Annex - D

PROTOCOL FOR INSTALLATION OF ARSENIC SAFE TUBE WELLS IN ARSENIC AFFECTED DELTA AND FLOODPLAIN AREAS OF BANGLADESH

GENERAL

Till 1993, 97% of the rural population of Bangladesh had access to safe drinking water, derived from hand tube wells within 150 meters of their households. These tube wells, other than in the coastal areas were shallow in nature within about 250ft.(about 79 meters) depth At the time, safety of tube wells was based on the fact that water from the wells was bacteria free. Arsenic menace came to the forefront in 1995 only, when DPHE first detected arsenic in some tube well water in Nawabganj district. From that time on, a series of survey was conducted by DPHE, by different government, semi government, non-government organizations and international agencies. It was found that a large number of hand tube wells used for domestic purposes in the Ganges-Brahmaputra-Meghna delta complex and the flood plains of rivers are contaminated by arsenic which is higher than the Bangladesh National Standard of 0.05mg/l. In many Upazilas more than 40% and in some more than 90 % tube wells are contaminated by arsenic in different degrees and levels.

Under the auspices of the Government, different aspects of arsenic calamity in the country were discussed in the last "International Workshop on Arsenic Mitigation in Bangladesh", held in Dhaka on 14-16, January 2002. A consensus was reached among the national and international experts that the arsenic contamination is of geologic origin. It was also agreed in the above workshop that the classical classification of the aquifers on the basis of depth used till now should now be reclassified on geological basis.

Considering the geological aspects it can be seen that the aquifers in the Holocene sediments younger than the last major glacial age of 21,000 years BP are mostly affected by arsenic contamination. Aquifers in the Late Pleistocene-Early Holocene are safe (DPHE-BGS, 2002)

Thus the arsenic contamination map show that the hand tube wells in the Hilly Region, the Mahdupur, the Barind Upland areas, and the northern most districts of Panchagar and Thakurgaon which consists of approximately 30% of the country are safe (Report of the Ground Water Task Force, 2002).

Among all the above areas where the Pleistocene Red Clay Formation is at the surface, tube well can be the best source of water for all purposes and will probably remain sustainable for a long time.

These areas are (Report of the Ground Water Task Force 2002):

a) **All the upazilas of the three hill districts, and all most the whole of Chittagong and Cox's Bazar dustricts except the narrow strip of the coastal plain and parts**

of 20 (twenty) upazilas in the northern hill front of Sherpur, Habigonj, Moulavibazar, Sunamganj, and Sylhet districts as shown below:

Division	District	Upazila
Chittagong	Chittagong & Cox's Bazar	All Upzilas except he coastal plain areas of the Mirersharai and the Sitakund Upzilas.
	Khagrachari,Ranga-mati,and Bandarban	All Upzilas of these Districts.
Dhaka	Sherpur	Jhenaigati (Northern part),Nalitabari (Northern part) Sribardi (North east part)
Sylhet	Habiganj	Bahubal (Central part along North west direction),Chunarughat (North west, South west and Part of South east), Nabiganj (South east part)
	Maulavivazar	Barlekha (Eastern part fully), Kulaura (Western part and part of Eastern side), Kamalganj Western and Eastern part), Ragnagar (Eastern part) Srimangal (North South central part and South east corner)
	Sunamganj	Bishwambarpur (North east part)
	Sylhet	Beanibazar (Central part), Fenchuganj (Southern end), Golapganj (North east part), Gowainghat (South east part), Jaintapur (Northern part), Kanaighat (Eastern part), Sylhet Sadar (North east and South west corner), Zokiganj (North eastern portion)

b) In the Barind region 12 (twelve) upazilas in 5 districts are completely and parts of 32 (thirty-two) upazilas of 8 (eight) districts as shown below:

A: Upazilas in the Barind Region with Completely Arsenic Safe Aquifers

Division	District	Upazila
Rajshahi	Bogra	Dhubchachia,Kahalu,Nandigram, Akkelpur
	Joypurhat	Kalai, Khetlal
	Naogaon	Niamatpur, Patnitola, Sapahar
	Nawabganj	Nachole
	Rajshahi	Godagare, Tanore

