PREPARATORY SURVEY
ON
COOPERATION PROGRAM FOR THE IMPROVEMENT IN WATER SUPPLY SERVICES IN THE PEOPLE'S REPUBLIC OF BANGLADESH

AUGUST 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

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(As of June 2010)

Preface

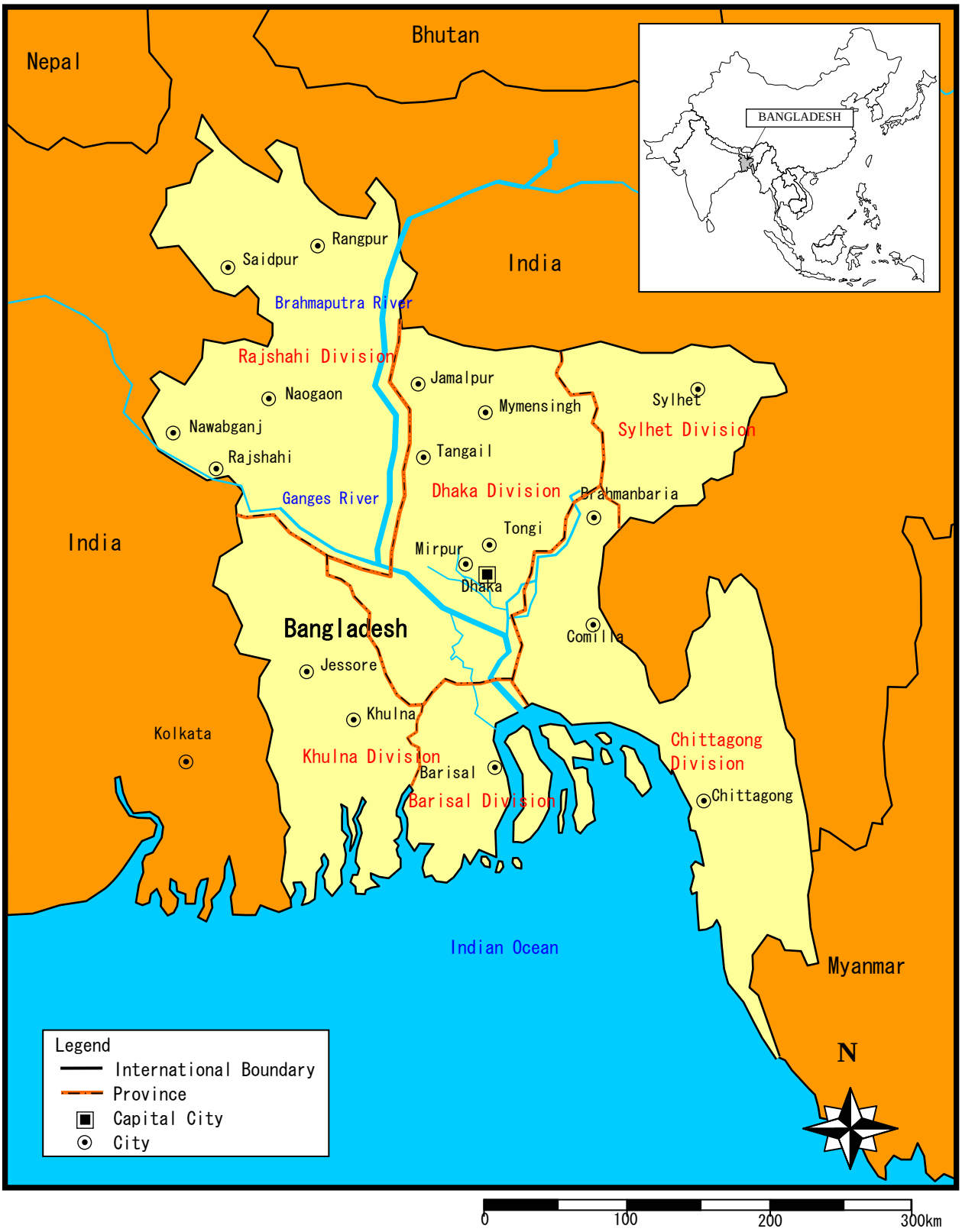
Recently, it is one of the important issues to secure safe and sufficient water resource all over the world. In March, 2009, “Istanbul Declaration of Heads of States on Water” was adopted at “the 5th World Water Forum” in Istanbul, Republic of Turkey, through a discussion on solutions for various water supply and sanitation issues. In Japan, water programs also have been actively implemented through water business for solutions of domestic and international water issues, such as to promote Public-Private Partnership programs in abroad.

In the People's Republic of Bangladesh, assistance on water service, such as mitigation of arsenic pollution of water, construction of water purification facility in cities and improvement of rural water supply, have been implemented with supports of NGOs and donors including JICA. Some of private companies in Japan have already started business on water service sector there. Promotion of this entry of private companies into the water sector is expected with the existing supports by NGOs and implementation agencies of ODA. Under such circumstances, JICA conducted this Preparatory Survey aiming at formulation of the projects by collecting and examining proposals of private sectors on water supply service as “Preparatory Survey on Cooperation Program for the Improvement in Water Supply Services in the People's Republic of Bangladesh”. JICA appointed and dispatched a survey team from Yachiyo Engineering Co., Ltd. to the People's Republic of Bangladesh, in order to mainly examine the possibility and prospect for partnership programs of ODA and private sector and private sector individual program on water service.
This report deals with the results of the Preparatory Survey, however, contents of this report do not necessarily reflect the present official opinions of JICA. I hope that this report will contribute to the promotion of the program formulation on water service sector in the People's Republic of Bangladesh,

Finally, I wish to express my sincere appreciation to the concerned officials for their close cooperation and assistance extended to the Survey.

August, 2010

Masataka Nakahara
Director General of South Asia Department
Japan International Cooperation Agency



Location Map

Photo (1/8)

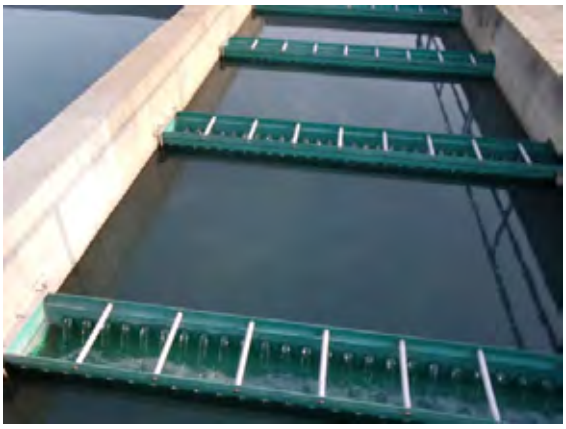
[Rapid mixing tank and slow mixing tank in Chandnigahd Purification Plant of Dhaka WASA] Flock formation by water flow is satisfactory.

[Water intake facility Chandnigahd Purification Plant of Dhaka WASA] Water intake facility is 1km far from the plant. The old water intake facility is not used because of the decrease of water volume.

[Surroundings of Chandnigahd Purification Plant of Dhaka WASA] The plant is in a dense residential area. There is no space for expansion in the plant site and the surrounding area.

[Baffling type flocculation basin and sedimentation tank in Godnail Purification Plant of Dhaka WASA] The plant is along with Shitalakshya River for water intake.

[Aluminum sulfate facility in Godnail Purification Plant of Dhaka WASA] Solid aluminum sulfate is used as coagulant.



[Collecting trough at the end of horizontal sedimentation pond in Godnail Purification Plant of Dhaka WASA] Turbidity of treated water seems to be low and sedimentation is relatively satisfactory.

Photo (2/8)

	
[Sedimentation pond in Khulna WASA] Filtration pond is broken and sedimentation treatment water is distributed.	[Megna River] It flows in the east of Dhaka City Turbidity was detected as 55 degree in the middle of April 2010.
	
[Megna River in the east of Dhaka City] Sediments are dredged and reused. Concrete production plants are dotted near the river.	[Landscape in Narsingdi] Width of the road is less than 5m. Number of rickshaw is huge.
	
[Deep wells in Narsingdi] Recently flow meter was installed.	[Megna River near Narsingdi] The river is one of the candidates in case of water source conversion.

Photo (3/8)

	
[Elevated water tank in Brahmanbaria] Groundwater from a well is delivered through this tower.	[Deep well in Brahmanbaria] Flow meter will be installed near future.
	
[Titas River in Brahmanbaria] The river is one of the candidates in case of water source conversion.	[Iron removal facility in Noahkali] The facility is constructed with the support of DANIDA. Iron is removed by oxidation with air diffuser and rapid sand filtration.
	
[Water supply pump facility in Noahkali]	[Elevated water tank in Noahkali] The tower is in the site of iron removal facility. It is also used for backwash of filtration pond.

Photo (4/8)

	
[Well facility in Gazipur] Maintenance seems to be satisfactory and the operation record is collected everyday. Water level gauge always works.	[Network piping figure in Gazipur] Commercial facilities and housing concentrate in the center of the city. There is no network piping, but handpumps in outskirts.
	
[Well facility Gazipur]	[Gomoti River in Comilla] It is 1km far from the city center. Because of the little water volume in the dry season, it is necessary to construct weirs and other devises.
	
[Elevated water tank in Comilla] It is greatly decrepit.	[Water intake point in Chandpur] It is in the city center.

Photo (5/8)

	
[Baffling type slow mixing pond in the surface water purification plant of Chandpur] Water in the pond is whitish turbid. Flock formation is not satisfactory.	[Horizontal sedimentation pond in the surface water purification plant of Chandpur]
	
[Landscape in Chandpur] Chandpur is a quiet local city and it takes 4 to 6 hours by car from Dhaka City.	[Outward appearance of well pump room in Shariatpur]
	
[Main road in Shariatpur]	[Arsenic removal facility for community in Muradnagar] Treatment water is distributed in the limited hours under CBO control.

Photo (6/8)

[Arsenic removal facility in DPHE office in Muradnagar] Filter media has not been changed.

[River near Muradnagar union in Muradnagar district] Water volume is plenty.

[Landscape of Muradnagar union in Muradnagar district] The administration size is in the middle between a rural area and a local city.

[People drawing water with shallow handpump in Lokkhipur village of Gazipur district]

[Well with seesaw in a school in Lokkhipur village of Gazipur district] It is an example of water supply and sanitation program by NGO and has 2 functions; to pump up from the well and to the elevated water tank.

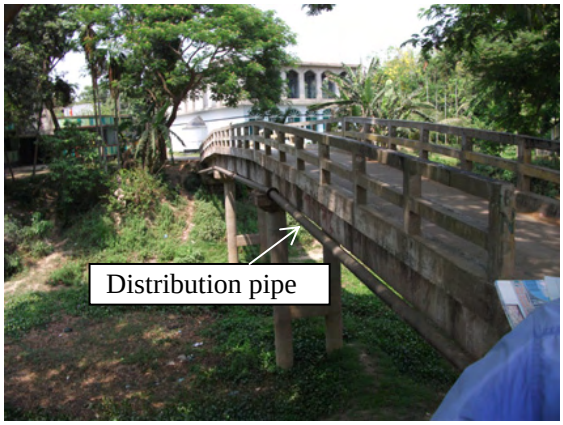
[Toilet facility for household in Lokkhipur village of Gazipur district] It is another example of water supply and sanitation program by NGO. This program aims to construct toilet facility to protect groundwater.

Photo (7/8)

[Target area of PPP involved with NGO in Fatenagar village of Keranjiganji district]

[Water supply facility in Fatenagar village of Keranjiganji district] Water source is groundwater. The tank is iron removal filtration facility.

[Water tap for household in Fatenagar of Keranjiganji village district] Handpump is still left in case of emergency.



[Construction of distribution pipe in Fatenagar village of Keranjiganji district]

[Elevated water tank in Kachua village of Chandpur district] Groundwater is pumped up by well pump and distributed through the tower.

[Irrigation channel in a rural area in Kachua village of Chandpur district] Groundwater is used both for irrigation and drinking water.

Photo (8/8)

	
[Irrigation channel in Kachua village of Chandpur district] Water source is groundwater.	[Residential area in Shahadia village of Gazipur district] There are 81 households. Residents do not own their lands.
	
[Shallow well handpumps in Shahadia village of Gazipur district] Residents share 4 handpump.	[Slum area near Dhaka City] 1 shallow well handpump is shared with residents.
	
[Slum area near Dhaka City] Purple colored factory effluent is discharged into the pond. It generates malodor.	[Utilization of pond] Pond is used for bathing, washing and fish cultivation regardless of the place.

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-Abbreviations-

AAN	Asia Arsenic Network
ADB	Asian Development Bank
AIRP	Arsenic Iron Removal Plant
BBS	Bangladesh Bureau of Statistics
BDP	Bangladesh POUSH
BEPZA	Bangladesh Export Processing Zones Authority
BGS	British Geological Survey
BIDS	Bangladesh Institute of Development Studies
BOO	Build Own Operate
BOP	Base of the Pyramid
BOT	Build, Operate and Transfer
BRAC	Bangladesh Rural Advancement Committee
B/S	Balance Sheet
BWDB	Bangladesh Water Development Board
BWSPP	Bangladesh Water Supply Program Project
CBO	Community Based Organization
CBA	Collective Bargaining Agent
CCWS	City Cooperation Water Supply and Sanitation
CIDA	Canadian International Development Agency
CSR	Corporate Social Responsibility
DANIDA	Danish International Development Agency
DBO	Design Build Own Operate
DCH	Dhaka Community Hospital
DFID	Department of International Development
DPHE	Department of Public Health Engineering
DTW	Deep Tube Well
DSP	Deep Set Pump
EC	Europe Community
EPC	Engineering Procurement and Construction
EPZ	Export Processing Zone
ERD	Economic Relation Division
FS	Feasibility Study
GDP	Gross Domestic Product
GNI	Gross National Income
GOB	Government of Bangladesh
HIES	Household Income and Expenditure Survey
HYSAWA	The Hygiene Sanitation and Water Supply (Fund)
IDA	International Development Association
IDB	Inter-American Development Bank
IPP	Investment Priority Plan
JBIC	Japan Bank for International Cooperation
JDCF	Japan Debt Cancellation Fund
JICA	Japan International Cooperation Agency
KOICA	Korea International Cooperation Agency
LGD	Local Government Division
LGED	Local Government Engineering Department
LGI	Local Government Institution
MBR	Membrane Bio-Reactor
MDG	Millennium Development Goals
MF	Micro-Filtration
MLGRD&C	Ministry of Local Government, Rural Development and Cooperatives
MoWR	Ministry of Water Resources
MP	Master Plan
NF	Nano-Filtration
NGO	Non-government Organization

NGOF	NGO Forum for Drinking Water Supply and Sanitation
NSAPR	National Strategy for Accelerated Poverty Reduction
NWMP	National Water Management Plan
NWP	National Water Policy
NWRD	National Water Resource Database
ODA	Official Development Assistance
OFID	OPEC Fund for International Development
O&M	Operation and Maintenance
OPEC	Organization of the Petroleum Export Countries
PC	Planning Commission
PFI	Private Finance Initiative
P/L	Profile and Loss Statement
PPP	Public-Private Partnership
PRSP	Poverty Reduction Strategic Paper
PSF	Pond Sand Filter
PSU	Policy Support Unit
PVC	Polyvinyl Chloride
PWSS	Pourashava Water Supply and Sanitation
RO	Reverse Osmosis
RDA	Rural Development Academy
RWHS	Rain Water Harvesting System
SIPP	Social Investment Program Project
SDC	The Swiss Agency for Development and Cooperation
SDF	Social Design Fund
SDP	Sector Development Programme
S/V	Supervision
TDS	Total Dissolved Solid
TOR	Terms of Reference
UF	Ultra-Filtration
UNICEF	United Nations Children’s Fund
WARPO	Water Resources Planning Organization
WASA	Water Supply and Sewerage Authority
WB	World Bank
WHO	World Health Organization
WSSPS	Water Supply and Sanitation Sector Program Project

CHAPTER 1 OUTLINE OF THE SURVEY

1.1 Background

JICA promotes to apply skills and experiences of private sectors in the formulation and implementation of overseas cooperation projects. This survey aims at formulation of the projects by collecting and examining proposals of private sectors on water supply service.

Safe and stable water have not been provided to the residents in the People's Republic of Bangladesh (hereinafter referred to as "Bangladesh"). Bangladeshi Government had envisaged on provision of safe water to entire nation by the year of 2010, however, achievement ratio is currently only about 70%. Bangladesh relies on groundwater in 97% of drinking water, but it is envisaged that 29% of tube wells is over drinking water standard value in arsenic. Meanwhile, drawdown of groundwater is a serious problem in urban areas including Dhaka city. Therefore, Bangladeshi Government declares to adopt policy of water supply service improvement by surface water development.

Water supply service of Dhaka, Chittagong and Khulna are managed by Water and Sewerage Authority (WASA), while those of other areas are managed by local governments. Water supply services are not sufficient due to lack of facilities, ineffective operation and maintenance (O&M), and so on. Meanwhile, lots of rural communities face with contamination of arsenic in groundwater. In addition, securing fresh water is very difficult because of intrusion of sea water into river during the dry season and saline groundwater in coastal areas.

Japanese government has been assisting water supply improvement in two projects in urban and rural areas through WASAs and Department of Public Health Engineering (DPHE), Ministry of Local Government, Rural Development and Cooperatives. Japanese government, in collaboration with other donors such as World Bank (WB), Asian Development Bank (ADB), Danish International Development Agency (DANIDA) and South Korea, has been implementing the projects such as construction/rehabilitation of purification plants with Japan's ODA loan, improvement of organizational capacity, non-revenue reduction, and improvement of water supply management of Chittagong WASA. While, Japanese government assisted rural areas in South-West in Sustainable Arsenic Mitigation, Strengthening Water Quality Analysis on Monitoring System, Mitigation Policy and countermeasures under Arsenic Contamination Mitigation Program.

