Report on

Short Term Consultancy to NGO Forum for Drinking Water Supply and Sanitation on

Domestic Rainwater Harvesting in Bangladesh

for

Swiss Agency for Development and Cooperation, Switzerland

by

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1. Mission Background and Objective

SDC and DANIDA have jointly been supporting NGO-Forum for Drinking Water Supply and Sanitation in carrying out the project “Integrated Water and Sanitation Programme through Partner Organisation” since 1997. A joint mid-term review mission was carried out in October 98. Karl Wehrle of SKAT has been member of the review team.

Based on recommendations of the mid-term review and on the needs arising, the objective of the short-term consultancy was focused on domestic rainwater harvesting. (Further details are presented in Annex 1).

2. Introduction to Domestic Rainwater Harvesting (DRWH)

Roof-water or rainwater harvesting is an option which has been adopted in many areas of the world where conventional water supply systems are not available or have failed to meet the needs and expectations of the people. It is a technique of water collection which has been used since antiquity. Examples of RWH systems can be found in all the great civilisations throughout history. (The letters “RWH” are used to refer to both large and small-scale rainwater harvesting systems, including schemes that serve whole communities, whereas “DRWH” refers to systems designed to meet the needs of just one household.) The technology can be as simple or as complex as required. In many societies it is often as simple as placing a small container under the eaves of the roof to collect falling water during a storm. One 20-litre container of clean water captured from the roof can save a walk of many kilometres, in some cases, to the nearest clean water source. This shows that even the simplest system can provide some relief to those who must walk to collect drinking water. Naturally, more complex systems that include larger storage facilities can result in wider and long-lasting benefits. In the industrialised countries of the world, sophisticated as well as simple systems have been developed with the aim of reducing water bills, minimising water consumption from overstretched pipe-borne supply systems or to meet the needs of remote communities or households in arid regions.

Many individuals and groups have taken the initiative to develop a wide variety of different RWH systems throughout the world. A recent initiative is the Roofwater Harvesting Research Group. Each member of the Group has an interest in one of the critical aspects of RWH (see. Annex 4). In this way more profound action research, global learning, as well as documentation and dissemination are facilitated.

3. Assessment of Domestic Rainwater Harvesting in Bangladesh

As a result of the limited time of the consultancy, this assessment remains incomplete at this point. However, activities are suggested in the recommended action plan to complete and update this analysis.

An assessment of DRWH in Bangladesh has been undertaken to a great extent and in a **participative** manner together **with NGO-Forum staff** - in particular with Zillur Rahman the engineer in charge, but also with other field staff (e.g. see the SWOT analysis with field staff in Khulna in Annex 5).

3.1 Context, climate

Bangladesh is a humid tropical country with an annual rainfall of 2500 to 3000 mm in the coastal belt, Sylhet and Chittagong Hill Tracts area, respectively 1200 to 1900 mm in other inland areas. The rainy season can be expected to last from April to October whereas for the rest of the year it remains generally dry. Detailed information about annual rainfall for the past 30 years and typical maximum and minimum. rainfall patterns over the years are available in figures for different stations. An approximate map has been drafted in Annex 6a to provide an overview of the annual rainfall distribution over the country.

3.2 Needs and potential for RWH

Scarcity and therefore reduction of access to sufficient safe drinking water are on the increase. The main reasons are overexploitation and sinking groundwater tables, intrusion of saline water in the coastal area, reduction of yield of sources in the hills and, in addition, contamination of large groundwater reservoirs with carcinogenic arsenic. All these factors, coupled with the increase of population, lead to a situation where a large part of the population - in particular in rural areas - is exposed to continuing and, in many cases, to increasing health risk. The map sketched in Annex 6b provides an idea about the areas affected.

DRHW has the potential to provide answers to these problems. However, it cannot provide the definitive answer to all these problems, considering the climatic conditions and the cost involved. But it can become a realistic, practicable and appropriate solution in combination with other supply systems, as the assessment below will reveal. This is in contrast to other alternatives such as bulk supply systems which have impossible cost implications.