B: Upzilas Partially Covered by Safe Aquifers in Barind Region

Division	District	Upazila
Rajshahi	Bogra	Adamdighi (Except South west corner),Bogra Sadar (Western part), Dhunot (Eastern part), Sherpur (Western part), Shibganj (Western part)
	Dinajpur	Birampur (Eastern and Western corner), Birganj (North west and South west part), Birol (South east corner), Bochaganj (Southern part), Chirirbandar (Southern half),Dinajpur Sadar (Southern half), Ghoraghat (South and South west part),Hakimpur (Except North west corner), Kaharol (North east part), Nawabganj (South west part), Phulbari (Western half and part of North east), Parbatipur (Central North South)
	Gaibanda	Gobindaganj (Western part), Sadullapur (South west part)
	Joypurhat	Joypurhat Sadar (Eastern part), Panchbibi (North east and South east part)
	Naogaon	Badalgachhi (Western part), Dhamorihat (Except North east and Central part), Naogaon Sadar (North west part), Porsha (Except North west part), Raninagar (Eastern part)
	Natore	Sihingra (North east part)
	Rangpur	Badarganj (North west and South west part), Mithapukur (Western part), Pirganj (Western part)
	Sirajganj	Raiganj (North west part), Taras (North east part)

c) In the Madhupur region 2 (Two) upazilas in Mymenshing and Tangail Districts and Dhaka City are completely and parts of 22 (twenty-two) upazilas in 8 districts as shown below:

A: Upazilas in the Madhupur region with Completely Arsenic Safe Aquifers

Division	District	Upazila
Dhaka	Mymensingh	Bhaluka,
	Tangail	Shakhipur
	Dhaka	Dhaka City

B: Upzilas Partially Covered by Safe Aquifers in the Madhupur Region

Division	District	Upazila
Chittagong	Comilla	Comilla Sadar (Part of Western side)
Dhaka	Dhaka	Dhaka Metro (Except Eastern part), Savar (Except extreme Southern and Eastern part)
	Gajipur	Gajipur Sadar (North west and South east part),Kapasia (Except South east part), Kaliakoir (Except South west corner), Sreepur (Except North east and Southern part)
	Jamalpur	Jamalpur (South east corner)
	Mymensingh	Gafargaon (Western part), Muktagacha (North west corner) Phulbaria (Eastern part and part of South), Trishal (South and South west part), Madupur (almost the whole), Jamalpur (Eastern part).
	Narayonganj	Rupganj (Only central part)
	Narsingdi	Belabo (North west and South west part), Palas (North west part), Shibpur (North east part), Monoharpur (most of the Upazila)
	Tangail	Ghatail (Central and Eastern part)
		Madhupur (Eastern part and part of due South)
		Mirgapur (North east corner)

In addition to the above areas, where the Pleistocene Red Clay Formation is within a depth of 200-250 meters or less, for example, whole or parts of 51 upazilas in 19 districts surrounding the Barind and the Madhupur Uplands and in some pockets like the whole of Bhola district and parts of Barisal district, tube well can be the source of potable (water for household use) with proper sealing of the upper aquifers so that water from those cannot contaminate the water below.

In certain parts of southwestern part of the country and in a narrow strip along the hill front in the northeastern areas, a hard and cemented gravel layer is encountered around a depth 35 to 200 meters. In these areas tube wells to reach the sediments below the gravel bed need diamond drills. In case diamond drill is used, tube wells to withdraw water from below the gravel bed can be installed with proper sealing of the upper aquifers.

In addition in a narrow part of the coastal belt (mainly in the tidal zone) where tube well water is withdrawn from below the marine clay layer (which are generally widespread in contrast to the fluvial clays which are lenses of short width and lengths) at depths of 200-300 meters or below will also be arsenic safe with proper sealing of the aquifers above.

PROPOSED ADHOC PROGRAMME FOR INSTALLATION OF DEEP TUBE WELLS.

During evaluation of alternative options it was found that in arsenic affected areas, people have the general tendency to go to tube well facilities (if it is arsenic safe), irrespective of its distance from their households. The reason may be that it is a tradition old practice and the behavior of the people will not be changed unless they find alternative options that are more comfortable and beneficial.

However, after reviewing all the situations, there has been a general consensus of opinion of the group of experts that when all the alternative options are found not feasible and in case piped water supply from any existing arsenic safe BADC production tube well is not possible, only then deep hand tube well installation in limited number may be considered before aquifer mapping in the country is completed and in the severely arsenic affected areas.

