthy and productive life. The Rights to Water, or more specifically the Human Rights to Water and Sanitation (HRWS), was recognized by the United Nations General Assembly on 28 July 2010. By the end of last century, Bangladesh achieved 95% water supply coverage using tube well technology based on ground water source, which was the highest achievement in water sector in South East Asian region. But in early nineties identification of arsenic in shallow ground water overshadowed the commendable success particularly in rural water supply. Access to safe water has become increasingly difficult due to change in the quality and quantity of groundwater, the main source of drinking water of the country. Gradual declining of water table, arsenic poising and salinity intrusion has posed a threat to the availability of potable water in the country.

Arsenic poisoning is spreading through the human body in a large level in Bangladesh like other arsenic affected countries of the world. Government and many other developing partner organizations took different initiatives in order to deal this problem after first detection of arsenicosis patient in 1993 at Chapainawabganj district of Rajshahi division. According to different national level survey the shallow tube wells are more arsenic contaminated in most of the areas of Bangladesh. About 29% shallow tube wells were found arsenic contaminated through a national survey. According to the Directorate of Health, 65,910 numbers of patients were identified upto the year 2012 but at present the numbers of patients are much higher. Beyond the identified patients, 7.5 million people are in risk of arsenic contamination and 2.4 million people are suspected to be contaminated with arsenic. A large number of populations die with arsenicosis skin lesion. The awfulness of arsenic contamination is not reflected properly due to unavailability of the actual number of population died due to arsenic contamination. To combat the situation Government of Bangladesh formulated National Arsenic Mitigation Policy and Implementation Plan in 2004. This changing circumstances demands regular water quality checking for ensuring potable water supply. The National Policy for Arsenic Mitigation and Implementation Plan also suggested to periodical water quality checking of groundwater.

After the detection of arsenic in groundwater, the Government of Bangladesh, NGOs and development partners has conducted various types of activities including screening, studies and mitigation intervention. Mitigation of arsenic contamination in Bangladesh is a multi-sectoral issue that has health, water

supply, and agricultural implications. Despite various efforts, it is anticipated a considerable number of people are still exposed to arsenic contamination in drinking water. Local Government Division under the Ministry of Local Government, Rural Development & Co-operatives introduced 'National Policy for Arsenic Mitigation 2004 & Implementation Plan for Arsenic Mitigation in Bangladesh'. This policy document revealed that the percentage of contaminated tube wells in villages varies from more than ninety percent to less than five percent. Geographically, the tube wells in the delta and the flood plains region, which comprise 72% of the land area, are more or less affected by arsenic contamination. The policy document indicated a number of initiatives including screening and monitoring of tube wells, development of local field kit, evaluation of field kit, public awareness, diagnoses and management of patients, alternative safe water supply, capacity building, research and development etc. Again Department of Public Health Engineering (DPHE) introduced 'Water Quality Monitoring and Surveillance Protocol for Rural Water Supply System in Bangladesh' in August 2005. But little focus has been given on development of Standard Operating Procedures (SOP) for testing arsenic in field level.

The Government in collaboration with NGOs and donor agencies undertook programs to identify and mark arsenic contaminated tube wells. The screening activities started in early 1990s in our country by the participation of both the GOs and the NGOs is ongoing. Many organizations are screening the tube wells by field kit methods. Some organizations, however, are performing laboratory analysis to cross check the data with comparison to their field data. Recently, controversies arose about the accuracy of the test results. Researchers have reported that some of the arsenic test kits gave inaccurate results. This has led to questions of the reliability of previous testing results. However, one should not expect that the field test kits would give the quantitative result as obtained by the expensive AAS and ICP-MS methods. But they should give estimates as close as possible to quantitative estimates so that the variations do not jeopardize permissible standards.