Thus, Japanese government has been assisting for the improvement of water supply services in Bangladesh, but implementing organization lacks in budget, labor and skills in water supply service. Currently, NGOs and a part of private firms in collaboration with public sector have been contributing to improve the water supply service. Japanese government needs to seek standpoint for cooperation in the future considering partnership between public sector and private sector.

In this survey, Japanese standpoint of cooperation was examined and some projects on water supply services were proposed targeting not only with ODA but also with collaboration among the Japanese private firms, NGOs, local government, and so on through collection of basic information, site surveys and meetings with relevant organizations such as government, NGOs, private firms and communities.

1.2 Objective

Through review of policy and implementation plans on water supply services of Bangladeshi Government and assistance by international donors and NGOs, current status of water supply and issues are clarified and the following objectives are examined:

(1) The specified project plans (ODA, collaboration of ODA and private firms and NGOs, and Private project) applying Japanese technology and experiences, targeting in urban and rural areas, are proposed, and the methods of the project formulation are organized.

(2) In terms of formulation of Master plan and development of regulation framework, information required for promotion of private sector involvement and expansion of ODA to wide areas is collected and organized.

(3) Based on the proposed project plans as stated in (1), Draft Cooperation Scenarios are prepared for the next five years.

1.3 Survey Team Members

Survey team members are as shown in Table 1.3-1.

Table 1.3-1 Survey Team Members

Sector	Members	Organization
Team Leader / Water Supply Planning	Taketoshi FUJIYAMA	Yachiyo Engineering Co., Ltd.
Urban Water Supply Planning / Maintenance	Keizo KIMURA	Yachiyo Engineering Co., Ltd.
Rural Water Supply Planning / Maintenance	Mitsuhito OMORI	Yachiyo Engineering Co., Ltd.
Water Resource Planning	Hitoshi OURA	Yachiyo Engineering Co., Ltd.
Deputy Team Leader / Private Firm Partnership I / Management Analysis	Noboru OSAKABE	Yachiyo Engineering Co., Ltd.
Private Firm Partnership II	Tomio SATO	Hitachi Plant Technologies, Ltd.
Private Firm Partnership III	Nobuhiko WADA	Yachiyo Engineering Co., Ltd.
NGO Partnership I	Akihiro SHIMOMURA	Yachiyo Engineering Co., Ltd.
NGO Partnership Ⅱ	Sachie TSUSHIMA	Asia Arsenic Network

1.4 Survey Area

Survey area is urban and rural areas of entire Bangladesh. Site survey area is described in Section 3.11.

1.5 Survey Scope

JICA Survey Team (JST) researched technology and knowledge on water supply services which Japanese private firms and NGOs have been possessing. During the site reconnaissance, JST learnt basic information on the needs of Bangladeshi side through meetings with relevant organizations, local private firms and NGOs in Bangladesh. Based on analysis of collected information, list of the projects were prepared and Draft Cooperation Scenarios were tentatively developed. Finally, two Draft TORs were prepared for the prioritized project plans. The contents of the Survey are presented in this report.

1.6 Government Organizations in Bangladesh related to Water and Sanitation Sector

Table 1.6-1 represents the organizations of Bangladeshi Government relevant to water and sanitation sector. JST held a meeting with the organizations on May 6, 2010 and explained the objectives of the survey. Afterward JST conducted hearings to several organizations regarding the current conditions, problems and needs of the sector. Detail of each organization is mentioned in Section 3.5.

Table 1.6-1 Government Organizations in Bangladesh related to Water and Sanitation Sector

Name of Organization	Abbreviation	Responsibilities for Water and Sanitation Sector
Local Government Division	LGD	Formulate strategy, policy and regulation and do monitoring also
Local Government Engineering Department	LGED	Development and management of infrastructure in the rural areas
Local Government Institutions	LGIs	Local governments. Each government owns an organization of water supply and sanitation sector named Pourashava Water Supply and Sanitation (PWSS)
Department of Public Health Engineering	DPHE	Development of water supply and sanitation sector in the local government and rural areas, and technical & institutional support
Water Supply and Sewerage Authority	WASA	Authorities to provide water and sewerage services in Dhaka, Chittagong and Khulna

Name of Organization	Abbreviation	Responsibilities for Water and Sanitation Sector
Water Resources Planning Organization	WARPO	Management and planning of water resources in the country
Bangladesh Water Development Board	BWDB	Large-scale development of water resources and monitoring of groundwater drilling

1.7 Survey Schedule

JST conducted hearings in March 2010 for a month to the Japanese private firms, NGOs and associations for their overseas experiences and policy. JST stayed from April 5, 2010 to May 17, 2010 in Bangladesh. In order to introduce the findings of field survey, JST held a seminar in Tokyo for private firms and NGOs in Japan on June 9, 2010. Table 1.7-1 shows the survey schedule.

Table 1.7-1 Survey Schedule

Month 時期 / Items	February	March	April	May	June	July	August
Preparatory work in Japan		■	■				
Inception Report Explanation			▲				
Field Survey			■	■			
Interim Report Meeting			▲				
Report Preparation			■	■	■		
Submission of Draft Final Report				▲			
Seminar in Tokyo					▲		
Submission of Final Report							▲

1.8 Survey Method

1.8.1 Preparatory Work in Japan

(1) Examination and Analysis of the Existing Information

The existing information and projects are examined and analyzed as follows:

- Review and analyze the existing documents of the past studies
- Compile the past studies including those under implementation and their outcome
- Understand donors' activities such as WB and ADB
- Compile areas and sectors applicable of technologies and experiences of Japanese private sector

(2) Hearings from Japanese Private Firms and Associations

In order to collect information for applying Japanese technologies overseas, JST conducted hearings from the representative organizations by visiting or over the phone for the information and visits to Web sites of Japan Water Association and Federation of Japan Water Industries Inc. (see Chapter 2). JST received their policy and intensions on business in overseas, original technologies, requirements, pre-condition and risk.

(3) Selection of Preliminary Target Areas for Site Survey

Preliminary target areas were selected from several aspects such as advanced project experiences, traffic convenience, large population, developmental stage, locations of headquarters or branches of NGOs and so on based on the information available in Japan.

(4) Identification of Preliminary Project Plans

As a result of (1) and (2) above, preliminary project plans were identified.

1.8.2 Survey in Bangladesh

(1) Inception Report Explanation

JST introduced objectives and contents of this survey in the Inception meeting. Bangladeshi side presented their views to JST on the current status, issues, development needs and the prioritized area to be developed in Bangladesh.

(2) Verification of Development Needs

Plans and contents of the existing projects of bilateral and international assistance were verified through hearings from the donors and relevant organizations of Bangladesh. As a result of hearings, JST examined possibilities of collaboration between the Japanese assistance and those of the other donors.

(3) Review of the Past and On-going Water Supply Sector Cooperation by the Japanese Government and other donors

JST conducted hearings from the main responsible organizations on the past and on-going water supply sector cooperation by the Japanese government and other donors, and studied solution of the problems for future development in water supply sectors.

(4) Collection of Data and Documents on Natural Conditions, Hydrogeology and Water Resources in Bangladesh

The data and documents regarding the natural conditions, hydrogeology and water resources of both surface and underground were collected through the Bangladeshi Government, private organizations and web-sites. And the basic data to study on the development potential of surface water and groundwater (or otherwise, regulation of groundwater extraction) were collected.

(5) Collection of Data and Documents on Socio-economic Conditions in Bangladesh

The data and documents regarding the socio-economic condition in Bangladesh were collected through the Bangladeshi Government, international donors and NGOs. Meanwhile, statistics information was obtained through the Web site of statistics division of Bangladeshi Government (http://www.bbs.gov.bd/).

(6) Collection of Data and Documents on Water Supply Facilities and Water Use

The current situation and problems were appraised through the hearings from the Government Organizations related to the waters supply and sanitation (especially, LGD, DPHE, WASAs and local governments). The existing information obtained from documents was reviewed through hearings from the relevant organizations on water supply services, and through information on the rehabilitated water supply facilities. JST also focused on the specific information in particular areas or organizations which are not disclosed in the printed reports or documents.

(7) Review of Implementations and Plans of Bangladeshi Government and Identification of the Development Needs

Implementations and plans of both at national level and regional level related to water supply were obtained through the hearings from LGD and DPHE and through the review of the related reports. The national level development plan such as SDP contained only the conceptual development plan and not the detail plan. Therefore, JST conducted hearings from DPHE mainly on their development needs.

(8) Study on Investment Regulations and Restrictions in Bangladesh for Japanese Private Companies and NGOs

Japanese private firms and NGOs should run their business in compliance with the Bangladeshi laws and regulations related to water supply. Moreover, in order to enter into the Bangladeshi PPP[1] business market, they must have full knowledge of the regulations and restrictions regarding the investments such as foreign exchange, foreign investment promotion, tax incentives, company act, company establishment, and labor law; accordingly these kinds of investment circumstances were studied.

(9) Verification of the Necessity of Formulation of Master Plan and Regulatory Framework

Based on information obtained through the need assessment survey in Bangladesh, the necessity of formulation of Master Plan on water supply development and water resource development were verified.

(10) Review of Regulations related to Water Supply Sector

Laws, regulations and policy, which are important at national level for formulating the projects on water supply sector in Bangladesh, were reviewed.

(11) Review of Regulations related to Activities of Private Company and NGO

Law, regulation and policy on PPP were reviewed.

(12) Compiling Issues on Master Plan and Regulations, and Verification of Improvement

Through the surveys mentioned above, JST compiled issues on the master plan and regulations and verified the necessity to improve them.

(13) Validity Confirmation and Revision of Preliminary Project Plans

Based on the results of the site survey, the validity of preliminary project plans prepared beforehand was reviewed. Preliminary project plans with less needs and validities were declined and other necessary project plans were added. As a result, Prioritized Project Plans were formulated.

(14) Preparation of Draft Cooperation Scenario

JST prepared two Draft Cooperation Scenarios only for prioritized project plans with high possibility in realization.

(15) Interim Meeting

JST reported to JICA headquarters and JICA Bangladesh office about the contents of the site survey, issues in urban and rural areas, Project Plans and so on.

1.8.3 Analysis in Japan

(1) Seminar

After the survey in Bangladesh, a seminar was held for private companies and NGOs in Japan. This seminar mainly aimed to present Draft Final Report and to collect views on the presented topics from invited organizations/persons. The main comments from the attendants are as follows:

- It is necessary to prepare Master Plan in order to promote PPP projects.
- Some rivers are insufficient for water source although the Government of Bangladesh sets an intention of water source conversion from groundwater to surface water.
- Evaluation of existing water works facility is important before the commencement of PPP

[1] PPP definition in this Survey is referred from the one of SDP in Bangladesh. The core role of the public partner is to basic safeguard water rights for all. And the core role of the private partners is to improve the allocate efficiency and demand responsiveness of water supply and sanitation (WSS) service delivery. PPP framework can be expanded in 2 ways; (a) from primarily the letting of contracts to deliver service in the form of service & management, lease & BOOT, concession, (b) by just private providers including NGOs and CBOs, landlords and households.

projects.

- It would be better that private company implement PPP Projects in the areas, which have existing water works facility.
- Component technologies in Japan are advanced although O&M technologies in Western countries are developed more than that in Japan.
- ODA support is necessary for Japanese private companies to start business in overseas.
- PPP project in low income countries is difficult, however, it is not so difficult in middle income countries.
- It is necessary to examine how to apply O&M technologies of municipalities in Japan.

(2) Examination of Draft Cooperation Scenarios

JST examined and revised the Draft Cooperation Scenarios for prioritized project plans by reflecting results of the seminar. Draft cooperation scenarios are composed of Purpose, Background, Advantage of Japanese technology, Draft cooperation scenario, Suggested components and issues for implementation.

(3) Development of Draft TOR

Draft TORs of prioritized project plans were developed with environmental and social considerations.

1.9 Flowchart of Project Formulation

Figure 1.9-1 shows the flow of project formulation in this Survey:

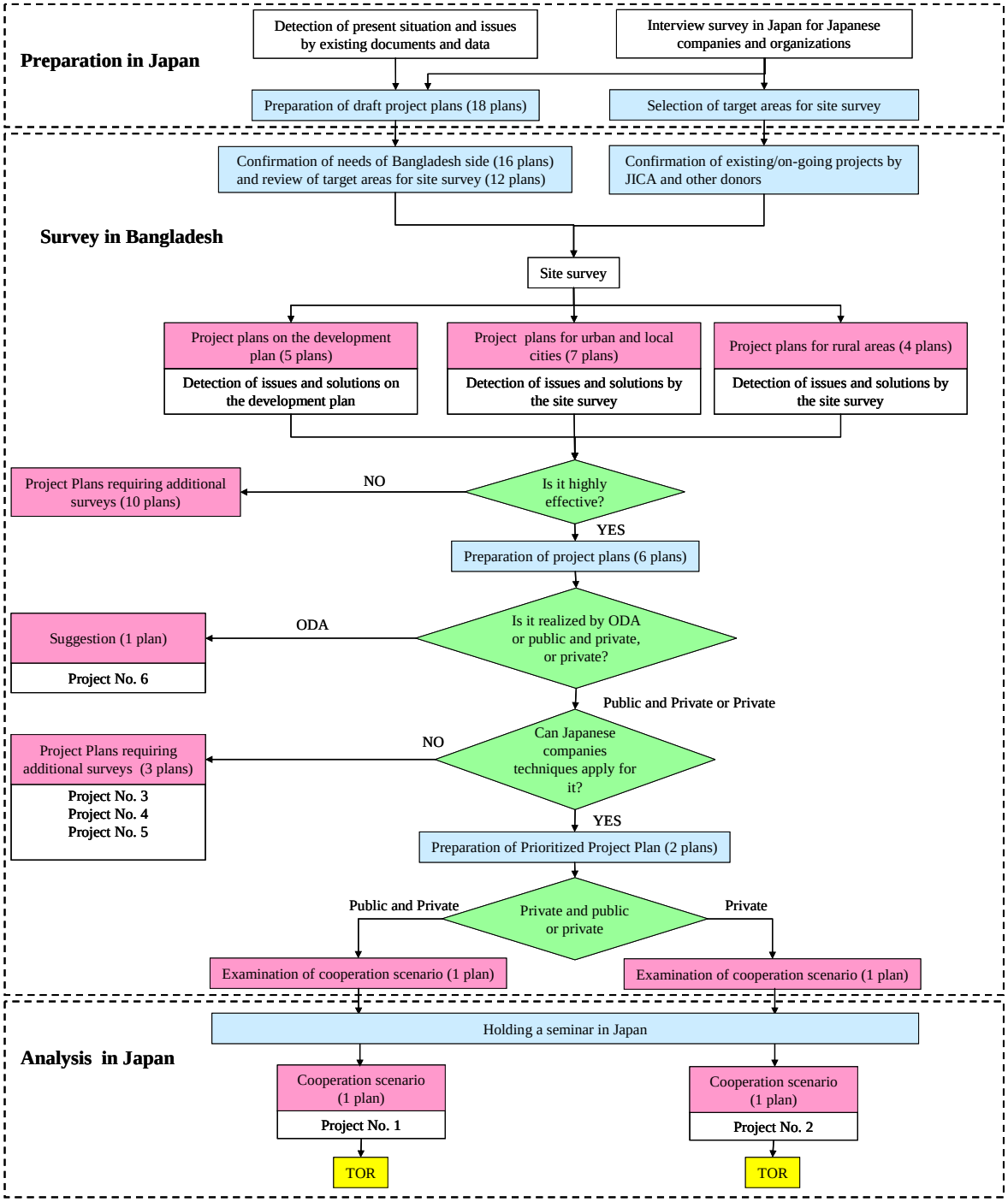


Figure 1.9-1 Flowchart of Project Formulation

CHAPTER 2 INITIAL STUDY FOR PRELIMINARY PROJECT PLANS

2.1 Summarization of Present Situation and Issues in Existing Documents and Data (Confirmation of Goals and Policy of Bangladesh)

Issues of water supply services in Bangladesh is described in "Sector Development Program (SDP) (Water and Sanitation Sector), (LGD, 2005)", which has 5 categories; 1) Improvement of piped water supply coverage, 2) Improvement of financing, 3) Revision of regulation and organization, 4) Capacity building and 5) Promotion of public involvement. Main point of each category is as follows (Note: Regulations and policy are shown in Table 3.3-1):

1) Improvement of water supply coverage

The coverage ratio in National Water Master Plan (NWMP) is 90% in urban areas and 40% in rural areas by 2015 based on Millennium Development Goals (MDGs). However, these target values are neither mentioned in other national plans nor shared among related agencies. Especially the target value for rural areas is not practical because the actual coverage ratio in rural areas is approximately 1%.

2) Improvement of financing

Beneficiary-payment principle for O&M is emphasized in order to rebuild water supply service. Additionally, beneficiary is expected to share a part of the initial cost for construction of a small water service facility.

3) Revision of regulation and organization

A huge cost is required to construct and to renew facilities for sustainable water supply service. Various actions are necessary, such as cost reduction, efficient use of resources and assets, appropriate balance of revenue and expenditure, deregulation and so on.

4) Capacity building

It is planned to share responsibility among all stakeholders, such as the Central Government, private sector, NGO and users. Especially SDP emphasizes capacity building of local governments.

5) Promotion of public involvement

Public involvement is indispensable through the whole process (from the planning stage to the O & M stage) for effective water use and appropriate service provision. It is also important to raise public awareness on water conservation in urban areas, and on environmental sanitation in rural areas.