3.3 History of RWH

In Bangladesh, traditional rainwater harvesting systems have been practised in the coastal and Hill Tract areas since ancient time. People of those areas were and are still using Motka (large earthenware pots) to collect and store rain water for use in the periods of no rain. An additional, and sometimes complementary, system is the collection of surface water runoff in deep, open ground-reservoirs or ponds. The nature of the soil in most of the areas is such that losses from seepage into the surrounding ground are minimal.

Although these **traditional RWH systems** are still applied to a certain extent these days; **their appropriateness has become questionable** for the following reasons. The increased density of population renders these systems unsafe and insufficient. For example, in former times people would distinguish between open tanks used for drinking water collection and those used for other purposes such as washing, watering animals etc. Today these ground-level reservoirs are mostly used for all purposes and are therefore heavily contaminated with bacteria. In addition the turbidity of this stored water is high since the surface runoff comes mostly from bare land.

3.4 Social Aspects

RWH puts control of water supply into the hands of the individual householder. Therefore its management requirement is less complex in contrast to most other technologies. On the other hand its autonomous nature may attract less interest from support agencies such as government organisations and the private sector. The flexibility of RWH system costs may lead to more advanced supply standards in richer households. Therefore subsidies to RWH systems need careful consideration.

Water collected from safe RWH systems is relatively costly. Therefore its consumption is in general only justified for drinking purposes. The long history of RWH in Bangladesh coupled with the tradition of distinguishing between drinking water and water used for other purposes favour the increased application of RWH.

Observations made during a field visit in Khulna area confirmed a **high level of awareness among the population about the value of safe drinking water**. Despite a prolonged drought period (8 weeks longer than the period used for designs), some rainwater collection tanks still contained drinking water. This is a clear indication that the precious rainwater is used only for drinking. Water for other domestic use is collected from nearby open ponds.

The over 60 DRWH plants constructed by NGO-Forum are highly appreciated and accepted by the users. In fact an obvious demand has been created in the area of Khulna.

3.5 Economic considerations

The construction cost per capita of safe RWH systems is comparatively high especially if they are designed with sufficient capacity to supply drinking water throughout the whole dry season. (For example, the cost per capita for NGO Forum's DRWH plant that is designed to supply drinking water for 5 months to one family amounts to 700 Tk. In comparison, a tubewell with handpump for 20 families costs 90 to 120 Tk. Some additional cost analyses are presented in Annex 8. This cost can be significantly reduced if the DRWH system is used in combination with other supply systems. The maintenance and operating costs for RWH are generally low and largely absorbed into the non-monetary household economy.

RWH offers a classic mechanism for encouraging the investment of family capital in water supply. The relatively high investment cost involved with RWH is the biggest challenge to the dissemination of this otherwise very appropriate technology. This aspect is explicitly considered below when potential options are proposed. In addition a strategy is recommended in order to reduce investment cost.

3.6 Water quality and health issues

Competently harvested roofwater generally has negligible levels of pollution by minerals and low levels of bacterial contamination (within limits recommended by WHO). **Its quality is likely to be superior to that of most other alternatives**. There has been concern that rain may become contaminated i) whilst falling through the atmosphere, ii) whilst running down the roof or iii) whilst in storage. These concerns can be answered as follows:

i) Measurements of precipitation even in industrialised areas indicate a fairly low take-up of heavy metals from the air and wholly tolerable levels of acidity. However no doubt it would be unwise to harvest rainwater immediately downwind of a brick kiln chimney.

ii) Roofs and gutters are made of a variety of materials. Those which may be considered in Bangladesh (with comments on their possible implications for health) are as follows:

- galvanised iron (GI) is safe to use (low toxicity) and has a smooth surface, hence it is not prone to contamination;
- asbestos cement (AC) is safe to use (asbestos fibres are carcinogenic only if inhaled, so AC poses a high risk for builders and others working with AC sheets);
- clay tiles are absolutely non-toxic, however their relatively rough surface may lead to contamination if the tiles are not well maintained;
- roof paints including bitumen may entail some risk to health or unpleasant taste (so it is advisable to check with the manufacturer);
- biomass such as thatch from palm leaves etc. may not be safe;
- plastic sheets are generally not durable.

iii) If water is stored hygienically its quality may even improve over time. That is why tanks have to be designed so that they remain well sealed. Maintenance normally involves annual cleaning.