Review of Field Kits

In 1999 NGO Forum conducted a study on Evaluation of Field Kit Used for Arsenic Detection in Ground Water in collaboration with School of Environmental Studies (SOES), Jadavpur University, Kalkota, India. The study evaluated four available kits like NIPSOM field kits, GPL kit, Merck kit, Digital Arsenator. The study revealed that arsenic detecting field kits under the study perform well when the arsenic content in drinking water is very low (less than 0.01 mg/l) or very high. At the nominal value of 0.05 mg/l, the sensitivity and specificity of these kits except arsenator were around 80% with False Negative Samples ranging from 10% to 17%. At the nominal value of 0.1 mg/l, the False Negative samples were more. This observation supported the in-built limitation of the field kits. This field kits are manufactured based on Gutzeit method.

In 2006 Arsenic Policy Support Unit (APSU) conducted review of locally available field kit and revealed that the HACH EZ, Wagtech Digital Arsenator and Wagtech VCDK, HACH kits were better options to get more dependable estimates of arsenic under field conditions. All of these kits have a good system for the removal of sulfide interference. Quantofix and GPL gave false value with the blank samples. The Merck Highly Sensitive and the Econo Quick test kit gave good result but during the testing most of the test strips become damaged. The Quantofix and the Merck sensitive has no good provision for removal system for sulfide interference. The errors showed by the field kits during field-testing were due to the operational and personal errors, reagent errors, method errors, colour detection by eye errors etc. The study mentioned that these errors should have to be minimized by employing trained and skilled manpower; electronic reader based colour detection apparatus with regular standardization of the reader, quality control of the reagents, commitment of the operators, commitment of the tester, cross checking options for checking results, standardization of test kit etc.

The present market situation does not have opportunity to get different types of field kit. Only the Hach EZ kit is readily available in the market. Others are needed to be imported directly or need to submit order with sufficient number and time to deliver. Even local representative are not available except Hach EZ and Wagtech Digital Arsenator while the digital arsenator is very expensive. Technoworth Associates Limited a concerned of Tradesworth Group is the authorized distributor of the product Hach EZ arsenic test kit in Bangladesh which has been further coordinated by the Analytical Division of the company. Technoworth Associates Limited have several outlet (Branch office) all over the country including Faridpur and Rangpur.

Regarding evaluating the arsenic testing performance of the product a rapid assessment of the kit has been done. A total of 42 tube wells' water samples were tested by the kit and the same samples were tested in the WQTL using AAS. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were analyzed.

Field Test

	Laboratory Test		**Total**
	Arsenic Unsafe (>50ppb)	**Arsenic Safe (<=50 ppb)**	
Arsenic Unsafe (>50ppb)	24	1	25
Arsenic Safe (<=50 ppb)	1	16	17
Total	**25**	**17**	**42**

The sensitivity and specificity of the field kit were 96% and 94% respectively while the Positive Predictive Value and the Negative Predictive Value were 96% and 94% respectively. The results indicated that the kit Hach EZ may be feasible for conduction field testing of arsenic of groundwater at field level.

Field testing of the guideline

The document was finalized based on the feedback received from field test conducted in different community under the intervention area of CDI program of Rangpur and Gopalganj district. The draft document was reviewed by concerned Community Organizer and Hygiene Promoter followed by arsenic test was done independently. Their review and arsenic testing experience feedback was incorporated in this publication. The document was also shared with district and upazila level DPHE official (Executive Engineer and Sub Assistant Engineer) for their valuable opinion and central office as well. The document was also reviewed by technical expertise of BDRCS in different stages.

Cost estimation

The groundwater arsenic testing and more specifically the arsenic testing of drinking water tube wells is estimated to cost the following –

Sl	Particulars	Unit	Unit Cost in Taka
01	**Testing Cost of single tube well** (Estimated 90 test per Hach Kit, 10 for loss of error, QC etc)	Per test	85.00
02	**Colouring of tube well's spout (Marking)** (two type of colour and brush, sand paper, duster cloth, thinner, three plastic containers etc)	Per tube well	15.00
03	**Man power for testing and Marking** (Estimated 16 to 20 tests per man-days depending on the geographical and seasonal condition may cost around Tk.1200/- only)	Per test	65.00
04	**Training for 20 testers** (A two-day long residential training including field exercise may cost Tk. 130,000/- only)	Per training	130,000.00
05	**Dissemination of results, data collection and management** (lump sum cost associate to data collection, entry, preservation, analysis and printing report card etc)	Per training	130,000.00
06	**Additional materials as per field situation** (distilled water, Scissors, Clipboard, umbrella, raincoat)	Per training	130,000.00