2.2 Hearings from Companies and Organizations in Japan

2.2.1 Selection of Japanese Companies and Organizations

JST collected information regarding possibilities of entry of Japanese companies into the water business market in Bangladesh, technical capabilities, field of entry, and benefits for the companies in Japan and Bangladesh. Criteria of the selection of the companies for hearings and methods of access to information are as follows:

1) Organizations or private companies that have already implemented overseas business development

2) Organizations or private companies that have local branches, such as affiliated companies in overseas

3) Willing Organizations or private companies towards overseas business

The participating organizations or private companies in the "Bangladesh water situation study meeting" and the participating organizations or private companies in the "Team Water Japan"

4) The organizations or private companies that have special technologies although overseas operations are not yet implemented

5) The organizations or private companies that are carrying out business shown below;

(1) Manufacturer of equipment

(2) Engineering, Procurement and Construction (EPC) of water supply facility

(3) O&M activity business of water supply facility

(4) Supporting activity for management of water supply business

- The organization of water supply work : 2
- Plant engineering companies : 5
- Manufacturers of materials : 4
- O&M Companies : 2
- NGO : 2
- Trading company : 1
- Consultant : 1
- Total 17

2.2.2 Methodology of Access to Information

Methodologies of access to information from the organizations and private companies in Japan as a result of the above exercise are shown as follows:

1) Hearing on present situation about overseas business by Japanese private companies

2) Hearing on overseas business policy for the current and the future

3) Hearing on corporate profile and business contents

4) Access to information regarding above 2) and 3) from web site

The points of concern at the time of access to information are as follows:

1) In "Team water Japan", several companies are working on various proposed subjects by subcommittee activity. The information regarding overseas business development, PPP, and new technology are gathered by the "Team water Japan", therefore survey by hearings from the organizations or private companies should be conducted comprehensively, not only including the overseas development but also cooperation between the companies, etc.

2) Survey is conducted not only about new technological products but also low technological products.

3) Survey is conducted regarding equipment and facility.

4) NGOs is undertaking the big role in the water supply business in rural areas of Bangladesh. Survey is conducted on NGOs in Japan regarding current situation and activity situation in Bangladesh. Opinions and recommendations for the draft version of project plan list shall be collected from NGOs in Japan.

5) Survey by hearings is conducted on the companies that have already conducted BOP business in Bangladesh regarding difficulties in their activities in rural areas, points of concern for their activity, health situation and consciousness for the water supply facility of the people in Bangladesh.

2.2.3 Collection of Information

The following information is the compiled results of hearing from Japanese private companies on current situation of overseas business and general opinions of business in developing countries:

1) Recently, membrane water treatment system is adopted and utilized in water supply facilities in Japan. Business development in overseas markets regarding delivery of membrane material itself is much; however business development in the overseas markets regarding business in water treatment plant engineering is still weak because of the delay of entry in the market.

2) Field operation test is often carried out to determine the design criteria of the facility. If the field operation test is not carried out, then under the condition of lack of water quality data in the overseas project, risk will be high.

3) Price competitiveness in the overseas markets for the Japanese water supply-related companies is not so strong currently. This is due to heavy price cultures of the Japanese company as Japanese customers have high quality and high performance products requirements and the cost of Japanese labors is expensive.

4) There are unavoidable risks in the process of business development overseas such as foreign exchange risks and country risks, etc. Analysis for measures against risk reduction and risk aversion are major issues for the business development overseas.

5) Sales of the coagulant by the Japanese private company for water purification are developing in Bangladesh. This business has been conducted based on the detail field survey about sale basis, characteristics of the customers, set of selling price, target selling area, etc. This business can be regarded as BOP business, if it is seen from viewpoint of the sales method which utilized the low income sales Women. This business utilizes not only the Japanese companies but also local Japanese trading company and local private company. And Japanese company staffs visit the Bangladesh and adjust the business development periodically. The difficulties in the business development are fault to the sale by the difference in the religion of people and keeping of the materials for filtration of water against theft.

6) It is appropriate that facility and/or equipment in developing countries are of break-proof design, easy to operate and maintain, and easy to be applied local produced spare parts, rather than the complicated high-quality facility/equipment. Therefore, it could be necessary to arrange specification of facility/equipment to match such local needs.

7) One of the major point for which Japan companies contribute in the improvement of water supply business in the developing countries is the capacity development field. Knowledge and skills required for water supply works operation are various such as financial management, organizational operation, technical knowledge about planning, design, construction and O&M activities of the facility. The capacity development about these knowledge and skills should be conducted in collaborations with public sectors and private sectors.

8) Entry of Japanese company itself in the developing countries such as Bangladesh is not realistics as business chance. So it is one of the practical chances that entry will be realized as a trigger for the discovery of business opportunity through the activity of Corporate Social Responsibility (CSR). For this activity, ODA project and/or collaboration activity with water authorities in local government is needed.

9) Compared with other developing countries, water supply situation of Bangladesh is said to be very bad. It is important that private companies improve the bad situations of water supply in Bangladesh through their company's CSR activity.

10) Issues of membrane water treatment system are high cost and complicated O&M activities such as periodical cleaning of membrane by chemical solution and periodical replacing of membrane, etc. These issues may be solved by applying BOT or BOO outsourcing business operation.

11) Reuse system of treated sewage is adopted in the Middle East countries in recent years. It is necessary to consider not only natural water sources, but also various sources, such as reuse system.

Results of hearings are summarized in Table 2.2-1 and details regarding "The usable technology in water supply field in Bangladesh" are mentioned in Clause 2.2.4.

Table 2.2-1 List of Hearing Results in Japan

Japanese company	Activity field in water supply business	Business experiences in overseas countries	Business experiences in Bangladesh	The usable technology in water supply field in Bangladesh	Overseas local branches
The organization of water supply work A	Water works administration and research on development about water supply technology, holding of international conferences	All areas of development countries Acceptance of training operation	—	Development of organization of water works authorities Operation and management of above organizations	Non
The organization of water supply work B	Technical support for water supply and sewerage	Support for development of overseas activities	—	Non	Non
Plant engineering Company A	Plant engineering of water treatment Membrane plant engineering (design/procurement/construction/O&M)	Treated water treatment technology Desalination plant engineering Water supply and sewerage plant engineering	Extension of Chandigarh water treatment plant (design/ manufacturing /supervising)	Construction of natural energy system Desalination plant Technology combined natural energy and Desalination facility	Asia: Singapore. Vietnam India, etc. Middle east: Dubai, etc.
Plant engineering Company B	Plant engineering of water treatment Membrane plant engineering (design/procurement/construction/O&M)	Treated water treatment technology Desalination plant engineering Water supply and sewerage plant engineering	Water treatment plan for fertilizer factory (design/ manufacturing /supervising)	Treated water treatment plant by MBR system Desalination plant	Saudi Arabia Asia: China Middle east: Saudi Arabia, etc.
Plant engineering Company C	Power supply plant O&M activity for water supply facility Water rate collection service	Power supply and power generating plant	Non	Membrane water treatment plant Management of water supply works including water rate collection service System formulation of natural energy applying system	Non
Plant engineering Company D	Desalination equipment (design/procurement/delivery)	Desalination equipment in Maldives and Tuval etc.	Non	Reverse Osmosis (RO) membrane water treatment plant	Non
Plant engineering Company E	Membrane water treatment plant (design/procurement/construction/O&M)	Non Ongoing project in Vietnam regarding membrane water treatment plant by MF	Non	Ceramic membrane water treatment plant	Non

Japanese company	Activity field in water supply business	Business experiences in overseas countries	Business experiences in Bangladesh	The usable technology in water supply field in Bangladesh	Overseas local branches
Manufacturer of materials A	Intake facility for ground water Water intake screen Iron & manganese removal treatment plant (design/procurement/delivery/construction)	Experience of groundwater intake screen	Non	Iron removal treatment plant without chemicals	Non
Manufacturer of materials B	Filter media, Sand cleaning equipment, filtering equipment, drain system (design/procurement/delivery/construction)	Filer media for rapid sand filter and iron & manganese removal	Filer media for iron & manganese removal	Filtration system with a device of specialized technology for filter sand cleaning	Non
Manufacturer of materials C	Compact mobile water treatment equipment (design/procurement/delivery)	Experiences of overseas delivery the products in Myanmar	Mobile RO equipment	Mobile filtration equipment with supplying power by bicycle	Local business agent in Bangladesh PQC Ltd.
Manufacturer of materials D	Sales of coagulants (Production/delivery/sales)	Experiences of delivery the products to Thailand and Mexico Ongoing business as local cooperation in Mexico and Korea	Ongoing business about sales of coagulants in Bangladesh	Easy handling coagulants	Local business agent in Bangladesh Water Tech Ltd.
Manufacturer of materials E	Ferrous materials for removal of arsenic in water (development/production/sales)	Non Ongoing research to practical application	Non	Ferrous powder for removal of arsenic in water	A lot of local offices in the world
O&M company A	Assistance of water works management O&M management of water supply facility Assistance of capacity development for water works management (Business operation management and O&M management)	Kick-off the activity from 2010 for overseas business	Non	Management of water supply works including water rate collection service	Non
O&M company B	Assistance of water works management O&M management of water supply facility Assistance of capacity development for water works management (Business operation management and O&M management)	Participation in the project in Vietnam regarding assistance for O&M capacity development of sewerage and drainage facility	Non	Management of water supply works including water rate collection service	Non
NGO A	Countermeasures for mitigation of arsenic contamination in potable water	Operations in Bangladesh and India	Technical assistance project for Mitigation of Arsenic Contamination in Rural Areas of Bangladesh	Technology transfer and awareness campaign	Local office in Bangladesh

Japanese company	Activity field in water supply business	Business experiences in overseas countries	Business experiences in Bangladesh	The usable technology in water supply field in Bangladesh	Overseas local branches
NGO B	Rural development (wells, etc.)	Constructions of wells in rural areas in Bangladesh	Constructions of wells in rural area in Bangladesh	Technology transfer and awareness campaign	Local office in Bangladesh
Trading company A	Management of water supply works and sewerage through joint venture operations	A lot of experiences	Non	—	A lot of local offices in the world
Consultant A	Consulting services for water supply facility	A lot of experiences	Delivery of equipment for water quality analysis Training for O&M activity of equipment for water quality analysis	Urban development, technology transfer	Non

2.2.4 Japan's Technologies in Water Works System

(1) River water purification

There are two technologies for river water purification; Purification agent and Purification block. Table 2.2-2 shows the comparison of these two technologies. According to this table, purification block is suitable to apply in Bangladesh because it does not require maintenance.

Table 2.2-2 Comparison of River Water Purification Technology

	Purification agent	Purification block
Use	・ To purify pond, channel, etc. ・ To improve treatment water in aeration tank and to eliminate odor of it	・ To purify pond, channel, etc. ・ To decompose ammoniated odor and to remove Escherichia coli bacteria
Mechanism	After the input of purification agent, Protozoa, such as Volticella, and Metazoa are generated, and they decompose and intake organic materials. And they become one of the elements of food-chain system in the river.	Bacillus subtilis var. natto in blocks increase by the reaction with water, and intake the contaminants. This is one of the biological purification for organic materials decomposition and odor elimination (ammonolysis).
Environment Condition	・ Purification range is up to 2km	・ Water temperature: 10°C to 65°C (optimum: 25°C to 60°C) ・ pH: 3 to 11 ・ Oxygen in water is necessary.
Overseas achievement	China, South Korea and Thailand	Malaysia and India
Maintenance and frequency	It is necessary to sprinkle once a year for 2 to 3 years. After that, sprinkling is once per 3 to 10 years.	Maintenance and periodical works are unnecessary.
Install condition	30ppm of the agent for continuous water volume	3 to 5 blocks per 1 ton of static water
Performance stating time	After 1 month	After 2 weeks
Cost estimation	(for 30m width, 2m depth and 2km length) 1) Continuous water volume : 30m x 2m x 2km = 120,000 ton 2) Input: 1) x 30/100 million = 9,000kg 3) Estimation cost: 2) x 5,000 yen = 45 million yen	(for 30m width, 2m depth and 1km length) 1) Continuous water volume : 30m x 2m x 1km = 60,000 m^3 2) Input: 1) x 5ton/block = 12,000 blocks 3) Estimation cost: 2) x 3,600 yen = 43.2 million yen
Evaluation	Initial cost is relatively cheap, but periodical sprinkling is necessary.	Initial cost is relatively expensive, but it is semi-permanent and maintenance-free. It is suitable for developing country.

(2) RO filter treatment system

There are mainly three desalination methodologies; Evaporation, Electro Dialysis and RO filter. RO filter treatment is a safe and reliable system and enables direct desalination. Japanese private companies have an advantage of this RO filter treatment system. And the demand of this system can be high in the coastal areas of Bangladesh.

However, it is far more costly compared to former rapid sand filtration system, therefore, reduction of the initial and O&M costs are very important. To cope with these issues, establishment of a production system in Bangladesh would be the most effective way.

(3) Rapid sand filtration system for surface water sources

Coagulation and rapid sedimentation is the most common method for purification of surface water source, such as rivers and ponds, if the water does not contain heavy metals. If the turbidity of the water source is low through the year, slow sand filtration system is also applicable. However, it is rare in Japan because the

system and the facility require large space.

The coagulation and rapid sedimentation filter system is a method for water purification. Putting the flocculation agent in the water source and form the flocks, and sediment the flocks in the sedimentation basin (coagulation and sedimentation process, and then, remove the sediment flocks from the filter basin. Proper knowledge and experiences on water processing is required to manage this process appropriately. Typical example is that the operators need to adjust the amount of the flocculation agent according to the results of water analysis. In the developing countries, many water purification plants are operated improperly because of immature operation: Load to the sedimentation pond is high because of high density of the flocks. As a result, the flocks which should be removed by periodical cleaning would remain in the pond and spoil the function of the system, and affect the quality of water. The filter materials also need to be replaced because of blockade.

Though some operators try to recover the function of the filter system by repeated filter cleaning processes, once the filter material is blocked, the filter cleaning process would not function properly because rinse water cannot reach to the filter system properly, and this attempt causes increase of wasted water.

In the developing countries, it is assumed that managing the coagulation and rapid sedimentation system appropriately and maintaining good quality of water are difficult. It is important to manage the process and the function of the system, filtering and cleaning, even if the turbidity of the water increases.

The issues about the O&M of the coagulation and rapid sedimentation facility are described below.

- Keeping the condition of the filter material, filter pond, stable and reliable water quality
- Maintaining the filter material reducing the loads, and saving the consumption of the filter materials
- Saving the consumption of the water for cleaning the filter

Items below is required to overcome the above issues

- Easy operation and cleaning of the facility
- Effective, efficient, and reliable cleaning process for the filter material
- Minimizing the consumption of the fitter material, and frequency of the replacement

To cope with these issues, there is a special cleaning filter system which is developed by a Japanese manufacturer.

(4) Mobile Water treatment facility combining flocculation agent for simple treatment

Not many Japanese technologies are applicable for Bangladesh because the situations of waterworks in Bangladesh explained above are very different from that of Japan. However, the situations of the agricultural villages in Bangladesh are similar to the situation under disaster in Japan, and Japanese water supply system for disaster relief is applicable for the villages in Bangladesh. Water purifying system with resinous filter and bicycle system, and flocculation agent made from polyglutamine acid are the examples.

Water purifying system with resinous filter and bicycle system does not require electricity because it uses manpower for all process and can purify the water in the swimming pool to drinking water.

Specification of the system is shown in Table 2.2-3.

Table 2.2-3 Specification of Mobile Water Purifying System

Items	Specifications
Level of separation	Clarification・sterilizing
Filter	Micro filtration（MF）
Applicable source	Surface water(river, ponds, well, pool, water reservoir for extinguishing fires
Capacity	5 L／minute
Size	Length：1,780mm　Width：620mm　Height：1,100mm
Weight	54 kg

(5) Chemical-free iron removal system

One of the chemical-free iron removal systems is the oxidation treatment, which is to blow tiny air bubbles into the water. In Bangladesh, water source conversion is promoted to be shifted from underground water to surface water gradually, however, the current high groundwater dependency will continue because of the insufficient investment to water supply facility. At present, the underground water contains excessive iron content, so installation of the chemical-free iron removal system is necessary to supply safe water. And JST confirmed that the oxidation treatment device for iron removal was available and utilized in Bangladesh. This device is cheaper than the one made in Japan and the quality is mostly the same. Therefore JST concluded that application of Japanese technology is not necessarily competitive in Bangladeshi market.

(6) MBR and MF filter

Membrane Bio-Reactor (MBR) is a technology to utilize treated sewage water, and it is not applicable for Bangladesh at this stage because sewage Micro Filtration (MF) system in Bangladesh is not developed well yet.

MF is costly and not applicable for waterworks in Bangladesh because it use underground water source. This technology is applicable after completion of conversion of water source from underground water to surface water.