In addition to these factors the quality of water collected from a roof depends also on the way the RWH plant is designed and constructed. It is, for instance, important that the collecting system from the roof to the tank provides facilities to drain off the *first flush* after a period of drought. Debris which may have collected on the roof during the dry season needs to be flushed away to ensure a good quality of water in the tank. Tree branches should never be allowed to grow over a roof used for drinking water catchment.

The observations made in the field at five of the over sixty plants (built with the assistance of NGO Forum) in the Khulna area confirm above statements. Since the DRWH plants had been designed for a dry period of five months, but the current drought had already lasted for **seven months** only two of the storage tanks were still providing water. However, as a result of proper maintenance, t**he water quality was still of a high standard.** Tests conducted by an Indian scientist as well as by NGO Forum confirmed this fact. Moreover consumer satisfaction is very high and rainwater is considered as a precious good.

Open ground-level reservoirs are at high risk of contamination as already stated. This risk may be reduced by some protective measures such as planting vegetation in the collection area, restricting the use of the pond etc. However, in any case, treatment of pond water will be required for the removal of both turbidity and bacterial contamination. So-called pond sand filters (PSF) have been installed for this purpose with different levels of success as shown below.

3.7 Technologies applied and skills available

This present assessment of the technologies applied in Bangladesh is limited to the RWH systems visited in the Khulna area, which include domestic roof water harvesting (DRWH) systems and RWH in open ponds including an adjoining treatment plant.

3.7.1 Domestic Roof Water Harvesting (DRWH)

NGO-Forum has initiated and supported the design and construction of over 60 DRWH plants out of which five were visited. In the following paragraphs they are described and assessed regarding the three principal components that make up a DRWH system:

- **Collection area:** In the absence of an adequate roof surface (mostly roofs thatched with palm leaves or straw) the collection area consists of a special cloth measuring 4.5 x 4.5 metres. It is fixed to erect bamboo sticks whenever rain falls. The advantage of the system is that it remains clean (if carefully stored, which was the case in all places visited) since it is only erected during periods of rain. However in strong winds the cloth tends to tear quickly (it was observed that some repairs had already been required). Since the expected service life of the collecting cloth is short it is more economical and reliable to improve at least part of the roof either with clay tiles, or with G.I. or A.C. sheets. This will not cause any problem even for most of the existing systems, since the edges of roofs are normally higher than the intakes of the storage tanks. However, in any case the houseowners should be advised to plan any roofing in future in such a way that it meets the requirements of a DRWH system.

- **Guttering:** Water is allowed to flow directly from the centre of the cloth into the storage tank, hence no additional guttering system is required. However with the improvement of the collection area a guttering system would be required. It is recommended that the design should be as simple as possible. This means for instance that the last piece of the gutter before the tank should remain moveable, simply to facilitate flushing.

- **Storage Tank:** Storage tanks are designed for a 5 month dry period, assuming a family of 10 people, each consuming 2 litres of drinking water a day. Based on these assumptions the required capacity of the tank is calculated to be 3200 litres. The tanks are constructed in ferrocement.

  All the ferrocement storage tanks that were visited were of high quality. They had been constructed by a local mason who had undergone training by an expert from AIT Bangkok, facilitated by NGO Forum.

  The design was professionally done and the drawings were of reasonable standard.
  The assumptions used seemed to be justified. Except for two families, all had run out of water after six months despite very restricted usage. Since the ongoing drought was exceptional there is no reason to increase the capacity of the storage tanks. In view of the need to reduce the cost the opposite should be considered. However, manageable alternatives need to be developed to complement the DRWH during periods of drought (chapter 4).