Scope and Application

Purpose of the process

This document is applicable for screening of groundwater arsenic contamination of Bangladesh for the purpose of drinking water supply intervention using the specified field kit and procedure described in the document. The aim of this document is to provide technical assistance to the tester for testing arsenic of groundwater and also provide technical assistance to the district level implementation authority for ensuring quality of field test and effective monitoring. Testing will be conducted in collaboration with concerned district level DPHE office.

The guideline focused on the testing of drinking water quality parameter, arsenic of groundwater only using the Hach EZ kit. The kit is designed for obtaining semi-quantitative results from the range of 0 to 500 ppb and this semi-quantitative process may be extended up to 4000ppb.

Regulatory requirements

'National Policy for Arsenic Mitigation 2004 and Implementation Plan for Arsenic Mitigation in Bangladesh' emphasize on screening of tube wells for any mitigation initiatives related to drinking water supply. The policy also focused on the regular testing and monitoring of groundwater of at least 2% of the greened marked tube wells on a six-monthly basis along with building capacity of testing at local level. For ensuring safe drinking water supply, arsenic level should be within 50 ppb as per the ECR 1997, Schedule -3.

Principles of testing

The Gutzeit method of testing arsenic in drinking water is one of the oldest methods for detecting Arsenic, where the detection is effected by the stain produced on a dry mercuric bromide paper. The intensity of Colour Stain on the bromide paper will give semi-quantitative idea as to the content of Arsenic (As2O3) when compared with the standard stained bromide paper. All the available kits are following this principle with differences in process of producing arsine gas. The Hach EZ kit is using sulphaic acid and powdered zinc to create strong reducing condition in which inorganic arsenic is reduced to arsine gas (AsH3). The generated arsine gas reacts with the test strip impregnated with mercuric bromide and discolours the test strip if arsenic was present. The Colour ranges from yellow through tan to brown depending on the concentration of arsenic presence in the water samples.

Definitions

Field kit: A set of articles or equipment needed for a specific purpose in order to experiment, research or trial conducted under actual use conditions, instead of under controlled conditions in a laboratory.

Test strip: A strip of sensitized material, sections of which are exposed or used in testing for varying lengths of time to assess its response.

Reaction zone: An area having a particular characteristic, purpose, or use for an action performed in response to a situation or event.

Bromide paper: A type of paper impregnated with Mercury bromide attached at the reaction zone of the test strip which is used for the detection of arsenic.

Colour chart: A sheet of information in the form of a colour. Each colour contains separate values. In the HACH kit when 50ml sample water will be taken then '0-500' value of 50ml serial will be used. When 9.6ml sample water will be taken then '0-4000' value of 9.6ml serial will be used.

Arsenic contamination: When arsenic came in contact with any substances such as water.

Reagent 1: Crystallized form of sulphaic acid provided in the Hach EZ kit in small pillows and marked as 'Reagent # 1'.

Reagent 2: Powdered form of zinc provided in the Hach EZ kit in small pillows and marked as 'Reagent # 2'.

Interference

Hydrogen sulfide is the potential interference of the procedure that can be produce similar result.

Other interferences that can be influence result are mostly amount of sample to be taken for testing and retaining reaction time.