2.3 Preparation of Preliminary Project Plans

In order to promote efficient utilization of vitality of private sector and to develop regional ODA projects, preliminary project plans were identified based on the existing data and hearing results in the following order:

1) Summarization of present situation and problems (See Section 2.1)
2) Identification of issues based on 1)
3) Summary of hearings (See Section 2.2)
4) Primary identification of preliminary project plans according to 2) and 3)

Considering these issues, preliminary project plans were elaborated as shown in Table 2.3-1:

Table 2.3-1 List of Preliminary Project Plans

NO.	Item	Preliminary Project Plans	Project Outline
1-1	Capacity development on water works at country and district levels	Policy advisory service on organization and operation of water works	• Advice and guide on policy related to operation and organization
1-2		Support for establishment of water works association	• Establish an association to hold annual meeting, to exchange technique/information, to give training, to present a petition, etc. (refer to Japan Water Works Association)
1-3		Suuport for establishment of regional union of water works	• Establish cooperation system for efficient works in several local cities
1-4		Operation and management of water works	• Review and improve cooperation of related organizations • Make a plan to utilize private sector
2	Cacity development on water supply facility planning and design (urban cities)	Capacity development of water supply facility planning and design	• Guide for investigation and rehabilitation of existing facilities • Technically support for surface water development • Support for capacity development of water supply facility planning and design
3-1	Capacity development on improvement of O & M of water supply facility (local cities)	Plan of water supply facility improvement	• Make a database of existing facilities • Prepare expansion and improvement plan for water works • Select projects with high priority • Prepare O & M plan • Implement activity for pubic awareness and

NO.	Item	Preliminary Project Plans	Project Outline
			community education
3-2		Support of improvement of O & M for water works	• Search causes of non revenue water • Revise water tariff collection system • Make a database of customers • Establish O & M system
3-3		Support for strengthening O&M of water works by utilizing private sector	• Construct and/or rehabilitate water works facility • Establish a system of O & M by private sector • Transfer techniques by private sector • Utilize regional unions • Estabilsh a human resource development center
3-4		Construction and technical support for water supply facility with solor power generation	• Utilize reservoirs and operate by soler power • Utilize experimental studies
3-5		Construction and technical support for community-based water supply facility	• Develop unit type treatment system • Supply with public water faucet • Utilize iron and manganese removal device without chemicals • Desalination brine water • Apply new techniques developed by arsenic pollution prevention program • Apply other new techniques • Utilize experimental studies • Implement activity for pubic awareness
3-6	Capacity development on improvement of O & M of water supply facility (rural areas)	Construction and technical support for community-based water treatment facility	• Apply new techniques developed by arsenic pollution prevention program • Develop and expand simple field kit for water quality analysis • Impkenet experimental studies for treatment system with arsenic removal techniques • Implement activity for pubic awareness
3-7		Construction and technical support for water treatment facility in schools and hospitals	• Develop unit type treatment system (film) • Utilize experimental studies
3-8		Construction and technical support for mobile water treatment facility	• Utilize natual gas vehicles • Utilize experimental studies • Implement activity for pubic awareness
3-9			• Utilize mobile water purification device (bycicle type) • Utilize experimental studies • Implement activity for pubic awareness
4-1	Water source development for network piping	Master plan for water works development	• Investigate water source and water quality all over the country • Prepare a harzard map • Prepare master plan of water works (utilization of existing data, demand estimation, natural condition survey, water quality and quantity evaluation, development plan)
4-2		Deep groundwater development	• Determine target areas for development • Construct wells, water intake and network piping facilities
4-3		Surface water development	• Determine target areas for development • Construct water intake and network piping facilities
5	Sustainable water source development	Examination of reuse of treatment sewage and rainwater	• Investigate present situation and needs • Implement pilot projects
6	Conservation and management of water source	Water quality monitoring all over the country	• Identify arsenic affected and seawater intrusion areas • Make a database of water quality • Develp hhuman resource for monitoring

2.4 Selection of Preliminary Target Areas for Site Survey

JST set the following criteria to select preliminary target areas because both urban and rural areas in Bangladesh could be target areas in this Survey:

- The area where the reference projects by WB and ADB or other donors are proceeding or have been proceeded (Chittagong)
- The area near from trunk roads from viewpoints of logitics and access
- The area where economic effects based on population growth will be large
- The area where is behind in implementation of development activity located eastern part of Bangladesh
- The area with many local offices of government organization or headquater offices of NGO

In consideration of Survey results in Sections 2.1 and 2.2, preliminary target areas were determined as Comilla, Chandpur, Brahmanbaria, Dhaka, Gazipur, Shariatpur, Chittagong and Narayanganji as shown in Figure 2.4-1.

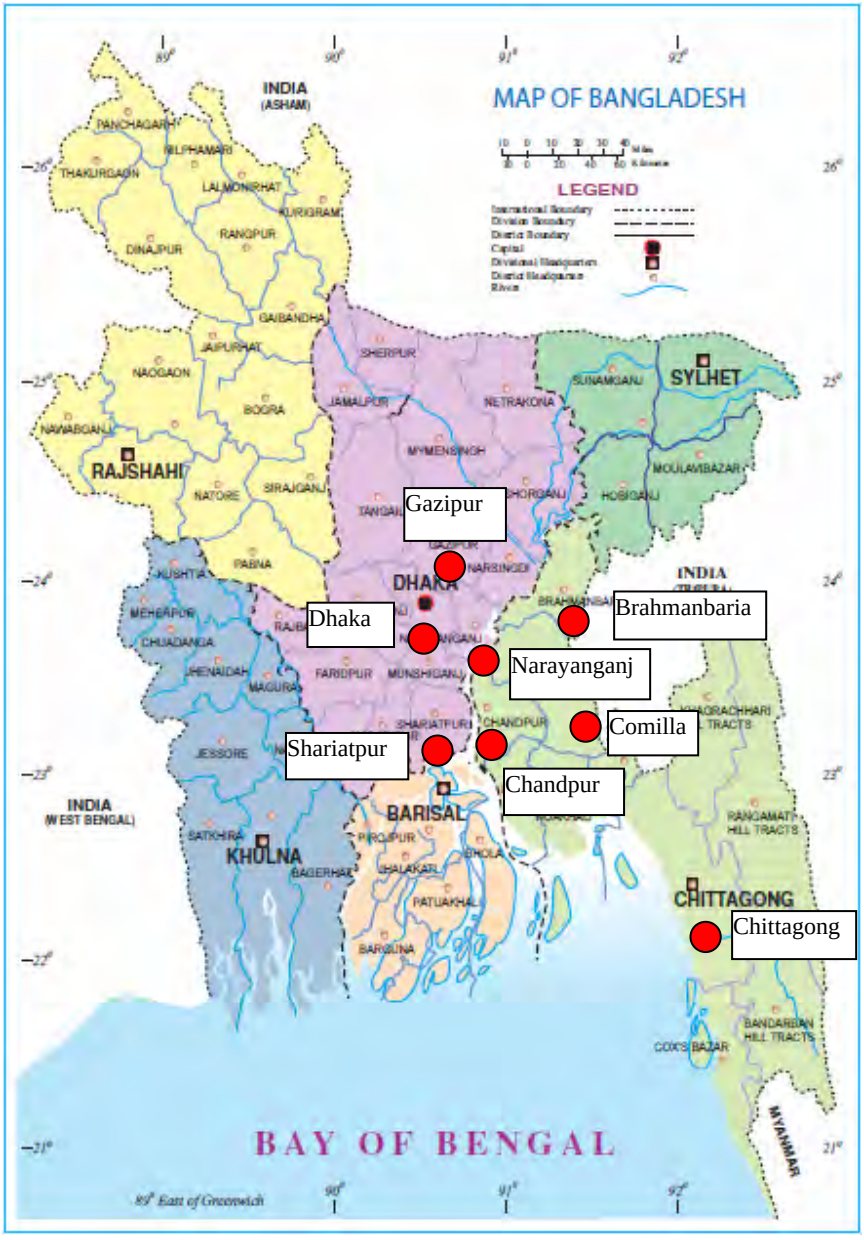
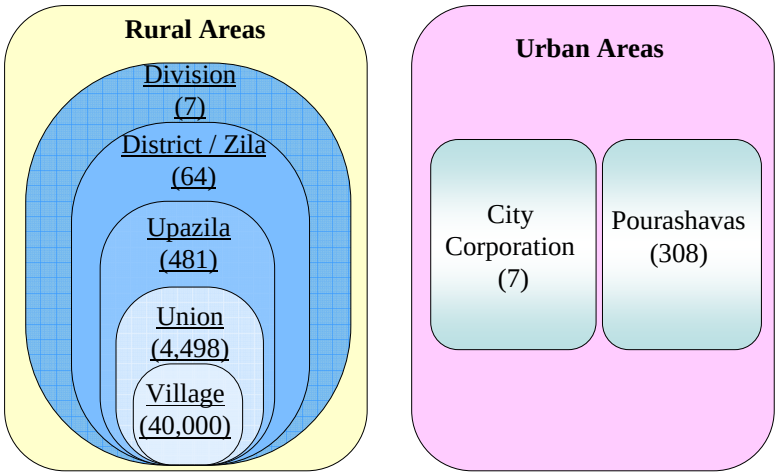


Figure 2.4-1 Preliminary Target Areas of Site Survey

CHAPTER 3 CURRENT STATUS OF WATER SUPPLY SECTOR

3.1 Administration in Bangladesh

Administration of Bangladesh is categorized as shown in Figure 3.1-1. There are 7 Divisions, 64 Districts/Zila, 481 Upazila, 4,498 Unions and 40,000 villages. Seven (7) Divisions are composed of Dhaka, Chittagong, Syilhet, Rajshahi, Khulna, Barisa and Rangpur that were separated from Rajshhi in 2010. In urban areas there are 7 City Corporations and 308 local cities called as "Pourashavas".



Source: Statistical Pocket Book Bangladesh 2007, Bangladesh Bureau of Statistics (BSS)
Note: ( ) shows numbers of administration.

Figure 3.1-1 Administration of Bangladesh

3.2 Water Resource Development Plan and Water Supply & Sanitation Development Plan at National and Local Levels

Water supply development is implemented by WASAs, PWSS and water supply service bureau to establish the policy for developing water resources, purification plants, storage tanks, rising and distribution mains and O&M system. The policy also contain budget allocation and development of information management system.

For water supply development, elements, such as construction contents, coverage areas, methods and sizes, are planned according to the present situation on the basis of the urgency, importance and cost of the development. If these plans are prepared by each PWSS or WASA, comprehensive development is expected because the developments are parallel to the plans, and plans can be revised according to the situation.

Water Resource Development Plan was formulated in 2004 focusing on effective use of water resources and their rationalized management, improvement of livelihood due to water access, clean water provision and conservation of ecosystem. Investment cost of the overall plan was estimated to be 1.2billion taka (USD18million) from the year of 2004 for 25 years.

Meanwhile, there is no Master Plan for water supply and sanitation except for particular areas and services of WASAs. Therefore, stopgap and un-planned development have been carried out without development guidelines, which resulted in inefficient development and wastage of the investment.

Currently, formulation of Master Plans is under preparation in three (3) WASAs and 148 Pourashavas as shown in Table 3.2-1.

Table 3.2-1 Status of Master Plan Formulation

Target Areas	Assistance	Period	Target Year	**Circumstances**
DWASA	ADB	2010-2012	2060	TOR will be completed for tender soon.
CWASA	KOICA	2007-2010	2025	Master Plan is under preparation.
KWASA	JICA	2008-2010	2030	Feasibility study is on-going.
148 Pourashavas	JDCF	2009-2013	-	Out of 4 phases, Phase I is on-going.

3.3 Policy, Goal and Laws related to Water and Sanitation Sector

It is said that there are 41 policy and laws related to water resources development and management[2]. Table 3.3-1 presents the policy and laws that regulate water and sanitation sector. The Water Act is currently under preparation, and expected to be enacted urgently because it is the essential law to implement the National Water Policy.

Table 3.3-1 Policy and Laws related to Water and Sanitation Sector

Policy and Law		Enacted Year	Responsible	Summary
Policy and Goal	National Policy for Safe Water Supply and Sanitation	1998	LGD	The policy aiming to accomplish the national goal "to ensure all citizens to access safe water and sanitation services with rational cost".
	National Water Policy (NWP)	1999	MoWR	The policy aiming to provide all related organizations with the direction to achieve the specified objectives.
	National Policy for Arsenic Mitigation	2004	LGD	The policy aiming to provide the nation-wide measures for arsenic mitigation.
	National Water Management Plan (NWMP)	2004	WARPO	The plan aiming for the rational management and wise use of the national water resources.
	Pro-Poor Strategy for Water and Sanitation Sector	2005	LGD	To support the poor nation-widely, the strategy established measures such as the definition of the poor and the minimum water supply, the selection of the poor family and necessary support.
	Sector Development Program (Water and Sanitation Sector)	2005	LGD	The program formulated the comprehensive and sustainable programs for water and sanitation sector for 10 Years.
	Moving Ahead National Strategy for Accelerated Poverty Reduction (NSAPR) II (PRSP II)	2005	General Economics Division	NSAPR revised the PRSP I targeting for year 2009 − 2011.
Law	Groundwater Management Ordinance	1985		The ordinance provides for management of the groundwater for irrigation.
	Water Resources Planning Act	1992		For the development and wise use of water resources, the act enacts the establishment of WARPO and its authority and role.
	WASA Act	1996		The act provides for the establishment of authority to provide water and sewerage services, and its management.
	Bangladesh Water Development Board (BWDB) Act	2000		The act provides for the establishment of the Board and its management.
	Bangladesh Water Act	2010 (expected)		The act aims to consolidate and supplement the existing laws to regulate the water resources of the country.

3.4 Issues on High Level Plan and Regulatory Framework

3.4.1 Water Supply Master Plan

As high level plans, the Government of Bangladesh has SDP and NWMP, however, these plans just mention the future policies without any practical project implementation plans. In May, 2010, SDP was being reviewed including investment plans and its entire contents were not opened.

On the other hand, some of WASAs and Pourashavas have just started to prepare each Master Plan for water supply as shown in Table 3.2-1. The contents of each Master Plan were not opened, so JST could not confirm them. In other areas, there are no Master Plans. Therefore, future plans for developing the

[2] Source: Process Development for Preparing and Implementing Integrated Water Resources Management Plans, July 2009, ADB

water supply services such as for water resource, management, implementation, investment, etc. is not clear, which may result in un-planned and ineffective development, and the wastage of the investment. And it is possible to prepare short, middle and long term roadmaps for each stage of water supply improvement.

However, the budget is not prepared by each district in Bangladesh. And NGOs involve greatly in local areas, especially in rural areas and their activities are not parallel to the development plan of the Government. Therefore, it is possible that Master Plan of each district is not effective so much.

DPHE was about to commence facility development in 148 Pourashavas applying Japan Debt Cancellation Fund (JDCF). However, basic information such as water use, population growth, etc. required for developing the water supply facilities is insufficient. Therefore, DPHE changed implementation policy and commenced the formulation of Master Plan prior to facility development.

3.4.2 Groundwater Management

At present, DPHE implements most of deep well drilling for network pipings under the plan of the Government, and has a standard to select drilling contractors. It can be said that the present groundwater development is under the control of DPHE. However, the management system for groundwater development has some points to be improved.

Approval framework for developing the groundwater and deep well registration system has not been established in most of the areas except Dhaka WASA water supply service area. Consequently, deep wells have not been developed deliberately, which results in excessive dewartering and mutual interference among wells. These activities cause drawdown of groundwater in wide areas. However, there is no action for mitigating drawdown of groundwater. The management of deep well database is not sustaining because there is no registration system for new wells.

In case of the arsenic affected water in shallow aquifer, it is possible that the deep well drilling causes the secondary pollution by the lack of contractors' skills and so on. The arsenic pollution is likely to expand by the progress of uncontrolled development.

For establishment of approval framework for developing groundwater, lateral scheme is required so that groundwater development can be controlled by various sectors such as domestic and agricultural use. In order to secure the qualified drilling skill, framework for giving license to the drilling companies should be established so that groundwater is developed intentionally.

3.4.3 Regulation for Effluent to Public Water Body

Based on Environment Conservation Act, Environment Conservation Rule and Environment Law, air, noise and water quality are regulated in Bangladesh. Regarding water quality, effluent standard and penalty are also regulated. However, deterioration of water quality in neighboring public water body of Dhaka city is remarkable as shown in Table 3.4-1. Water quality in public water body of large urban area has remarkably been deteriorated. Therefore, raw water cannot be treated by only conventional rapid sand filtration system. Even if effluent standard and penalty regulation were enforced, the regulation has not been respected by residents and Environment Law has not severely been enforced by the government. Consequently, deterioration of water quality in public water body such as river has been accelerated.

In order to secure good water quality of public water body, governmental organization regarding effluent regulation should be improved, and establishment of water quality monitoring system, patrol and direction to residents that discharge waste water, enhancement of penalty on effluent regulation may be effective way.

Table 3.4-1 Water Quality Deterioration of River in Dhaka

Items	pH	Turbidity NTU	Color PTU	Ammonium Nitrogen mg/l
WHO Guideline	6.5-8.5	5	15	1.5
Buriganga River	8.2	32.5	90	25
Shitalakhyer River	8.2	16.2	70	9.11

Source: DPHE, Data in March 2010

3.5 Government Administration

(1) Administrative Organogram related to Water and Sanitation Sector

Figure 3.5-1 represents the administrative organogram of the government of Bangladesh working for water and sanitation sector.

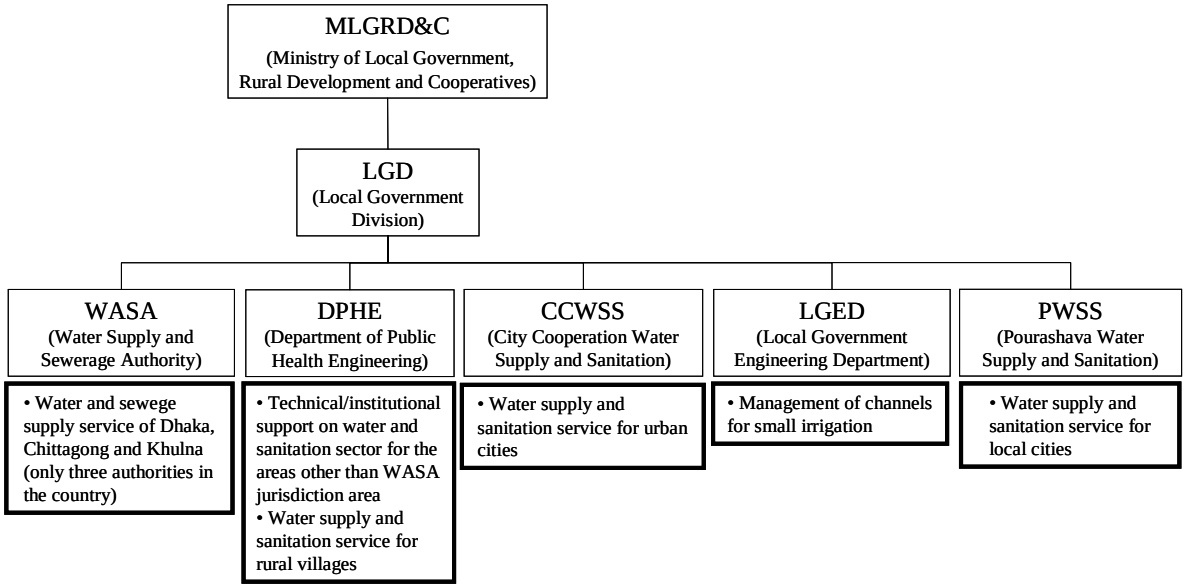


Figure3.5-1 Administrative Organization related to Water and Sanitation Sector

1) LGD

Local Government Division (LGD) is a division of Ministry of Local Government, Rural Development and Cooperatives (MLHRD&C) and composed of 3 wings such as administration wing, water wing and development wing. The water wing consists of 3 departments such as WASA, DPHE and LGED.