3.7.2 Open Pond RWH:

In areas with impermeable soil, RWH using open ponds at homestead or community level is a practice, which goes far back in history. While these supply systems may have been safe in those days also for drinking purposes, they do not serve this purpose today anymore because of the increased density of population and the higher risk of contamination. Communities are aware of this situation and water from these ponds is not used anymore for drinking except if it is purified by treatment such as pond sand filters (PSF). Operation and maintenance of PSF at community level cause problems because of the frequent cleaning required. Recent examination of bacteriological contamination revealed that PSF are mostly operated in an inefficient way and the treatment effect remains very limited. It is therefore recommended that PSFs be replaced with pond roughing filters (PRF). PRF mainly serve the purpose of removing turbidity whilst bacteriological disinfection can be achieved in a second step at the household level with the SODIS method. Properly designed PRF will be much simpler to maintain than PSF and any loss of effectiveness is made immediately obvious by the visible turbidity.
Open pond RWH will not be any further discussed in this report since the focus of this short term consultancy is on domestic roof water harvesting (DRWH).

3.8 Operation and maintenance (O & M)

Operation and maintenance for domestic roof water harvesting (DRWH) is quite simple. It consists mainly of flushing off with the first rains the debris which may have collected on the roof surface during a period of drought, and the annual cleaning of the storage tank. **The fact that control of the DRWH system is in the hands of the individual householder or user simplifies its management.**

The observations made in the field confirm this statement. All DRWH systems visited were well maintained. Interviews showed that the householders concerned are well aware about the operation and maintenance requirements. This means that NGO Forum’s awareness campaign and training have been effective.

3.9 Water security

The security or reliability of water supplies is an aspect which requires enhanced attention today in view of the increase of population and the limited (in some cases even reducing) availability of resources. This is particularly relevant in the context of Bangladesh where the increase of population is coupled with an alarming degradation of the environment. The situation is further aggravated by the arsenic contamination of large groundwater reserves.

Water insecurity can take many forms. The three most relevant for DRWH - chronic insecurity, acute insecurity (e.g. drought) and lack of entitlement - are discussed below.

- Chronic insecurity: DRWH can make a useful contribution to reducing chronic water shortage - particularly in providing safe drinking water.

- Acute insecurity: Since DRWH systems can not be designed to cope with severe droughts (because of the cost), it is essential to combine DRWH with other alternatives (as discussed in Sections 4.2 and 4.3).

- Differential insecurity Because of a lack of entitlement, the poorer sectors in a community are often excluded from access to safe water. DRWH offers opportunities for reducing differential insecurity by virtue of the range of design options, which facilitate solutions of reduced standard at lower cost but with the potential for upgrading in stages.

3.10 Agencies involved in RWH

Beside NGO-Forum there are various other organisations involved in RWH to different degrees.: These organisations include DPHE-UNICEF, CARITAS-Bangladesh, HEED, and Jagroto Subo Sarga in Khulna, to name just a few of them. (For further details see Annex 9). With regard to RWH, neither co-ordination nor exchange of experiences has taken place so far between these organisations. However, an awareness of the need for such links and an interest in establishing them has been indicated. That is why it is recommended that a forum should be formed and links established with international research on the subject (Section 5.3).

3.11 General observations

Some general observations are reported here with particular regard to the mid-term review. **NGO Forum has already taken some significant steps** since the midterm review in October 98. The indicators are as follows:

- Private sector involvement in latrine construction is on the increase. The necessary training is being provided.
- Privatisation of some Village Sanitation Committees (VSC) is under consideration.
- Training for regional staff on Participative Rural Appraisal (PRA) methods is already scheduled.
- The design for the iron removal plant has already been improved and a pilot plant is operating successfully. (Cost optimisation will be the next step to follow.)
- An increased openness to learning from other projects - in particular of the WATSAN partnership project – has been observed

4. Options for the application of Domestic Rainwater Harvesting

Roof water is usually the best quality water. It is in most cases more convenient than water from any alternative source as well as being cleaner and safer. However it is, at the same time, also usually the system with the highest cost per litre of water supplied. Therefore **the most obvious strategy is to move towards partial DRWH systems in which roof water is combined with water from other sources**. The challenge is, however, to find an optimal balance between access to safe water, reliability of supply and reasonable cost. Since the purchasing capacity of householders varies within the community and may change over time, there is no universal optimum for this balance. Therefore different options need to be developed for selection by the householder, and opportunities for **staged installation** must be publicised. The latter will allow for subsequent upgrading of service standards when the householder can afford to buy the extra components

In the following Section, different options are suggested at first for the DRWH system and secondly for the complementary supply systems. The type and degree of combination will depend on the specific context in the area concerned as well as on the preference and purchasing capacity of the householder.