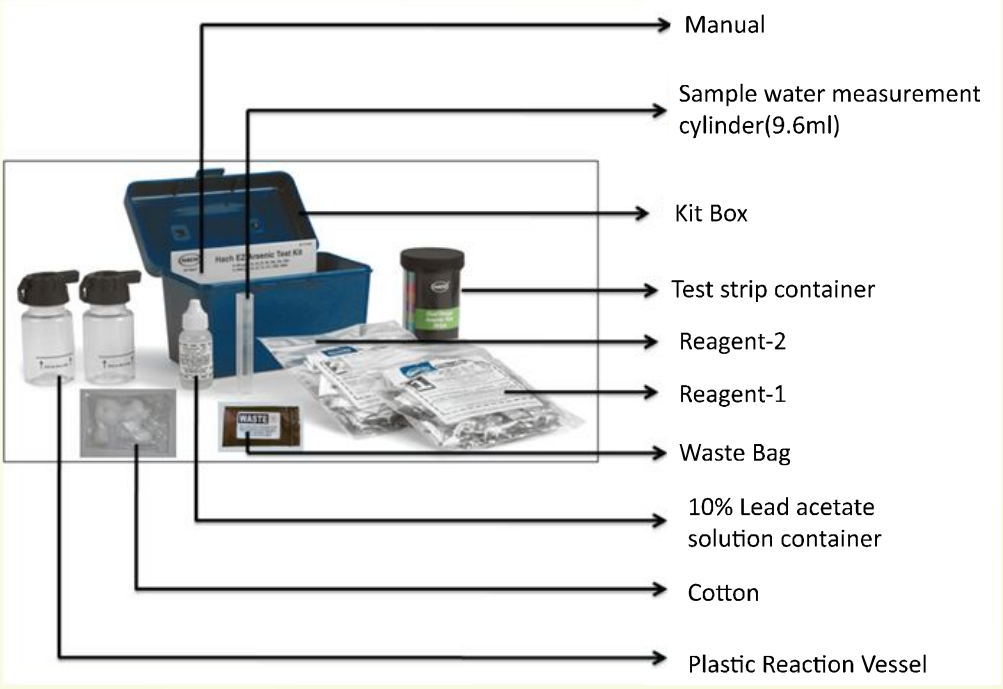
pH level of sample water below 5 is not suitable for testing. Acid-preserve sample water should not be tested directly, need to adjust pH between 5 to 6 before testing.

Selenium and sulfide of greater than 1 ppm and 15 ppb respectively may interfere potentially.

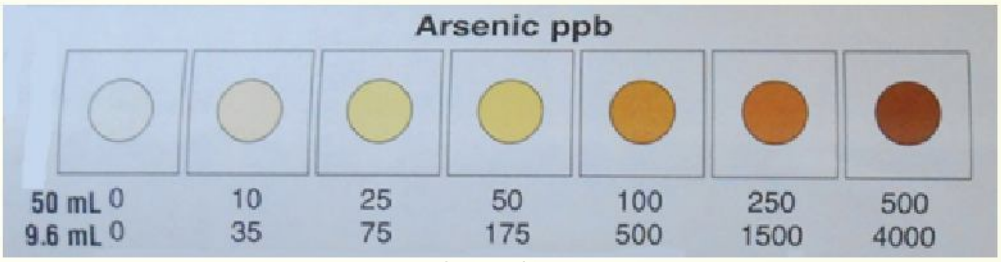
Equipments and Supplies

Parts of HACH testing kit

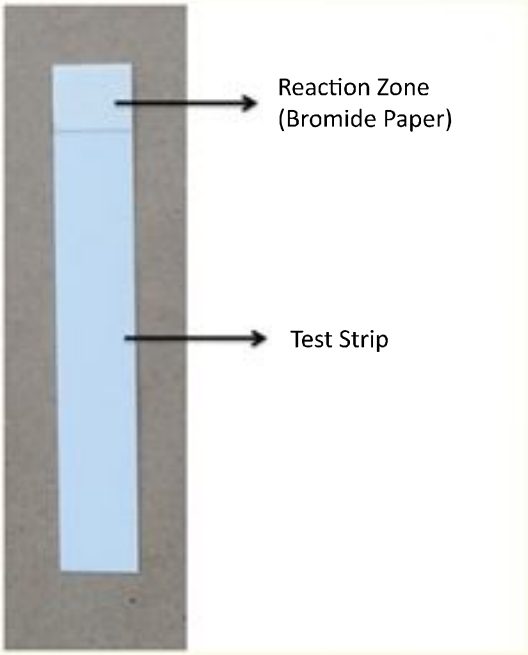
Sl	Name of Parts	Unit (nos)
01	Plastic Reaction Vessel	2
02	Sample water measurement cylinder (9.6ml)	1
03	Reagent- 1 (Plastic bag containing powder pillow)	100
04	Reagent- 2 (Plastic bag containing powder pillow)	100
05	Test strip container (There are 100 test strips in a container. A Bromide paper is attached at one end of the test strip which is also called reaction zone)	1
06	Colour chart: It is attached on the body of the test strip container. For 50ml sample water the scale will be 0 – 500 ppb. For 9.6ml sample water the scale will be 0 – 4000 ppb.	100
07	10% Lead acetate solution container	1
08	Cotton	1
09	Waste bag (To keep used test strips etc.)	1
10	Manual	1