2) WASA

WASA is an authority which was established in line with the WASA Act to provide water and sewerage services in the 3 city corporations of Dhaka, Chittagong and Khulna. The responsibilities of WASA are: 1) construction, improvement and O & M of the facilities necessary for drinking water supply, 2) construction, improvement and O & M of the hygienic sewerage system, 3) discontinuation of the existing unnecessary drainage facilities, and 4) construction and O & M of drainage system.

Water and sewerage service and the structure of WASA are regulated by NO.XIX The East Pakistan Water Supply and Sewerage Authority Ordinace, 1963, and The Dhaka/Chittagon Water Supply and Sewerage Authority (Water Connection and Water Rate) Rules, 1966. WASA is a subsidiary body of MLGRD&C, which controls water and sewerage service in the country. In only 3 urban cities i.e. Dhaka, Chittagong and Khulna have WASA and WASA provides water and sewerage service independently.

Table 3.5-1 Outline of Dhaka WASA, Chittagong WASA and KhulnaWASA

	Dhaka WASA	Chittagong WASA	Khulna WASA
1. Year of Establishment	1963	1963	2008
2. Total Number of Members	4,300 (as of 2010)	619 (as of 2007)	259 (as of 2010)
1) Director/Secretary	—	18	—
2) Administration	548	148	—
3) Finance	462	135	—
4) Engineering	3,390	318	—
3. Facility			
1) Well construction	546 (2010)	41 (as of 2007)	52 (as of 2010)

2) Iron removal facility	0 (2010)	1 (as of 2007)	―
3) Surface water purification plant	4 (2010)	1 (as of 2007)	1 (broken) (as of 2010)
4. Water supply capacity (m3/day)	2,113、000 (2010)	200,000 (as of 2007)	―
5. Actual Water supply volume (m3/day)	1,849、000 (2010)	192,000 (as of 2007)	90,000 (as of 2010)
6. Water supplied population	1,250 million (as of April 2010)	128.6 million (as of February 2005)	―
7. Number of water supply pipe connection	282,691 (as of 2010)	43,268 (as of 2007)	16,000 (as of 2010)

Source: Dhaka WASA: Water Supply & Waste Water Management in Dhaka City, April 2010 (provided by Dr. Engineer Mohamed Liakat Ali, Dhaka WASA)
Chittagong WASA: Preliminary Survey for the Project for Advancing NRW Reduction Initiative of Chittagong WASA, March 2009 (provided by Bangladesh office of JICA)
Khulna WASA: Hearing results of this survey

3) DPHE

DPHE is a department of the water wing of LGD, develops the water and sanitation sector in the country other than WASA jurisdiction area and provides the technical/institutional support. DPHE has 7,000 staff. The organization chart is shown in Figure 3.5-2. DPHE formulates the vision as below separately from SDP.

- Municipal water: 75% by 2015 and 90% by 2025 for piped supply (Achievement as of June 2009 : out of 315 local cities in the country, 100 cities have already been piped and 68 cities in progress)
- Rural water: 100% by 2015 for point supply (such as hand-pumped) and 25% by 2025 for piped supply (Achievement as of June 2009 : 85% for point supply)
- Safe water in the arsenic contaminated area: 100% by 2010 in the 80-100% contaminated areas and 100% by 2015 in the 40% or more contaminated areas.

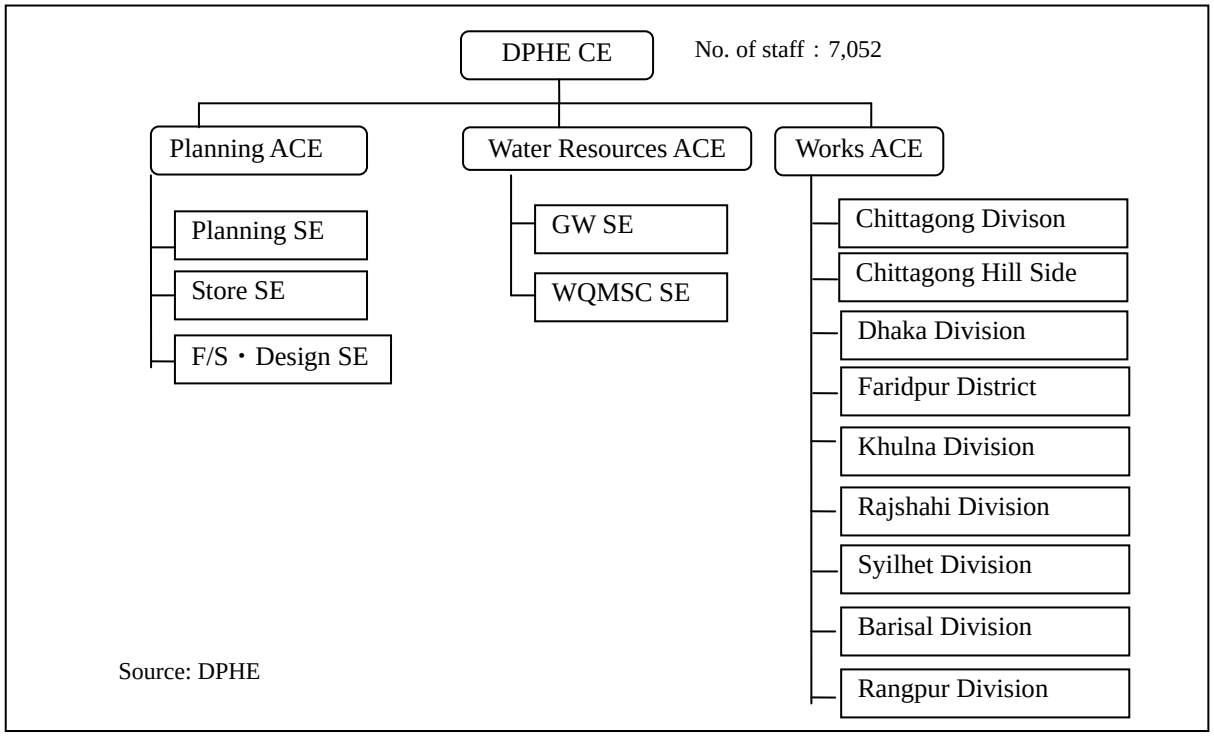


Figure 3.5-2 Organization Chart of DPHE

4) CCWSS

CCSS (City Corporation Water and Sanitation) is an organization of city corporations other than Dhaka, Chittagong and Khulna, and provides water and sanitation services.

5) LGED

LGED is also a department of LGD, and develops and manages the infrastructure in urban and the rural areas. Regarding the water sector, LGED develops the irrigation water to the areas less than 1000ha. LGED consists of 4 sections such as planning, implementation, maintenance and administration, and 8 division branches（6 divisions, Mymensingh and Comilla）. Total staff strength of LGED is 10,100.

6) PWSS

PWSS (Pourashava Water Supply and Sanitation) is an organization of local government, and provides water and sanitation services in the city. PWSS is generally organized with 4 sections such as well/pump maintenance, distribution network monitoring, customer service and guards. Repair and mechanical maintenance work is done by engineering department. The number of staff is shown in Table 3.5-2.

Table 3.5-2 Number of PWSS Staff

Narshingdi	Brahmanbaria	Noakhali	Comilla	Chandpur
19	21	16	56	53

Source: Result of hearing to PWSS by JST

Narshingji and Brahmanbaria where ADB supported through "Secondary Towns Water Supply and Sanitation Sector Project" keep the PWSS operation record and prepare the PWSS's own financial reports (balance sheet, profit & loss statement and fixed assets register book) independent from the local government, so that the top management of the 2 cities can easily understand the operation and management of water sector. However, according to DPHE, the operation and management capacity of most of the PWSS is very low.

(2) Administrative Organizations of Water Resources Sector

1) WARPO

WARPO is an organization under the Ministry of Water Resources, and responsible for development and management of water resources of the county. The principal functions of WARPO are: monitoring implementation of NWMP and its impact, upkeep of water resources assessment and maintenance, and updating of water resources data. WARPO is composed of 8 sections and has 87 staff.

2) BWDB

BWDB is an organization under the Ministry of Water Resources, and responsible for implementation of structural and non-structural measures such as flood control, drainage, river bank, town protection and flood forecasting and warning. BWDB consists of 5 sections and has 7,000 staffs. BWDP works also for monitoring of groundwater level and has the well network for the recording of groundwater level.

(3) Development Budget of Water and Sanitation Sector proposed by LGD

Table 3.5-3 shows the development budget of water and sanitation sector. The sector share to the whole budget of LGD was 15% in 2008/09 and 19% in 2009/10. Currently the budget is distributed more to WASA and rural areas than to local cities; however, DPHE intends to increase more to the local cities to cope with the growing population there.

Table 3.5-3 Development Budget of Water and Sanitation Sector (taka in Crore)

Organization	-	FY 2008/09	FY 2009/10
Central Government	Dev. Budget	25,600	30,500
- MLGRD&C	Dev. Budget	5,860	7,150
-LGD	Dev. Budget	5,250	6,740

Organization	-	FY 2008/09	FY 2009/10
-Water and Sanitation (note)	Dev. Budget	810	1,280
（% shared in the LGD Dev. Budget）		（15%）	（19%）
Distribution of development budget of water and sanitation	WASA	31%	46%
	Local Cities	25%	23%
	Rural Areas	39%	27%
	Technical	5%	4%

Source: Web-site of the Ministry of Finance and DPHE-PSU
Note: Development budget of on-going projects

3.6 Needs for Water Supply Development

Hearings were conducted to main organizations related to water works to find their needs for water supply development. Table 3.6-1 shows the hearing results.

Table3.6-1 Results of Hearing to Each Related Organization

Organization	Needs	Target Area
LGD	• Improvement of organization and system • Improvement of profit mechanism of water supply service • Establishment of implementation system with private sector • Consideration for poverty groups for construction of water supply and sanitation plant • Construction of desalination plant for coastal areas	• Khulna • Khulna and all Pourashava • Khulna and all Pourashava • All areas in Bangladesh • Noalhali, Khulna, Bhola and other coastal areas
DPHE	• Promotion of PPP projects • Arsenic damage is a problem in Daudkandi, Muradnagar and Laksamm of Comilla district. These areas can be candidates for PPP projects because they are economically and relatively sound. • Preparation of Master Plan for each district	• Each districts • Tungipara of Gopalganji district (Arsenic), Satkila (Arsenic, salination), Comilla (Arsenic) • All areas in Bangladesh (except for WASA administrative areas)
DPHE (PSU)	• Improvement of water supply in small Pourashavas and districts	• Satkila (Arsenic), Khulna (Arsenic), Noakhali (salination), Bhola (salination)
DPHE (ADB project section)	• Investment for water supply sector (Dhaka WASA and Khulna WASA) • Expansion of experiences of Secondary Towns Water Supply and Sanitation Sector Project (on-going with ADB support) into other areas except for the project target 16 cities (Braman Baria, Jessore, Pirojpur, Sirajganj, Natore, Jhenaidah, Moulvi Bazaar, Kishoreganj, Mymensingh, Netrakona, Madaripur, Choumuhani, Narshingdi,Joypurhat, Sherpur and Laksmipur)	• Madaripur river basin (water quality degradation), Moulvi Bazaar river basin (groundwater table depression, water quality degradation), Narsingdi river basin (groundwater table depression, water quality degradation)
DPHE (JDCF)	• Surface water supply through the pipe line • Preparation of Master Plan for each district	• 148 Pourashava • All areas in Bangladesh (except for WASA administrative areas)
LGED	• Conversion into surface water	• All areas in Bangladesh
Dhaka WASA	• Expansion of pipe line network adjusting to population increase	• Dhaka City

Organization	Needs	Target Area
	• Rehabilitation of existing pipes, such as leakage and degradation	• Dhaka City
	• Improvement of water quality of river water near Dhaka in the dry season	• Dhaka City
	• Improvement of Non revenue water	• Dhaka City
Khulna WASA	• Capacity development on O & M	• Dhaka City
	• Preparation of master plan for water supply	• Dhaka City
	• Establishment of accounting management system	• Dhaka City
	• Establishment of water tariff charging management system	• Dhaka City
	• Installment of elevated tanks	• Dhaka City
	• Construction of drainage facility for sewage and rainwater	• Dhaka City
PWSS	• Development of surface water source and construction of purification plant	• Gazipur, Tongi, Narsingdi, Noakhali, Chandpur, Comilla
	• Development of deep wells	• Gazipur, Shariatpur, Chandpur
	• Expansion of pipe line network	• Gazipur, Shariatpur, Chandpur
	• Installation of water meter	• Gazipur, Chandpur
	• Installation of iron removal equipment for all wells	• Brahmanbaria
	• Securing equipment and engineers for water quality analysis	• Brahmanbaria
	• Utilization of rain water as domestic water	• Tongi

3.7 Past and On-going Japan's Cooperative Activities in Water Sector

Table 3.7-1 shows the past and on-going Japan's cooperative activities in water sector (as of April 2010). Physical development and capacity development is carried out in Chittagong. Under Japan's Cooperative Activities ccomprehensive assistance considering both aspects i.e. soft and hard are implemented. A continuous assistance on the countermeasures of arsenic contamination has been provided in Jesssore and its outcomes have been steadily accumulated.

Table 3.7-1 Japan's Cooperative Activities in Water Sector

No.	Project Name	Location	Scheme	Status
1	Project for Strengthening Capacity for Water Quality Analysis and Monitoring System in Bangladesh	Dhaka, etc.	Technical Cooperation Project	On-going
2	Strengthening Water Quality Examination System of Bangladesh	Dhaka	Grant Aid	Completed
3	The Project for Modernizing, Rehabilitation and Expansion of Chandnighat Water Treatment Plant	Dhaka	Grant Aid	Completed
4	Karnaphuli Water Supply Proejct	Chittagong	Yen Loan	On-going
5	The Project for Advancing NRW Reduction Initiative(PANI)of Chittaqgon WASA	Chittagong	Technical Cooperation Project	On-going
6	Feasibility Study on The Extension and Expansion of Mohara Water Treatment Plant in Chittagon	Chittagong	Development Study	Completed
7	Preparatory Survey on Khulna Water Supply Improvement Project	Khulna	Project Formulation	On-going
8	Technical Cooperation Project at the Grass-roots Level for Suppression of Arsenic-affected Health Hazard and Poverty in Abhaynagar, Jessore District	Jessore	Technical Cooperation at the Grass-roots Level	On-going

No.	Project Name	Location	Scheme	Status
9	Dispatch of expert "Arsenic Mitigation Advisors to Department of Public Health Engineering (2004~2006), and to local Government Division (2004~2006)	Dhaka, etc.	Dispatch of experts	On-going
10	Project for Sustainable Arsenic Mitigation under the Integrated Local Government System	Jessore	Technical Cooperation Project	Completed
11	Integrated Approach for Mitigation of the Arsenic Contamination of drinking Water in Bangladesh	Jessore	Development Partner Project	Completed
12	Study of Groundwater Development of Deep Aquirfers for Safe Drinking Water Supply of Arsenic Affected Area in Western Bangladesh	Jessore	Development Study	Completed
13	Integrated Approach for Mitigation of Arsenic Contamination of Drinking Water in Bangladesh	14 Districts	Grant Aid	Completed
14	Project for Water Supply Facilities	Narayanganji, etc.	Grant Aid	Completed

In addition, the following two projects are implemented under JDCF:

Table 3.7-2 Water Sector Projects under JDCF

No.	Project Name	Target Area	Status
1	Groundwater Management and TPP for Survey, Investigation and Feasibility Study in Upazila and Growth Center Level Pourashava having no Piped Water Supply System	148 Pourashavas without piped water supply systems	On-going
2	Rural Water Supply in South Western Part of Bangladesh	4 Districts in South Western part (Bagherhat、Jessore、Khulna、Shatkhira)	On-going

3.8 Past and On-going Other Donors' Cooperative Activities in Water Sector

Table 3.8-1 shows the past and on-going other donors' cooperative activities in water sector.