4.1 Options for DRWH system

- **Sizing of DRWH system:** The main calculation when designing a DRWH system is to size the water tank correctly to give adequate storage capacity. However, there are a number of interrelated factors, which need to be considered to engineer the most economical solution in a given context. These factors include:
  - local rainfall data and weather patterns
  - the roof collection area
  - the roof material and its corresponding runoff coefficient
  - the number of users and consumption rates.

  There are a number of different methods for sizing system components. Additional information on sizing methods including some examples is provided in Annex 10.

- **Collection area:**
  Although it is possible to collect water from thatched roofs it is recommended for hygienic reasons to improve the required collecting area either with clay tiles, G.I. or A.C.-sheets. Cost calculations show that it is more economical to use this improved roofing material because of the limited service life of biomass material. Since the initial cost for the cladding of the entire roof with improved material can not be afforded by many families, only the area required for collection may be considered for improvement. The improvement of the entire roof may be achieved in stages according to the financial ability of the family concerned. Improvements may involve increasing the collecting area, enhancing the RWH plant, or both.

- **Guttering:**
  It is recommended that the design of the guttering system should be kept as simple as possible for economical reasons as well for the convenience of maintenance and operation. This means for instance that the last piece of the gutter to the tank should remain moveable, simply to facilitate the diverting of the first flush. Advanced flushing systems may be introduced if they can be afforded and their operation can be managed.

- **Storage tank:** The cost of the storage tank constitutes over 80 % of the DRWH system. Therefore the principal possibility for cost reduction concerns the storage tank. Since storage tanks have to be watertight, durable, hygienically sealed, easy to construct on site or easily transported, there are only limited options for saving cost on design and construction. The most effective way to save cost is to reduce the size of the tank. However, if the capacity of the tank is reduced, alternative sources of safe drinking water supply need to be offered, even if they are less convenient. As already explained at the beginning of this chapter, different options need to be developed for selection by the householder in addition to the opportunities for staged installation. The latter will allow for subsequent upgrading of service standard at the time when components become affordable for the householder concerned. This means that storage tanks of different capacities should be designed. The minimum size should cover at least the days of no rain within the rainy season. It is suggested that tank sizes of 500 to 5000 litres should be developed. Although construction with ferrocement is very viable, NGO Forum has used it successfully and its continued application is highly recommended, research on alternatives should be carried out.

However, underground tanks should not be considered because many areas are prone to frequent flooding.

4.2 Possible substitutes for safe roof water

For all those cases where the designed capacity of storage tanks will not cover the entire period of drought, and this may be the situation in most cases, alternative options are needed for the provision of safe drinking water when the tank is empty. For reasons of cost it can be expected that these alternatives are less convenient and/or provide lower quality water. Depending on the context and the wishes of the householders, the following options may be developed and made available:

- Collection of raw water from either an individual or a community pond, removal of turbidity with appropriate methods such as with Moringa seed, alum (aluminium sulphate) which seems to be already widely used at low cost (less than 1 Tk to treat 20 litres of water) or with a roughing filter. Action research will be required to identify the most effective and acceptable method. This low turbidity water can be disinfected with SODIS. The SODIS process can be expected to be very effective since this will take place outside the rainy season when temperatures are high and the sky is not cloudy.

- Collection of water from a shallow dug well and disinfection with SODIS. Action research may be required to identify existing construction methods and/or develop alternative low cost techniques. In the arsenic-prone areas the correct depth for such wells should be investigated since it may be possible to obtain arsenic-free water from the top layers of the groundwater. This may involve some risk because of the lowering of the water table.