Parts of Hach testing kit



Colour Chart



Test Strip

Accessories per tester

Sl	Name of Parts	Unit
1.	Duster cloth	2 nos.
2.	Scissors	1 nos.
3.	Distilled water	500 mL
4.	Clipboard	1 nos.
5.	Colour – Red	1 container
6.	Colour – Green	1 container
7.	Sand paper	1 nos.
8.	Thinner	500 mL
9.	Brush	2 nos.
10.	Plastic Pot	2 nos.

* amount of items mentioned in the above table may vary as per number of test.

Sample Collection

The process of sample water collection plays an important role in order to do arsenic test correctly. Accuracy of the result will not be achieved if the sample water is not collected according to the sample water collection procedure. The following procedure should be maintained during collection of sample water in order to test arsenic using field kit method-

1. The sample water should be collect in a neat and clean container.
2. The sample water container should be wash 3 times with the water of the tube well that is selected for arsenic test.
3. The water of the selected tube well should be pumped out contentiously for 5 minutes, alternatively, continuous pumping out the water considering the depth of the tube well and the discharge rate of each pump to discharge an equivalent amount of water containing in the pipes and body/barrel of the tube well.
4. After collection, the sample water should be test immediately without any delay.

Testing Procedure

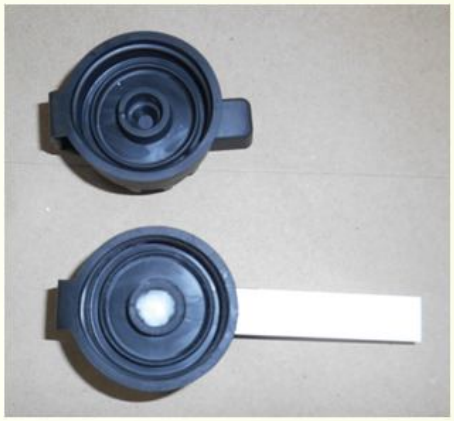
Initial Startup:

- Check the validity of the reagents (expire date mentioned in the pillow of reagent - 1 and 2).
- Check appropriateness of physical condition of all items of the kit for testing.
- Select a safe, open and dry place away from direct sunlight to open the kit's items and operate for testing.
- Clean the reaction vessel if necessary (if any residue of reagent – 2 exist in the vessel, it must be removed).
- Start pumping out of the tube well's water for a five minutes period which is going to be tested or start purging of tube well for the specific number of purge as per calculation considering the depth of tube well and discharge rate of each pumping.

Method of testing for 50ml sample water

1. Open the twisted black cap. There is a small hole/groove on the black cap and a small flap attached on the head of the cap.

2. Lift the flap on the head of the black cap and slide a test strip into the groove so that the reaction zone faces the small opening and completely covers it. Secure by pressing the flap back in place.



3. Tear off a small piece of cotton and form a ball the size of a pea. Saturate the cotton with a few drops of lead acetate. Squeeze the excess liquid out of the cotton, leaving it damp.
4. Change the cotton ball if it discoloured (normally light yellow or brown) after a test and use freshly prepared cotton ball for every day.
5. Press the saturated cotton ball into the small opening of the reaction bottle cap (black cap) from the bottom. Be sure that the cotton is firmly in place and that a gap remains between the cotton and the top surface of the cap.
6. Wash the plastic Reaction Vessel thoroughly for 3 times with the sample water.
7. Fill the Reaction Vessel with sample water to the black coloured fill line (50mL line). To confirm the actual measurement place the reaction vessel on a horizontal platform and make sure your eye, water surface and the black mark are in same line.