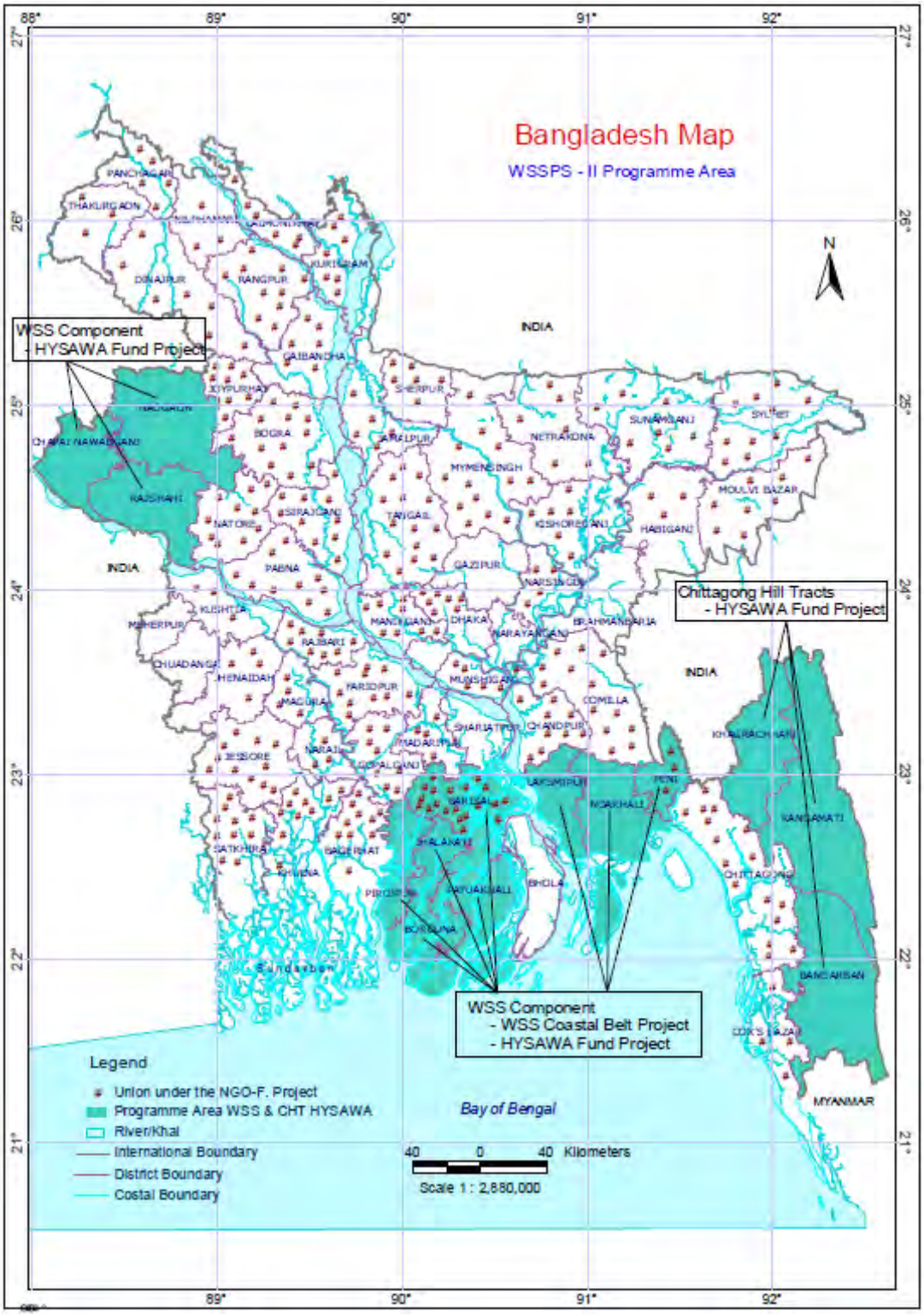
Table 3.8-1 Other Donors' Cooperative Activities in Water Sector

Donor	Project Name	Remarks
World Bank (WB)	Social Investment Program Project under SDF – Pilot Projects of piped water supply system in rural village	Sponsor and community bear a part of investment cost.
	Bangladesh Arsenic Mitigation Water Supply Project (BAMWSP)	- Collaboration with Swiss Agency for Development and Cooperation (SDC) - Sponsor and community bear a part of investment cost.
	Bangladesh Water Supply Program Project (BWSPP)	Sponsor and community bear a part of investment cost.
	Dhaka Water Supply and Sanitation Project (DWSSP)	Will be approved in end of May 2010
UNICEF	Deployment of Arsenic Removal Technologies (DART)	Collaboration with Canadian International Development Agency (CIDA)
	Sanitation, Hygiene Education and Water Supply in Bangladesh (SHEWA-B)	Collaboration with Department for International Development (DFID)
Asian Development Bank (ADB)	Supporting the Establishment of the Khulna Water Supply and Sewerage Authority	
	Dhaka Water Supply Sector Development Program (DWSSDP)	

Donor	Project Name	Remarks
	Secondary Town Water Supply and Sanitation Project Improvement of Urban Governance and Infrastructure	Collaboration with OPEC Fund for International Development (OFID)
Danish International Development Agency (DANIDA)	Water Supply and Sanitation Sector Program Support (WSSPS) - Sector Policy Support - Water Supply and Sanitation (WSS) in Coastal Belt Project - Hygiene, Sanitation and Water Supply (HYSAWA) Fund Project - Hygiene, Sanitation and Water Supply (HYSAWA) Fund Project in Chittagong Hill Tracts	- Implemented by local NGO (NGO Forum) as main body - Cost sharing like BWSPP is applied to HYSAWA Fund Project.
	Saidabad Water Treatment Plant Project -Phase II	
Netherlands Government	Water , Sanitation and Hygiene Program Project	Implemented by local NGO (BRAC) as main body
Department for International Development (DFID)	Community-based Arsenic Mitigation Project	Implemented by local NGO (NGO Forum) as main body

As a trend of donors' activities, assistance to promote usage of surface water is still less, and usage of groundwater in deeper aquifer which is not contaminated by arsenic is dominant. In "Social Investment Program Project - pilot projects of piped water supply system in rural village" which SDF implemented with assistance from WB, there was 50:50 percent costs sharing of initial investment between service provider (sponsor) and community. This is the first case of PPP for water supply services in Bangladesh (mainly carried out by NGOs). In the Bangladesh Water Supply Program Project (BWSPP) currently implemented, the number of schemes realized increased, owing to decrease of cost sharing rate for sponsors (70 % for the government). Hygiene, Sanitation and Water Supply (HYSAWA) Fund Project, which is implemented by NGO Forum with assistance from DANIDA, applied same method as BWSPP, and announced application for EOI. This means that water supply services using BWSPP method expand to the north western and south region, target area of HYSAWA Fund Project, in addition to the area carried out under WB assistance. However, since scale of assistance for each donor is limited, utilization of the method by some donors can promote expansion of piped water supply systems in rural area.

As for decentralized water supply aimed by SDP, further capacity development of local government institutions will be needed. For example, DANIA is carrying out capacity development of local government institutions (Pourashavas and Unions) in Water Supply and Sanitation Sector Program Support (WSSPS). Figure 3.8-1 shows the target area of WSSPS by DANIDA.



Source: Ministry of Local Government, Rural Development & Cooperatives, Water Supply and Sanitation in Coastal Belt Project (WSS Coastal Belt) Project Document Water and Sanitation Sector Programme Support (WSSPS) Phase II

Figure 3.8-1 Target Area of WSSPS by DANIDA (Phase II)

Figure 3.8-2 shows the locations of other donors' cooperative assistance in water sector.

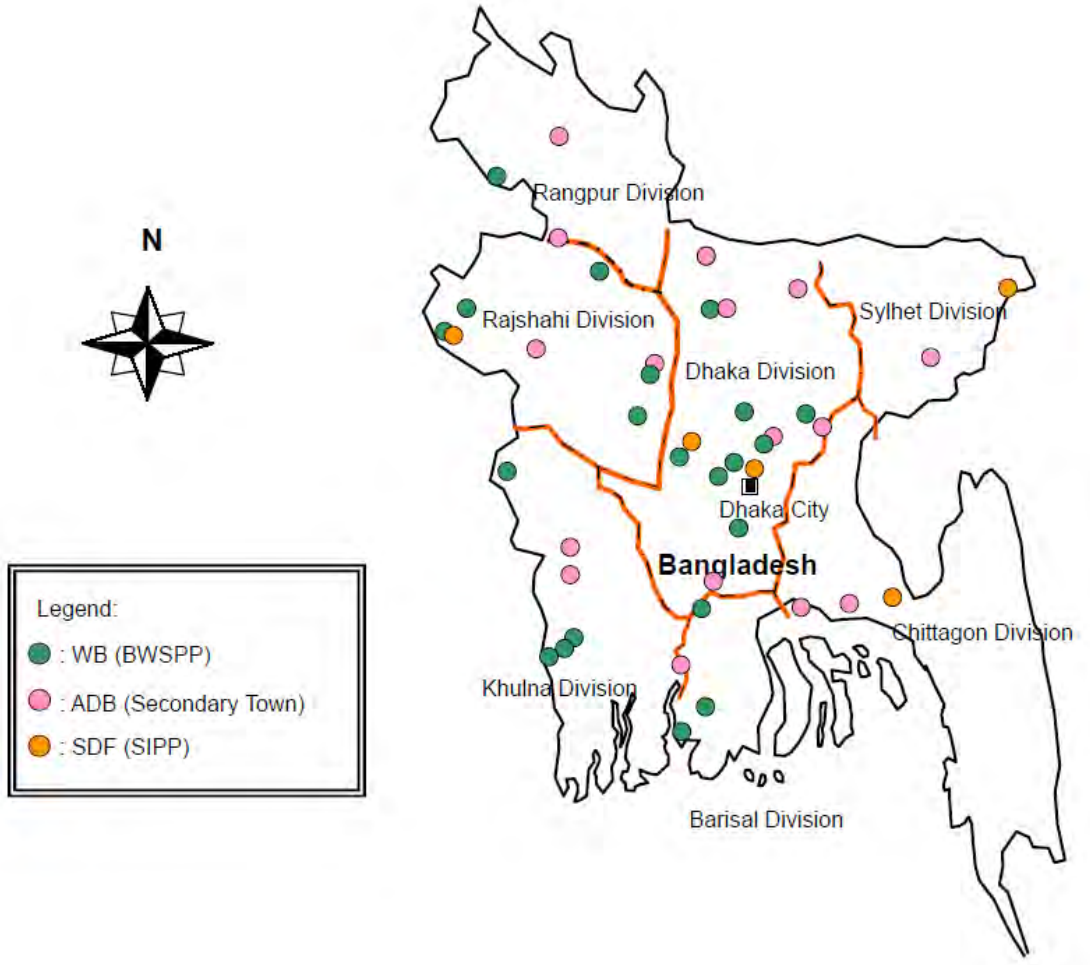


Figure 3.8-2 Locations of Other Donors' Cooperative Assistance in Water Sector

3.9 Natural Condition, Hydrogeology and Situation of Water Resources

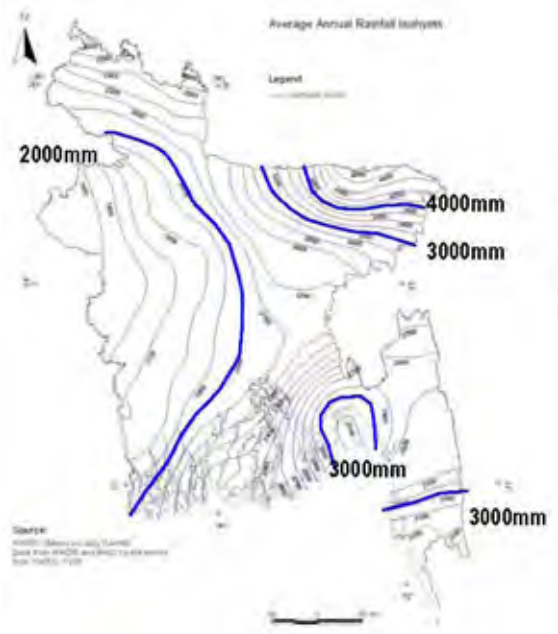
3.9.1 Natural Condition

(1) Meteorology

The climate of Bangladesh belongs to the savannah and tropical monsoon climate. It is apparent in the rainy season and dry season with high temperature, high humidity, and a lot of rain.

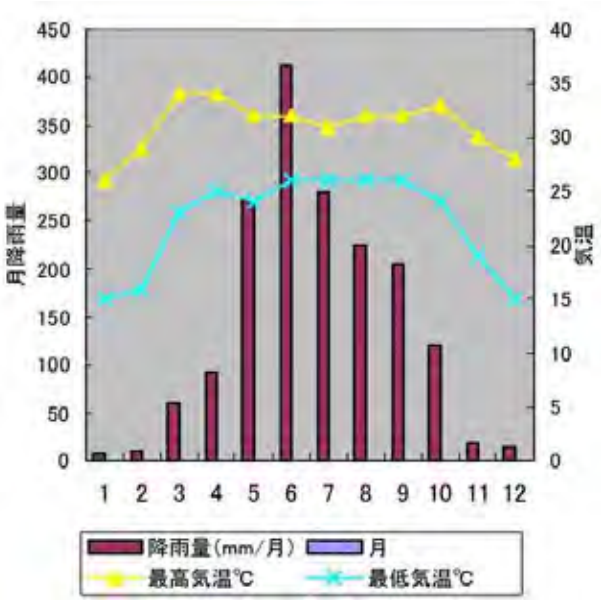
The dry season is from November to March, and the rainy season is from June to October. Cyclones pass Bangladesh in many cases from April to March and October to November when there is change in season.

Although annual average precipitation is 2,200mm in Bangladesh, there is large difference with 1,200-6,000 mm by the area. 80% or more of yearly precipitation concentrates during the rainy season. About half of the country during rainy season is inundated by flood water by the southwest monsoon from India. Moreover, drought damage occurs during the dry season with the northeast monsoon.



Source ; Factor Analysis for Flood Damage in Bangladesh 2007 Technical Note of PWRI Vol.4052

Figure3.9-1 Isohyetal Map of Bangladesh



Source ; Water and Sanitation Situation in Bangladesh 2006 Takahashi & Sakai Japan Association of Drainage and Environmen

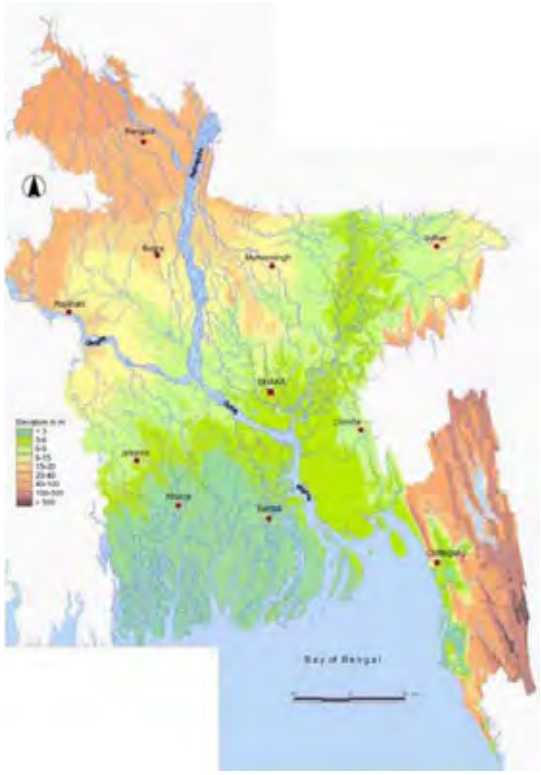
Figure3.9-2 Monthly Rainfall, Monthly Mean Maximum and Minimum Temperature in Dhaka

(2) Topography

Bangladesh is located in the world's largest delta area and the Bengal lowlands which were formed by Ganges River which flows from the west, and Bramaputra (Jamuna) river which flows from northeast.

Most of the area is low land with an elevation of 10m or less, and the hilly land of the northern part and the eastern part where elevation is high is only 13% of the country's land area.

The Bengal lowlands from land classification are divided into Ganges delta, the Bramaputra (Jamuna) flood plain, and the Sylhet basin. The Barind plateau are in the north side of Rajahi and the Madpur plateau is in the north side of Dhaka (Refer to Fig. 3.8-3 Geographical Feature of Bangladesh).



Source; National Water Management Plan 2001 WARPO, MoWR

Figure3.9-3 Geographycal Feature of Bangladesh

(3) Geology

As for the geology of Bangladesh, Holocene strata are distributed over the Bengal lowlands with the Ganges delta, and Pleistocene to Tertiary strata are distributed over hill parts with relatively high altitude. The Tertiary strata, which are distributed over Chittagon Hills and northern hills, consist of sandstone, shale and limestone in part. In the Bengal lowlands, delta clay, silt and sand are mainly distributed in lowland part, and seashore sand and silt are distributed in seashore part. Moreover, in the Barind diluvial upland extended over the north of the Rajshahi division and the Mudpur diluvial upland of the north of Dhaka, diluvial clay is distributed (Refer to Figure 3.9-4 Surface Geology of Bangladesh).

Source ; Report of the Basic Design Study Project on Strengthening of Water Examination System in the People Republic of Bangladesh 2002 JICA, Kokusai Kogyo CO., LTD.

Figure3.9-4 Surface Geology of Bangladesh

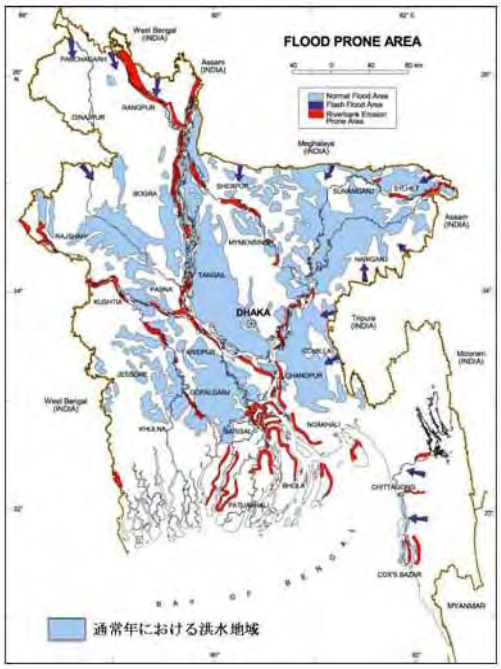
Bangladesh has a junction zone of the Eurasia plate and the India plate in the east side and the north side, respectively and it is supposed that the formation of hills, plateaus, and lowlands is related to the structure movement of plates. The big earthquake has occurred on the border in Nepal and India and the border in China and India which meet the junction of plates in 1934 (Mw8.0) and 1950 (Mw8.6), and also the earthquake has occurred in the Assam district in adjoining India in 1897 and 1930.

Although earthquake with magnitude 7 has occurred in Bangladesh in 1885, 1918, and 1935, remarkable damage is not recorded.

(4) Flood

In Bangladesh 80% of the land consists of flood areas in 3 big rivers' mouth of Ganges, Brahmaputra and Megna River. Moreover, 80% or more of annual precipitation (an average of 2,200mm) concentrates during the rainy season from May to October, and water, which is 4 or more times of domestic precipitation, flows in through three big rivers at the same time. For this reason, when the peak discharge and rain situation of each river overlap, it becomes flood. It is flood-prone area around which flood occurs almost every year (Refer to Fig. 3.9-5 the flood area in Bangladesh).