- Collection from an arsenic-free tubewell located at some distance from the household. Depending on the local context, distances up to one kilometre seem to be acceptable. (In the Khulna area the mission team encountered some households who collected drinking water from a tubewell at a distance of seven kilometres). In some cases it may even be justified to use tubewells which yield water contaminated by low levels of arsenic during the limited period when the DRWH system runs out of water. This option needs to be cross-checked with the health authority.

4.3 Options for complementing safe roof water with non-potable water (cf. graph on next page)

In the view of the relatively high cost involved in rainwater harvesting – particularly the storage during periods of no rainfall, it is crucial that the precious, safe stored rainwater is exclusively used for drinking purposes. This means that alternative options have to be made available for other domestic uses. This is essential also for health reasons since many of the water-related diseases are not only water-borne but also water-washed. Therefore a sufficient quantity of water for domestic uses such as hand washing and bathing must be made available and reasonably accessible. The following options seem to be obvious in the prevailing context:

- supply from open ponds at household or public level;
- supply from shallow or tube wells, even if they may not be suitable for drinking water because of high salinity or arsenic or bacteriological contamination;
- collection of unsafe water from any other surface water sources such as rivers etc.

5. Conclusions and general recommendations

Domestic roof water harvesting (DRWH) is a viable alternative for the supply of safe drinking water of superior quality if competently managed. Its potential for providing realistic solutions in many instances to the problem of increasing scarcity of water at global level is being recognised more and more. In view of the challenges facing the WATSAN sector in Bangladesh - in particular regarding salinity of groundwater in coastal areas and arsenic contamination in other parts of the country -DRWH is an opportunity, which needs to be urgently grasped. The humid tropical climate provides sufficient rainwater in all parts of the country. However, the annual rainfall patterns - a dry period of up to six months - require large and costly storage tanks. To bring the cost down to a reasonable level, DRWH systems should be combined with other supply systems. Fortunately the rural population already practises a traditional dual supply system - in that water for drinking and water for other domestic uses are often collected from different sources. RWH systems at household level are simple to maintain and easy to manage. DRWH systems can be flexibly adapted to the household purchasing capacity and provide opportunities for development in stages and therefore upgrading of supply standard and convenience.

The recommendations below are based on the (incomplete) assessment (Chapter 3) and the discussion on various options in Chapter 4. They are listed according to the key considerations for balanced development.

5.1 Context

The data available on climatic condition and in particular on rainfall patterns over the years are available in table format. In order to render this information more user-friendly it needs to be translated into graphs and maps. (Some preliminary maps have already been sketched and are shown in Annex 6a).

5.2 Technology

Action research is required to investigate the various technology options, in particular to develop the required combinations of DRWH systems with other alternatives as suggested in **Chapter 4**. This action research will normally involve the following steps:

- assessment of ongoing activities and practices (completion of the assessment described above);
- development and design of technology options in collaboration with relevant sector institutions and in consultation with the potential users, and at the same time consideration of the local context including climatic conditions, with a special emphasis on cost minimisation;
- design of action research, including monitoring;
- implementation, including monitoring and adaptation of technology to the users' requirements through continuing interaction;
- finalisation of designs, options and processes;
- documentation of the different options in different formats to suit the needs of the various stakeholders and actors, such as users and contractors, and the compilation of these guides into a "toolkit".

Those parts of the necessary action research which are obvious can be started immediately. Examples are the design and construction of smaller tanks.

5.3 Institutional aspects

The following three aspects should be considered: (i) the needs of the users, (ii) instruction, dissemination and marketing, and (iii) the perspective of the producer.

- At the user level, domestic roof water harvesting (DRWH) systems are strongly recommended for obvious reasons, such as easy management.

- Concerning instruction, dissemination and marketing, it is recommended that a forum be initiated and plans for collaboration on DRWH developed at the first meeting. It is further recommended that NGO-Forum takes the lead in such a forum and therefore provides the co-ordination, monitors and documents the technology options, and maintains a resource centre for DRWH with international links such as to the Roof Water Harvesting Research Group. SKAT may act as adviser (for technologies, documentation, etc.) as well as facilitator for establishing links to global learning.

- Ideally the objectives of the producer are identical to those of the user (notably the reduction of labour cost). If the technology can not be mastered directly by the users, the private sector (comprising local artisans) is to be preferred to public sector supply for the production of DRWH systems.