8. Add the contents of one pillow of Reagent- 1 and Reagent-2 to the sample one after another after cutting the upper part of the pillows and immediately attach the black cap fitted with the test strip to the Reaction Vessel.
9. Swirl lightly to dissolve the chemicals properly with the water. Be conscious that the sample water does not touch the Reaction zone.
10. Allow the vessel to react for 20 minutes. Swirl lightly for 2 to 3 times within this period to mix the chemicals properly with the water.

11. Remove the Test Strip after 20 minutes from the black cap and match colour with the '50ml, 0-500' serial colour chart. The colour of the Reaction zone of the test strip will indicate the level of arsenic present in the sample water.

Method of testing for 9.6ml sample water

If the colour of the Reaction zone of the test strip differs from (50ml, 0-500) colour chart or the Reaction zone shows more deep colour than the (50ml, 0-500) colour chart, then the following test method can be used subject to instruction of concerned authority -

1. In this method all the procedure of testing will be the same as mentioned in the sub-section 'Method of testing for 50ml sample water' except the number 6 which is described as follows-
   Fill the 9.6ml cylinder with sample water and pour it into the Reaction vessel.

Shutdown procedure:

- After getting result keep the used Test Strip in the supplied waste bag.
- Discard the liquid remaining in the reaction vessel with residues into a dumping ground or toilet or wastewater trap pond/well of the concerned tube well.
- Washout the reaction vessel thoroughly with the tube well water and remove, if any residue trapped inside the vessel.
- Remove the lead acetate shocked cotton ball into the waste bag if discoloured or at the end of the day.
- Keep all the parts of the kit into box in dry condition for next use.
- Coloured the spout of the tested tube well either green or red according to the test result.

Interpretation of Results

Result (50 mL scale)

1. Each colour in the colour chart '50ml, 0-500' serial contains number and the number indicates the level of arsenic in ppb. Match the colour of the reaction zone of the Test Strip with the '50ml, 0-500' serial colour chart and record the data properly.
2. If the colour of the Reaction zone of the test strip is more than the colour contains number 500 in '50ml, 0-500' colour chart, then note the result in following way –

   >500ppb

   Or, Test can be done again following sub-section 'Method of testing for 9.6ml sample water'.

3. If the colour of the Reaction zone of the test strip does not match directly with any of the colours of the chart and shows in between any two colours of the chart (such as more than 50 but less than 100), in that case write the result in following way –

   >50ppb

   Give a '>' at the left side of the value from which the colour of the Reaction zone is more.

   Or, record the value under the colour of the Colour Chart to which the colour of the Reaction zone is more similar.
4. If the developed colour is other than the reference colour of the scale (green, red etc) repeat the test or inform the supervisor for decision.
5. Follow the similar method for recording every result.

Result (9.6 mL scale)

1. Each colour in the colour chart (9.6ml, 0-4000) serial contains number and the number indicates the level of arsenic. Match the colour of the Reaction zone of the test strip with the (9.6ml, 0-4000) serial colour chart and record the data properly.
2. If the colour of the Reaction zone of the test strip is more than the colour contains number 4000 in (9.6ml, 0-4000) colour chart, then write the result in following way –

   >4000ppb
3. If the colour of the Reaction zone of the test strip does not match directly with any of the colours of the chart and shows in between of any two colours of the chart (such as more than 75 but less than 175), in that case write the result in following way -

   >75ppb

   Or, record the value under the colour of the colour chart to which the colour of the Reaction zone is more similar.
6. If the developed colour is other than the reference colour of the scale (green, red etc) repeat the test or inform the supervisor for decision.
7. Follow the similar method for recording every result.

Data Collection and Management

1. Data will be collected as per prescribed format provided by the authority. A sample data collection form is attached as annex-1.
2. Collected data will be checked by concerned field office daily.
3. Checked and corrected data will be entered into computer using appropriate software as per data preservation and analysis plan.
4. Time to time data may be shared with the MIS unit of DPHE central office as per their prescribe format.