Except for flash floods generated in hill part, the flood spreads gradually around from July. The water level will usually go up gradually by several meters/ month in speed, and the flood period is said to be about 15 to 45 days. The usual flood is expressed as "Barsha" and the flood with extraordinary damage is expressed as "Banna" in Bangladesh. The flood of the year of Barsha will start on the low flat ground (Haor area) in the northeast part around April to May, and about 20%



Source ; Factor Analysis for Flood Damage in Bangladesh 2007 Technical Note of PWRI Vol.4052

Figure3.9-5 Flood Area in Bangladesh

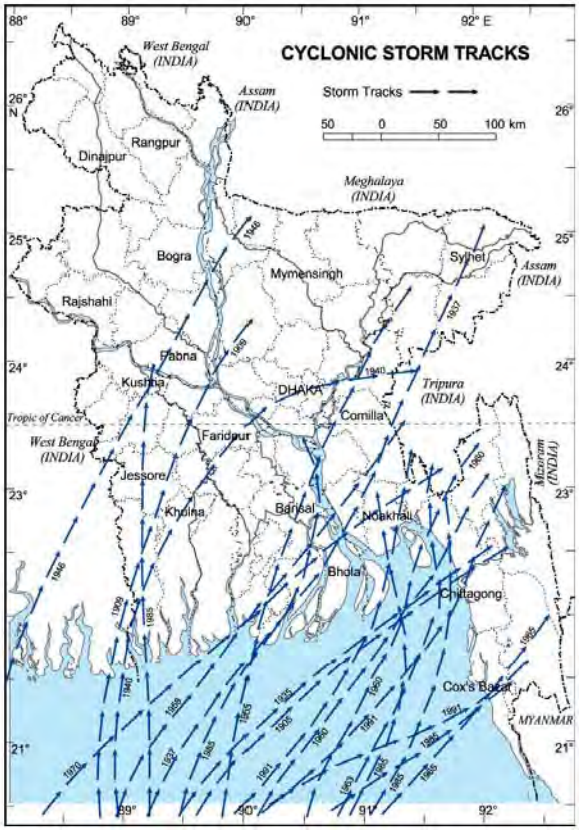
of countries will be covered with water from July to August. There is little damage and it plays an important role for the agricultural output after the rainy season, or growth of fishing resources. The yield of agricultural products falls during the dry season in a year without flood. On the other hand, for the year of Bonna, 30 to 50% of countries are covered with water, and the great damage containing human life occurs.

(5) Cyclone

Bangladesh receives the attack of cyclone before the monsoon (April to May) and after the monsoon (October to November). Before the rainy season, cyclones pass to southeast coastal area with high frequency. After the rainy season, cyclones pass to Indian side in the western Bengal bay.

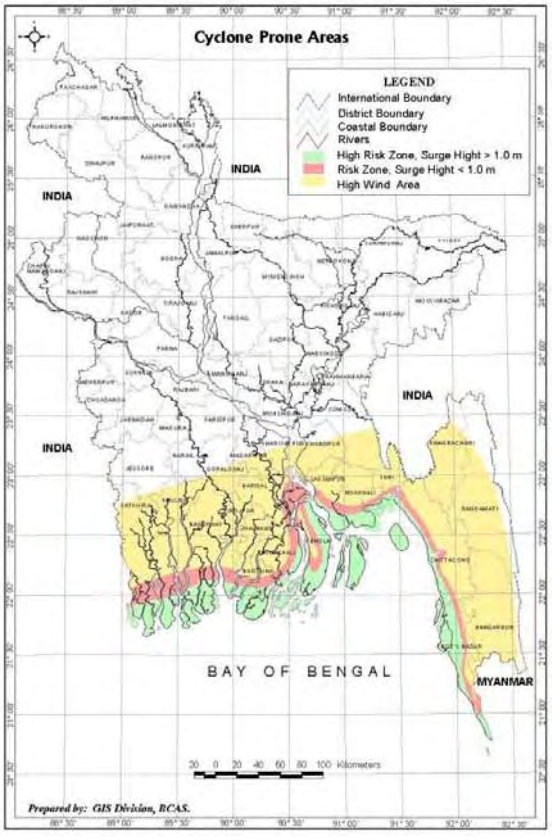
Large-sized cyclones including human life damage are 14 while 25 years applying from 1975 to 2000, and it has received the damage by large-sized cyclone annually.

The cyclone of Bangladesh heightens the external force due to the geographical feature of the triangle of the Bengal bay, and causes large-scale high tide, and causes destructive damage to areas along the shore, and takes many human lives. When the attack of cyclone overlaps with high tide, especially the tidal wave of 5 to 9 m height is said to roll on the shore, and enlarges the damage in case that sea water permeates to inland area up to 5 to 8 km inside (Refer to Fig. 3.9-6 and Fig. 3.9-7).



Original Source; Bangrapedia(BA_S_19)
Source ; Factor Analysis for Flood Damage in Bangladesh 2007 Technical Note of PWRI Vol.4052

Figure3.9-6 Route of Cyclone of Bangladesh



Source; Increase of Environment and Climate Refuge in Bangladesh 2008 Bangradesh Centre for Advanced Studies (Presentation Material)

Figure3.9-7 Salt Water Intrusion Area by Tidal Wave of Cyclone

3.9.2 Hydrogeology

Groundwater is mainly present in sand and gravel layers of the Holocene and the Pleistocene age, and the sandstone layers in the Bengal lowland. Generally, the shallow aquifer of depth 10 to 20m (the first aquifer), the deep aquifer of depth 100-200m (the second aquifer), and the deep aquifer of depth 300m and more (the third aquifer) are withdrawn.

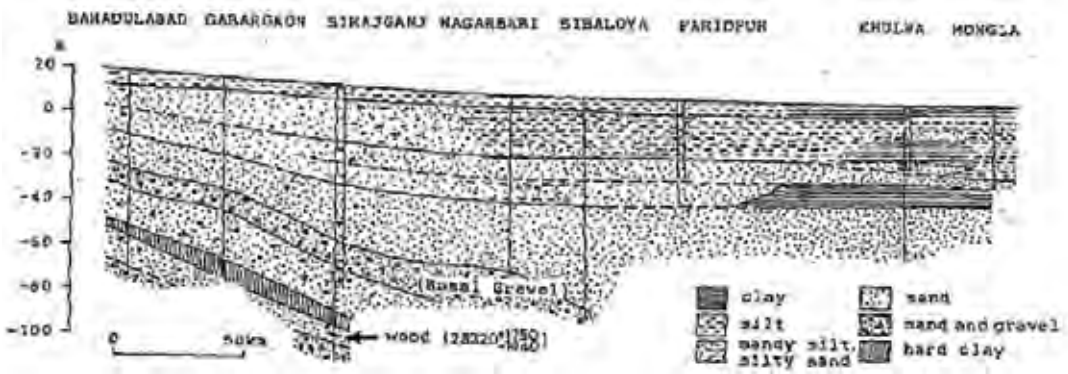
In rural village areas, many shallow wells are used generally for drinking water and domestic water.

The withdrawal from the second aquifer is actively performed for water supply in big cities and main local cities. The withdrawal from the second aquifer is mainly used for irrigation water use, industrial water use and commercial water use also, and the groundwater fall of the second aquifer has been a problem in many cities. The withdrawal from the third aquifer of the deep portion has begun partly.

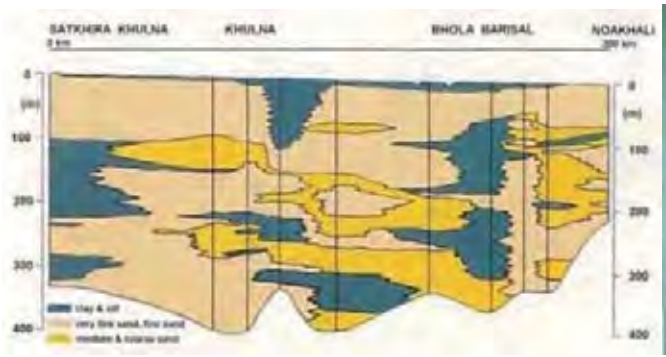
Although it has tendency that each aquifer separates by impermeable formation such as clay layer, there are areas where clear aquiclude dose not form. The geological cross section of the Bengal lowland is assumed as shown in Figure.3.8-8. Sand layers mainly excel in the lowlands central part. Although distribution of fine and coarse sands is seen in the well columnar section of Gazipur, Narsingdi, and Brahmanbaria where hearings were conducted, fine sand is predominant.

In the delta region of the seashore part like Noakali, the alternation of clay layers and sand layers form. Since the salt water aquifer or brackish water aquifer or freshwater aquifer are different every sand layer intercalated clay layers, a freshwater aquifer is discovered, and the screen is installed at selected fresh water portion avoiding contamination of salt water or brackish water (Refer to Figure.3.9-8).

（A） BAHADULABAD-MONGLA (Cross Section of South to North Direction)



（B） SATKILA-NOAHKALI （East-West Direction） (C) Hydrogeological Cross Section of NOAKHALI (South-North Direction)



Source ; (A)(B) ; Report of the Basic Design Study Project on Strengthening of Water Examination System in the People Republic of Bangladesh 2002 JICA, Kokusai Kogyo CO., LTD. (C) ; O&M Manual for Water Supply System in Noakhali Pourashava, Noakhali PWSS Matrial

Figure3.9-8 Geological Cross Section of Bengal Lowland

3.9.3 Situation of Water Resources

By this clause, reference is made only about the area where field survey has been carried out in this Survey.

Although surface water is used as water supply source in Dhaka WASA (257,000m^3/day, 13% of total water supply), Khulna WASA(9 m^3/day, 1% of total water supply), Chandpur Pourashava (4,600m /day, 60% of total water supply) and Gopalganji Pourashava (14,000m^3/day, 100% of total water supply), the capacity factor of surface water in the whole Bangladesh is low.

Some of big cities and local main cities, which have caused groundwater level decline by excessive dewatering of groundwater, and have a limit in groundwater-supply development, have newly schemed for extension or shift to surface water supply. Although many places have difficulty of surface water development due to the water pollution of the river near big city, and the remarkable water level decline during the dry season, the possibility that the river water of Meghna river and Padoma river can be used, etc. are high.

Moreover, Dhaka WASA has a plan to use river water to repair the canal from Jamuna River and convey water, and purifiy water. In Khulna WASA, feasibility study on extension of intake and water-purifying facility is carried out by JICA.

Groundwater is used as a pipeline water supply source in Dhaka WASA (Yield of 1,720,000m^3/day by 546 wells, 87% of total water supply), and Khulna WASA (Yield of 32,000m^3/day by 52 wells with pipeline and yield of 60,000m^3/day by 9,900 handpump wells, 99% of total water supply in both), Tongi, Gazipur, Narsingdi, Brahmanbaria, Noakali, Comilla, and Shariatpur Pourashavas (Yield of 2,000-5,500m^3/day by wells and pipeline).

Although the pipeline water supply by only groundwater is performed in many local cities, a diffusion rate is 30 to 40%, and a diffusion rate is low compared with the city where surface water combined use or pipeline water supply only by surface water is performed. Moreover, in Dhaka WASA and Pourashavas such as Tongi, Gazipur, Narsingdi, Brahmanbaria and Noakali, many wells for agriculture or for industry also compete and the groundwater level fall by extra dewatering. In addition, hand pump wells and dug wells are used in the area where pipeline water supply has not covered.

An arsenic contaminated area is shown in Fig.3.9-9.The area which shows the arsenic concentration where water quality of groundwater mainly exceeds the standard (Bangladesh standard; 0.05 mg/L, WHO standard; 0.01 mg/L) in shallow aquifer is distributed widely.

The case where high concentration is shown also in some deep aquifers although there are generally few reports which show high arsenic concentration at the deep aquifer (the second aquifer), and in order that there may be no impermeable formation between the shallow aquifer (the first aquifer), shallow groundwater and deep groundwater are mixed by free flowing each other, and arsenic contamination may be reported also in the second aquifer depth.

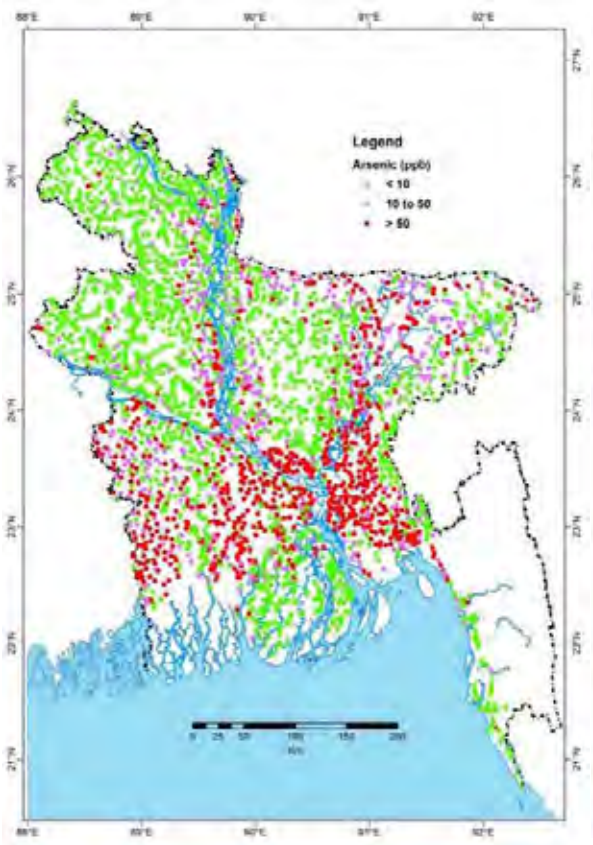
There are areas which show high iron concentration in the second aquifer (in Narsingdi, Brahmanbaria, Chandpur, Noakhali, etc.), and there are areas which do not have problem in water quality even if there is case of groundwater level fall (in Dhaka, Khulna, Gazipur, Gopalganji, Shariatpur, Comilla, etc.).

In addition, an iron removal institution is installed by DANIDA at PWSS of Noakhali and it is working. Iron removal equipment is installed also in a part of Candpur.

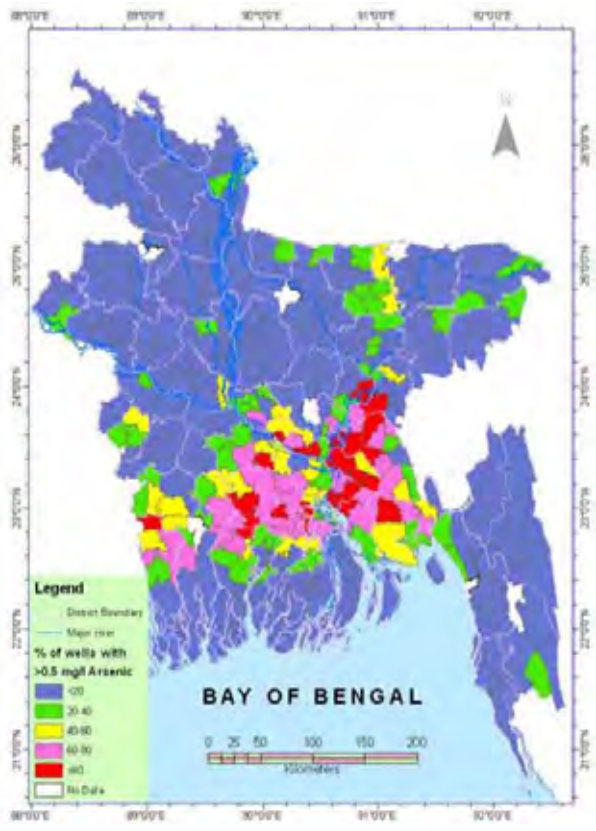
In the area where other iron concentration is high, though considered as a problem, iron removal equipment is not installed (in Narsingdi, Brahmanbaria, etc.).

(A) Summary of DPHE/ BGS National Hydrochemical Arsenic Analysis

(B) Percentage of Wells Exceeding 50 ppb in various Upazilas



Summary of DPHE/BGS NationaI HydrochemicaI Survey Arsenic Analysis of 3534 wells



Percentages ofwells exceeding 50 ppb in various upazilas (combined data of BAMWSP NationaI Screening in As Affected upazilas and DPHE/UNICEF Screening in Non-affected upazilas)

Source; Report on Situation Analysis of Arsenic Mitigation 2009, JICA/DPHE Arsenic Mitigation Project, 2010

Figure3.9-9 Arsenic Contamination of Shallow Aquifer in Bangladesh

3.10 Socio-Economic Situation

In Bangladesh, the economy has achieved relatively stable because trade and investment have been deregulated and state-owned enterprises have been reformed since 1980s, and democratic government has introduced policy to liberalize economies since 1991. Growth rate for the last five years is around 6 % and steady economic development has continued (see Table 3.10-1). Factors of the development are growing in manufacturing sector and private consumption based on remittance from overseas laborers. The economic development has contributed to recent poverty reduction, while GNI per capita is around 690 US$ (2008/2009). With regard to distribution ratio of GDP by industry origin sector, agriculture and forestry was dominant up to 2004/2005, however, most dominant sector has been manufacturing since 2005/06. It can be projected that demand to industrial water will increase because the manufacturing sector will continue to grow.

Table3.10-1 GDP for the Last Five Years (Constant Price, Base: 1995/96)

(Unit: Million taka)

	2004/05	2005/06	2006/07	2007/08	2008/09
Agriculture and Forestry	442,298	465,449	487,297	501,567	525,684
Fishing	128,069	133,083	138,499	144,285	150,067
Mining and Quarrying	29,090	31,783	34,430	37,509	41,024
Manufacturing	422,690	468,197	513,722	550,772	583,393
Electricity, Gas and Water Supply	41,915	45,129	46,075	49,193	51,416
Construction	231,195	250,418	267,964	283,177	299,372

	2004/05	2005/06	2006/07	2007/08	2008/09
Wholesale and Retail Trade	361,552	385,961	416,996	445,434	473,713
Hotel and Restaurants	17,509	18,814	20,228	21,756	23,405
Transport, Storage & Communication	255,522	275,922	298,093	323,566	348,176
Financial Intermediations	43,380	47,068	51,391	55,960	60,435
Real Estate, Renting & Business Activities	208,009	215,687	223,805	232,205	241,062
Public Administration and Defense	68,604	74,198	80,436	85,432	91,432
Education	62,559	68,221	74,331	80,129	86,571
Health and Social Works	57,682	62,174	66,926	71,627	77,035
Community, Social and Personal Services	190,824	198,630	207,725	217,314	227,484
Total	2,669,740	2,846,726	3,029,709	3,217,260	3,406,524
Growth Rate	5.96%	6.63%	6.43%	6.19%	5.88%
GNI per capita (US$)	463	476	523	608	690

Note: The figure for 2008/09 is provisional.
Source: BBS

Table 3.10-2 shows import and export for the last five years. Both the figures of imports and exports in 2007/2008 increased more than twice, compared to those figures in 2003/04. However, trade deficit has been increasing year by year because of excess of imports. Principal imported commodities are rice and wheat, petroleum products, and machinery and equipment including electrical appliances. Major directions of imports are China and India. Principal exported commodities are readymade garments, fish, and jute goods. Major directions of exports are United States and Germany.