5.4 Social factors

In case any subsidy is being considered, it is recommended that it should be based on a minimal standard and following cost sharing principles. Any strategy for subsidies should be commonly accepted and uniformly applied.

5.5 Economic issues

A strategy for cost reduction should urgently be developed and applied in an action research programme. As a first step the storage capacity should be economically and optimally sized for the given RWH system and context (see Section 4.1). The general strategies to be followed for further cost reduction are mostly covered by the following considerations:

- optimise the design (including reducing the quantity of materials used – by using thinner walls for example - and reducing the quality of the materials used;
- reduce transport cost;
- reduce labour cost (by involving the householder in construction); and
- remove the need for special shuttering or facilitate the reuse of shuttering.

Additional ideas can be drawn from Annex 12.

5.6 Skill and know how

Technologies should be selected so that they meet the criteria for sustainability and at the same time make as much use as possible of locally available skills and know how. In any case it will be necessary to develop a training strategy for mass dissemination.

5.7 General aspects

NGO Forum is recommended to take the following measures to reinforce its capacity to act as a contact point and resource centre for DRWH:

- to reinforce the technical section with an assistant engineer;
- to update the documentation section and organise it in a more user friendly way;
- to enhance the services to the Partner Organisations (PO's) with a professional enquiry answering service;
- NGO Forum, as a RWH resource centre, is further recommended to offer its services for the application of DRWH in ongoing projects such as in the WATSAN partnership project (see Chapter 6).

5.8 Action Plan

It is recommended that recommendations should be prioritised (and in particular the action research programme) regarding their importance as well as urgency. (See the Eisenhower plan in Annex 13). The action plan may be developed in accordance with this prioritisation.

6. Specific Recommendations for DRWH in the WATSAN Partnership Project

6.1 Introduction

The WATSAN Partnership Project is located in the Rajshahi and Chapai Nawabgonj district, in the low water table area. The action research project applies approaches and technologies based on latest global learning. Drinking water from groundwater is lifted with deep-set handpumps (based on locally known technologies such as the No.6 and Tara handpumps). Unfortunately many of the tube wells are contaminated with arsenic. The partnership project is in the process of developing and testing different alternative options such as simple arsenic treatment methods (SORAS), and surface water treatment with SODIS. DRWH is considered to be an additional or complementary drinking water supply option.

6.2 Specific Recommendations

The recommendations that are presented in Chapter 5 are also valid for the Partnership Project. The particularity of the context and aim of the project ask, however, for some specific approaches and design considerations. The guiding principles are local availability of technologies and affordability, which are both expected to lead to replicability and sustainability. The implications of these principles on DRWH are as follows:

Assessment of existing RWH: As a first step it is essential to assess the existing practices of rainwater harvesting. At the same time locally available capacities and solutions for improvements should be traced.

Development of Design Options (See Section 5.2): Based on the results of the assessment, different design options shall be developed. It is important that this development is done in close consultation with the users. Domestic roof water harvesting (DRWH) is strongly recommended for reasons of easy management. Affordability asks for cost minimisation, which means minimum sizes of storage tanks with the potential for upgrading of service standard. The choice of different construction methods and materials will depend on the local context. Ideally the objectives of the producer are identical with those of the user (i.e. reduction of labour cost). Low prices for storage tanks may also be negotiated with the private sector because of the potential size of the market.

Options for the substitution of safe drinking water with water for other domestic uses shall be investigated, developed and documented (see Sections 4.2, 4.3).

Dissemination and Marketing of DRWH: It will be important to develop an appropriate marketing strategy for the dissemination of DRWH concepts and designs. The marketing tools available within the Partnership Project should be applied. It will be crucial that information about the different design options is packaged in such a way that the users can make informed decisions.

Monitoring and Adaptation of Technology: The implementation and application of DRWH options should be continuously monitored. Learning should be drawn from successes and failures, and designs and approaches be adapted accordingly.

Dhaka, 4th May 99 and St.Gallen, 9th June Karl Wehrle, SKAT