Safety

1. Do not touch the bromide paper attached with the Test Strip as mercury bromide is a poisonous substance in nature. Wash the hand immediately and use soap in necessary if the hand came in contact with Mercury Bromide.
2. Conduct the test in a safe, open and dry place away from direct sunlight. Arsine gas is released during testing and it is very toxic in nature.
3. Do not let the lead acetate solution come into contact with skin or eye, it may cause irritation or itching in the skin. Wash the affected area with sufficient clean water and use soap if necessary. Apply water gust in the eye for 15 minutes and consult with doctor immediately if necessary.
4. Do not stand against the wind flow during testing.
5. Keep the flammable materials away from the testing area.
6. Do not eat or swallow any reagent.
7. Keep the kit's materials away from the children.

Precaution

1. Collect sample water after appropriate purging.
2. The sample water should be test immediately without any delay after collection.
3. Handle all the testing instruments with care.
4. Close the cap of the Test Strips' container immediately after bringing out a test strip.
5. Do not let the lead acetate containing cotton come into contact with the Reaction zone.
6. Do not take result under subdued light or in night time.
7. Do not take result (matching the developed colour of the test strip with the colour chart) under direct sunlight. The developed colour of the test strip may change in contact with direct exposure to sunlight.
8. Clean the Reaction vessel and cylinder properly at the end of every test.
9. Keep every materials/parts of the kit dry.

Quality Control

Testing at Field Level

Considering the field situation the following issues may be introduced to maintain the quality of field work

1. Test blank sample (water sample known to be arsenic free, i.e. distilled water) at beginning of daily testing schedule.
2. Duplicate testing of every 20th sample.
3. Monitoring of field work.
4. 10% of tested samples should be Cross checked in appropriate laboratory.
5. Periodical (half yearly) evaluation of field and laboratory data.

Kit Purchase

After purchasing the kits, considering the number of total kit, one or two kits may be selected on random basis to verify the efficiency from a reputed laboratory. This process may be adopted in case of purchase a large number of kits. Settlement about the efficiency of the kits can be done on the basis of any previous similar information/experience.

Waste collection and disposal

1. Collect the entire used test strip, cotton balls and empty pillows in the supplied plastic bag.
2. At the end of the day bury the collected Test Strip, cotton balls and empty pillows under the ground by digging a hole and cover it with soil or cow dung.

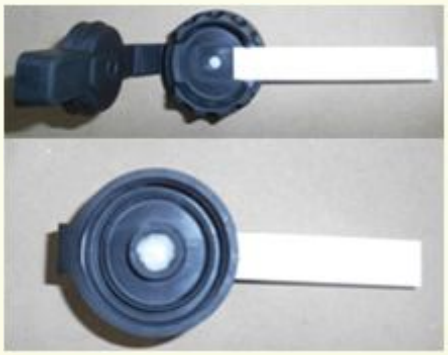
Summary of Testing Procedure

Initial Startup

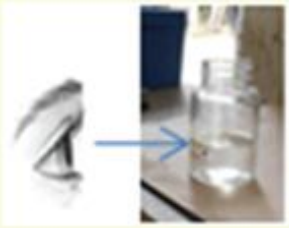
- Check the validity of the reagent - 1 and 2.
- Check appropriateness of physical condition of all items of the kit for testing.
- Clean the reaction vessel if necessary.
- Collect the sample water as described in 'Sample Collection' procedure.

Method of testing for 50ml sample water

1. Open the twisted small flap attached black cap. Lift the flap on the head of the black cap and slide a test strip into the groove so that the reaction zone faces the small opening and completely covers it. Secure by pressing the flap back in place.



2. Tear off a small piece of cotton and form a ball. Saturate the cotton with a few drops of lead acetate. Squeeze the excess liquid out of the cotton and Press the saturated cotton ball into the small opening of the reaction bottle cap (black cap) from the bottom. Change the cotton ball if it discoloured (normally light yellow or brown) after a test. Be sure that the gap remains between the cotton and the top surface of the cap.
3. Wash the plastic Reaction Vessel thoroughly for 3 times with the sample water.