For the purpose, an investigatory approach has been accepted for adoption.

Pending completion of aquifer mapping, the following may be the guidelines, described as scope of work for installation of deep tube wells on ad hoc basis as under, in severely arsenic affected areas.

SCOPE OF WORK FOR INSTALLATION OF DEEP HAND TUBE WELLS ON AD HOC BASIS IN SEVERELY ARSENIC AFFETED AREAS

For installation of arsenic safe deep tube wells in different severely arsenic hot spot areas, the following steps of work may be followed:

1. In severely arsenic affected areas all alternative options should be explored for supplying arsenic safe water to the community.

2. Improved Dug wells, should be considered as an option, which can serve small clusters of population and in some cases even individual households. In places where the walls of the dug wells are not stable or are collapsing, dug wells with rings may be tried. Top of the wells may be covered and hand pump should withdraw water from the well. To serve a large community, improved dug wells may be tried in strategic locations of a village. In such cases protective measures should be built to withdraw water from the well. In places where there is sand boiling a float with a flexible pipe or "inverted filter" may be tried where possible. Water of dug wells should be monitored yearly to check for arsenic and bacterial contamination.

3. For villages on both sides of perennial rivers or irrigation canals RSF should be the first option.

4. In case of Pond Sand Filter where a pollution free pond is desirable, some kind of incentive may be provided to the owner of a pond so that he does not use the pond for fish cultivation.

5. Irrigation tube wells, if found arsenic safe, may be used as source of drinking water to the community through pipe system but in such cases continuos monitoring, at least once in six month should be made mandatory.

6. Areas where alternative options are found successful should not be included for consideration to install deep hand tube well.

7. A committee will be formed from among the members of the National Committee of Experts to review the feasibility of installation of alternative options in the affected area and decide on installation of deep tube wells.

8. As a matter of procedure, agencies intending to install deep hand pumps will first collect all particulars of test tube wells in arsenic affected areas from R&D Division of the Department of Public Health Engineering. These will include well

logs, depths of test tube wells, water quality, geophysical exploration data etc. Similar information on aquifer, well logs, water quality including that of arsenic will also be collected from DPHE territorial Divisions, BADC, BWDB etc.

9. Locations of successful tube wells, producing arsenic safe water will be plotted on Upazilla map with union boundaries. The next step will be to select a suitable depth, based on best geology of the well logs, for installation of deep hand tube well at selected site/sites in the union/ Upazilla.

10. Following this exercise, a deep tube well will be installed, **observing all precautions with improved well design including clay seal with bentonite clay** of all the upper contaminated aquifers so that water from those aquifers do not pollute the deeper aquifer during operation.

11. On completion of the tube well, the quality of water will be checked. If the water is found acceptable, having safe arsenic concentration and other critical parameters (specifically chloride), the tube well will be retained and **will be allowed to be used by the community for drinking and cooking purposes only.**

12. Monitoring of a successful deep hand tube well will be done annually for arsenic concentration, if any, during operation of the tube well. The purpose of monitoring will be to observe the trend of change of arsenic concentration or any other critical parameters and take decision on the matter accordingly.

13. Deep tube wells can only be installed where there are no other alternative options. Proper investigations of the aquifer parameters particularly lithological logs and probability of leakage from the upper layers should be carried out before installing deep tube wells.

14. This exercise is intended to provide guidance for installation of more tube wells in the unions/upazilas in future. At the same time t**his exercise will aim at complimenting and providing supporting data during detailed aquifer mapping**.

15. For mitigation activities through community action plan, one deep tube well will be provided for minimum 500 users.

16. In areas where the presence of Pleistocene red clay was not proven, random testing would be carried out to examine the possibilities of sinking deep hand tube wells in those areas, following the conditions of this protocol.

17. The protocol for sinking deep hand tube wells in arsenic affected areas would be further refined and modified in the future, if necessary.

18. The protocol should be followed by all agencies involved in sinking deep hand tube wells in arsenic affected areas.

POSSIBLE PROBLEMS AND HAZARDS

During and after installation of a new deep tube wells in an area, efforts are to be taken to discourage indiscriminate installation of deep tube wells. Otherwise there will be considerable risk of contamination of deep aquifer from arsenic contaminated upper aquifers.