4. Fill the Reaction Vessel with sample water to the black coloured fill line (50mL line).
5. Add the contents of one pillow of Reagent- 1 and Reagent-2 to the sample one after another after cutting the upper part of the pillows and immediately attach the black cap fitted with the test strip to the Reaction Vessel. Swirl lightly to dissolve the chemicals properly with the water.

6. Allow the vessel to react for 20 minutes. Swirl lightly for 2 to 3 times within this period to mix the chemicals properly with the water.
7. Remove the Test Strip after 20 minutes from the black cap and match colour with the '50ml, 0-500' serial colour chart. The colour of the Reaction zone of the test strip will indicate the level of arsenic present in the sample water.

Shutdown procedure

1. After getting result keep the used Test Strip and lead acetate shocked cotton ball into the waste bag. Discard the liquid remaining in the reaction vessel with residues into a dumping ground or toilet or wastewater trap pond/well of the concerned tube well.
2. Washout the reaction vessel thoroughly with the tube well water and remove, if any residue trapped inside the vessel.
3. Colour the spout of the tested tube well either green or red according to the test result.

Different Kits for Testing Arsenic at Field Level

Different Kits for Testing Arsenic were available in the markets of Bangladesh at different times, of which the testing principles are similar but the testing procedure varies from kit to kit. Short descriptions of such type of kits are as follows-

GPL-Kit General Pharmaceuticals Limited, Bangladesh **Result type:** Semi Quantititive **Result Interval:** 50 mililiter- 0, 10, 50 ppb 2 mililiter- 100, 500, 1000, 1500, 2000ppb Technique to obtain result: Compare with the standard colour chart.	

Quantofix MACHEREY-NAGEL GmbH & Co., Germany **Result type:** Semi Quantititive **Result Level:** 0, 0.005, 0.01, 0.025, 0.05, 0.1, 0.25, 0.5 miligram/liter **Technique to obtain result:** Compare with the standard colour chart.	
Merck Arsenic Test Merck, Germany **Result type:** Semi Quantititive Result Level: 0, 0.1, 0.5, 1.0, 1.7, 3.0 miligram/liter **Technique to obtain result:** Compare with the standard colour chart.	
Merck Arsenic Test (Sensitive) Merck, Germany **Result type:** Semi Quantititive **Result Level:** 0, 0.01, 0.025, 0.05, 0.1, 0.5 miligram/liter **Technique to obtain result:** Compare with the standard colour chart.	
Wagtech Digital Kit (Arsenator) Palintest (Wagtech), UK **Result type:** Quantititive **Result Level:** According to the calibration curve **Technique to obtain result:** Digital display of result.	
Econo Quick Kit Industrial Test System, USA **Result type:** Semi Quantititive **Result Level:** 0, 0.01, 0.025, 0.05, 0.1, 0.2, 0.3, 0.5, 1.0 miligram/liter **Technique to obtain result:** Compare with the standard colour chart.	

Reference

- Environmental Conservation Rules, 1997
- Water Quality Monitoring and Surveillance Protocol for Rural Water Supply in Bangladesh 2005, Department of Public Health Engineering
- National Policy for Arsenic Mitigation 2004 and Implementation Plan for Arsenic Mitigation in Bangladesh, Local Government Division, Ministry of Local Government, Rural Development and Co-operatives
- Rapid Review of Locally Available Arsenic Field Testing Kits 2006, Arsenic Policy Support Unit
- Evaluation of field kits used for arsenic detection in ground water, 1999, NGO Forum for Drinking Water Supply & Sanitation

Annex-1

Bangladesh Red Crescent Society

INFORMATION SHEET– Arsenic Testing by Hach kit

District: _____ Upazilla: _____ Union:_____

Sl. No.	Tube Well Code	Name of Tube-well(TW)/Water Point Owner/Caretaker	Village	Depth of TW (ft.)	Year of Installation	Date of Test	Result (ppb)

Signature:	
Name of tester:	

Checked by -	
Signature:	
Name & Designation:	
Date:	/ /