Table 3.10-2 Imports and Exports for the Last Five Years

(Unit: Million taka)

		2003/04	2004/05	2005/06	2006/07	2007/08
Import		630,363	769,954	962,345	1,118,664	1,496,722
Principal Commodities	Rice and	21,064	23,235	36,208	40,127	81,791
	Petroleum Products	57,260	34,141	110,310	125,251	121,253
	Machinery and Equipment including Electrical Appliances	95,850	150,241	204,951	243,665	136,150
Export		437,098	532,831	691,950	850,309	985,931
Principal Commodities	Readymade garments	336,901	398,149	449,174	633,430	734,651
	Fish	22,184	23,447	31,040	43,257	47,662
	Jute Goods	12,569	11,615	18,836	26,757	28,142
Trade Balance		193,265-	-237,123	-270,395	-268,355	-510,791

Source: BBS, "Foreign Trade Statistics of Bangladesh 2007-08"

According to estimates of BBS, population in 2008 is 145 million and population growth rate is about 1.4 % (see Table 3.10-3). Urban population accounts for about 25 % of national population. Based on BBS data, urban population growth rate is 3 % per year from 2006 onward and exceeds national population growth rate.

Table 3.10-3 Demographic Data

	2006	2007	2008	2015	2020
Population (million)	140.6	142.6	144.5	161.6	172.2
Urban Population (million)	34.6	35.7	36.7	52.1	62.6
Rural Population (million)	106	106.9	107.8	109.5	109.6
Growth Rate (%)	1.41	1.40	1.39	-	-
Urban Population Growth Rate (%)	3.3%	3.2%	2.8%	-	-
Population Density (per m^2)	953	966	979	-	-

Note: The figure for 2008 is provisional. The figures for 2015 and 2020 are projected population.
Source: BBS, "Statistical Pocket Book of BANGLADESH 2008" and "Sectoral Need-based Projections in Bangladesh"

Population growth in Dhaka metropolitan area is estimated at 5 %. Population density is also increasing year by year. According to BBS's "Sectional Need-based Projections in Bangladesh", it is projected that national population will increase by 162 million in 2015 and 172 million in 2020. Particularly, urban population growth will be high and urban population will account for 63 % of national population in 2020, while the figure is 25 % in 2008. Therefore, in addition to improvement of access to safe drinking water in rural area, it is necessary to address increase of demand to water supply especially in urban area.

Table 3.10-4 shows population ratio by religion. Muslim accounts for 89.35 % of national population, followed by 9.64 % for Hindu.

Table 3.10-4 Population Ratio by Religion

(Unit: %)

	National	Urban	Rural
Muslim	89.35	89.07	90.22
Hindu	9.64	9.88	8.93
Buddhist	0.57	0.56	0.60
Christian	0.27	0.32	0.13
Others	0.17	0.17	0.12

Source: BBS, "Key indicators on Report of Sample Vital Registration System 2008"

As for income level in Bangladesh, BBS conducted the "Household Income and Expenditure Survey" in 2005. According to the results of the survey, monthly income in urban area and rural area is 10,463 taka and 6,095 taka respectively, and 7,203 taka in whole country. Monthly expense in urban area and rural area is 9,878 taka and 4,816 taka respectively, and 5,842 taka in whole country. Supposed that monthly expense is disposable income, that is 81 % for urban area, 87 % for rural area, and 85 % for whole country.

Table 3.10-5 Income and Expense in Urban and Rural Area

(Unit: taka)

	HIES 2005			HIES 2000		
	Urban	Rural	Whole Country	Urban	Rural	Whole Country
Monthly Income	10,463	6,095	7,203	9,878	4,816	5,842
Monthly Expense	8,533	5,319	6,134	7,337	4,257	4,881

Source: BBS, "Household Income and Expenditure Survey (HIES) 2005"

BBS also conducted the survey on wage by type of job. According to the results of the survey, average daily wage is 130 Taka for informal sector. As for educational level of informal sector wage-earners, 35 % is primary class 1 to 5 and 30 % is uneducated.

Table 3.10-6 Average Daily Wage for Informal Sector

(Unit: taka)

	Percentile					Average
	Lower 10%	25%	50%	75%	90%	
Daily Wage	60	80	120	160	200	131

Source: BBS, "Wage Survey 2007"

According to the result of hearing to Brotee, a local NGO carrying out piped water supply utilizing surface water as a pilot project under SDF in Chamagram, Laharpur, and Laxmipur, Chapai Nawabganj District, average monthly income is 3,000 to 5,000 taka in that area. Supposed that monthly income is 4,000 taka and disposable income is 90 % of the monthly income, ability to pay for water supply services is 144 taka per month, applying 4 % of disposable income as maximum benchmark set by the World Bank. Water supply charge paid to the NGO is 120 to 150 taka per month

per household in those villages. The amount is almost equivalent to the ability to pay.

Based on information from RCDS (Rural Community Development Society), a local NGO promoting multiple use of groundwater in Sacha village, Kachua, Commila District, average monthly income is 5,000 taka. In a similar way as abovementioned, supposed that disposable income is 90 % of the monthly income, ability to pay for water supply services account for 4 % of disposable income, ability to pay for water supply services is 180 taka per month. RCDS set water supply charge at 100 taka per month, however, the service has not been realized because the village people do not have habit of paying monthly charge for getting water from wells.

Projukti Peeth, a local NGO working in Laksamm, Debidwar and Bancharampur, Comilla District, told that monthly income is 5,000 taka in that area. The income is same level as the cases of the villages as abovementioned.

According to CISD (Centre for Integrated Social Development), a local NGO implementing assistance to homeless people in rural area of Sreepur, Gazipur District, monthly income is 4,000 taka in that area. Major income sources are rickshaw-pulling and day labor in garment factories and agricultural lands. Ability to pay is 144 taka per month like the case of Brotee as abovementioned.

As just described, the average monthly income is 4,000 to 5,000 taka in rural area surveyed this time and maximum amount of ability to pay for water supply could be 180 taka per month. Therefore, when planning for water supply services in rural area, it is necessary to select technologies which enable villagers to pay for the services or provide financial assistance for initial investment and operation and maintenance.

Based on the result of hearing in slum areas of Dhaka City, the average monthly income is 5,000 taka and major income sources are rickshaw-pulling and day labor in garment factories and construction sites. People living in slum area surveyed live in rented house. House rent is 1,500 to 2,000 per month and this amount includes water supply charge.

Most of households get drinking water from wells in urban and rural area and the figure is 65 % and 97 % respectively. Households getting drinking water from tap account for 35 % in urban area and 1.5 % in rural area. Piped water supply system is not in widespread use in rural area because initial investment cost is higher than that for hand-pump, capacity of villagers is not enough to operate and manage the facilities, and ability to pay in rural area is lower than that in urban area. In whole country, 99 % of households use tap or wells as water sources for drinking water. Most of households get water for other use from wells, however, percentage of households that use ponds as water source is higher, compared to the figure of drinking water. Pond water is used for not only cooking, washing and bathing but also fish farming. Ratio of pond water utilization as drinking water source is low, but pond is important water source in area with salinity problem and limited alternative water sources.

Table 3.10-7 Water Source for Drinking and Other Use

(Unit: %)

	Whole Country		Urban		Rural	
Drinking Water	Tap	9.98	Tap	34.63	Tap	1.48
	Tube well & well	88.75	Tube well & well	65.03	Tube well & well	96.87
	Pond	0.99	Pond	0.19	Pond	1.27
	Canal/River	0.19	Canal/River	0.08	Canal/River	0.23
	Rain/Others	0.09	Rain/Others	0.07	Rain/Others	0.07
Water for Other Use	Tap	9.96	Tap	34.89	Tap	1.39
	Tube well & well	45.66	Tube well & well	38.67	Tube well & well	48.06
	Pond	39.21	Pond	22.76	Pond	44.87
	Canal/River	5.10	Canal/River	3.61	Canal/River	5.61
	Rain/Others	0.07	Rain/Others	0.07	Rain/Others	0.15

Source: BBS, "Key indicators on Report of Sample Vital Registration System 2008 "

3.11 Selection of Target Areas and Review of Preliminary Project Plans

3.11.1 Selection of Target Areas

Both urban area and rural area are included in site survey area in this Survey but the area throughout the country of Bangladesh is not covered in this Survey. Therefore, target areas for the site survey were specified based on needs of Bangladesh side and requests at the discussion on the inception report, according to criteria for selection. In the preparation work in Japan, JST considered Chittagong was one of the target area, however, Bangladesh side did not mention it at the discussion on the inception report and JST removed it considering the purpose and the period of the site survey. Finally, the target areas are determined; Dhaka, Khulna, Gazipur, Gopalganji, Shariatpur, Comilla, Brahmanbaria, Chandpur, Noakhali, Narsingdi, Tongi and Muradnagar as shown in Figure 3.11-1.

＜Criteria for selection of site survey area＞

- The area where the reference projects by WB and ADB or other donors are proceeding or have been proceeded
- The area near from trunk roads from viewpoints of logistics and access
- The area where economic effects based on population growth will be large
- The area where implementation of improvement activity is behind as located in east of Dhaka city
- The area with many local offices of government organization or headquarters offices of NGO

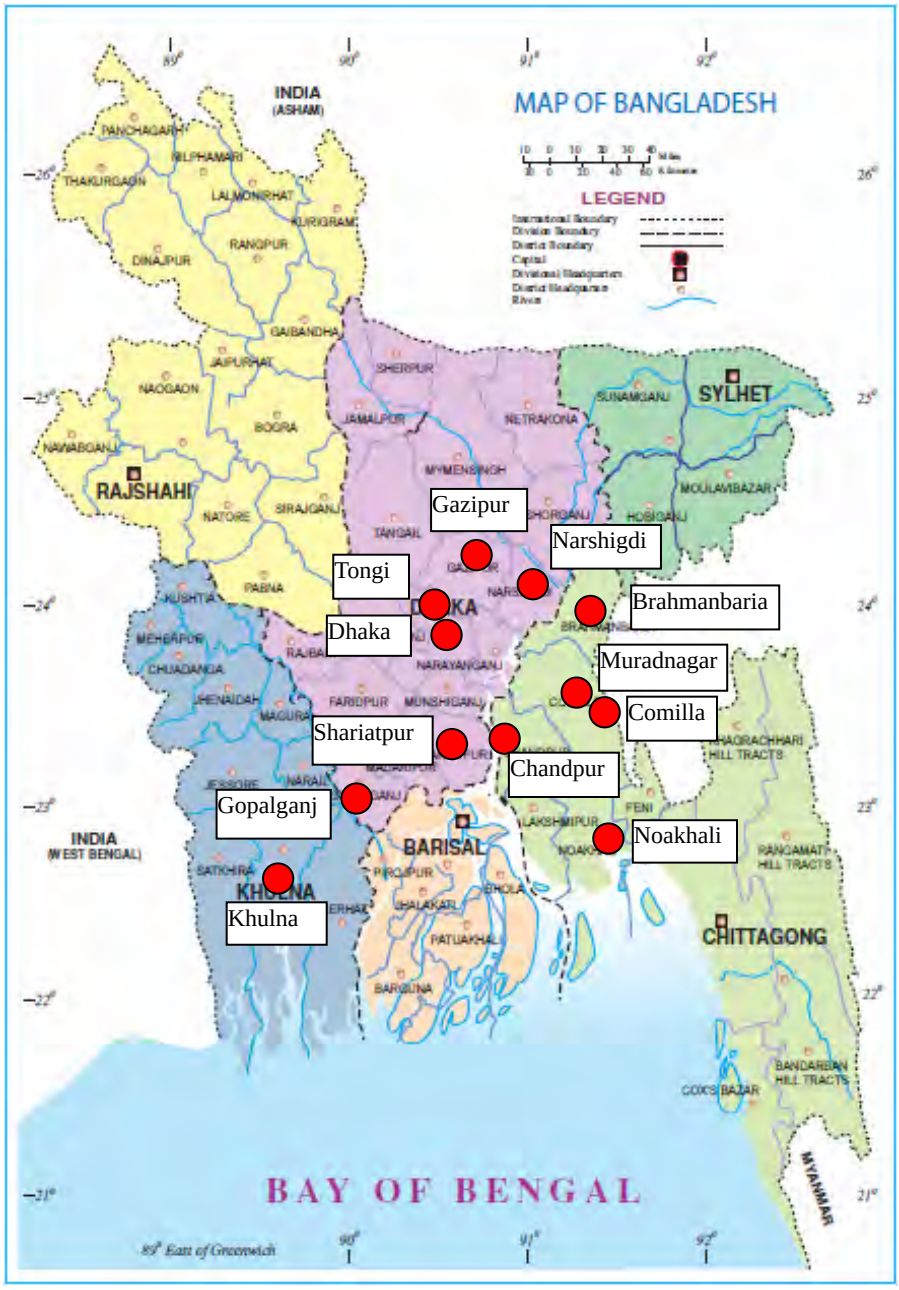


Figure 3.11-1 Target Area for Site Survey

3.12 Current Condition of Water Supply Works according to Specified Area

JST visited 2 WASA's, 8 pourashavas and 4 areas where water works organizations and NGOs' that are supporting offer water supply services. Hearing and site survey in the urban area were conducted regarding organization, management condition, and condition of water source and water supply facility.

The current conditions of Dhaka WASA, Pourashavas, and rural areas are explained as follows:

(1) Dhaka WASA

Current condition of water supply in Dhaka WASA is shown as follows:[3]

1) 24 hours water supply by 546 deep tube wells
2) Water levels of deep tube wells are continuing falling because of excessive pumping of groundwater
3) Production water quantity in a day is 1,849,000m^3/day, and it depends on groundwater for 87% of production
4) Dhaka WASA has 4 water treatment plants and all of them use river water as water source. The quantity of production water from 4 water treatment plants is only 13% of the whole.

Dhaka WASA has a policy for making a sharing rate for groundwater and surface water as water source in the ratio of 50:50 in the future. This policy stipulated that above target rate will be achieved by the end of 2016 by means of extension of existing water treatment plant, constructions of new water treatment plants and transmission of groundwater from adjacent district. This policy is a strategic policy and does not include any specific procedures or timeframe for achievement of the above-mentioned target sharing rate.

The construction work for the expansion of the existing Saidabad water treatment plant with a capacity of 225,000m^3/day has been started in April, 2010. Construction of new water treatment plants are planned with capacities of 500,000m^3/day and 450,000m^3/day. Transmission of groundwater from adjacent district is planned with capacity of 300,000m^3/day. It is planned that the dependence to groundwater will be lowered by 2020. Donors for these 3 plans are not yet determined.
River water from Sitalakhya River is taken into Saidabad water treatment plant for water source. Every year, quality of raw water from Sitalakhya River gets remarkably bad at the dry season. Therefore, it may be difficult to maintain treated water quality good. Hence, it is planned that raw water will be taken from Megna River for planned new water treatment plant and raw water will be led to the plant at Khilkhet. In addition, raw water through transmission from Megna River will be distributed to Saidabad water treatment plant.

And Dhaka WASA has a concept of cleaning plan of 5 contaminated rivers round Dhaka city. In this plan, river water will be led into 5 rivers from Jamua River far away from Dhaka city and flush out waste river water to downstream of rivers. Dhaka WASA is finding donors for this plan.

JST visited 3 out of 4 water treatment plants of Dhaka WASA, which are Saidabad, Godnyle, and Chandnighat water treatment plants. Raw water is taken from Sitalakhya River for both water treatment plants of Saidabad and Godnyle. Raw water for Saidabad water treatment plant is led to intake basin at first and next from intake basin it is pumped out to transmission canal. River water is fed to Saidabad water treatment plant through the canal by gravity flow. Goadnyle water treatment plant is located beside Sitalakhya River and raw water is taken directly from river to the plant through intake pipe. Raw water quality of Goadnyle water treatment plant seemed to be better than water quality of Saidabad water treatment plant. The color of raw water at raw water basin in the plant is green and in Saidabad plant green color is deeper than in Goadnyle plant. This difference in raw water color may because of eutrophication and algae propagation while having passed through the canal. Difference in pH of raw water for these 2 plants is found in water quality analysis records. pH of raw water is 8.2 in Saidabad plant and 7.39 in Goadnyle plant. It is difficult for coagulation reaction to

[3] Based on the booklet" Water Supply & Waste Water Management in Dhaka City", April, 2010

proceed appropriately under raw water condition of high pH such as 8 or higher. Reason of difficulty is that pH of raw water may not reach the suitable value for coagulation reaction by dosing of aluminum sulfate. JST confirmed coagulation treatment condition in flocculation process on site and condition in Goadnyle plant was better than Saidabad plant condition.

Raw water for Chandnighat water treatment plant is taken from Buriganga River and quality of raw water from Buriganga River gets remarkably bad at the dry season every year. pH of raw water from Buriganga River is recorded as 8.1 and ammonia nitrogen of raw water from Buriganga River is remarkable high value as 25mg/l. Ammonia nitrogen of raw water from Sitalakhya River is 9.1mg/l in Saidabad plant and 12mg/l in Goadnyle plant.

O&M condition of the equipment under operation such as lubrication, painting, indoor cleaning and indication meters in 3 visited water treatment plants is maintained in good.

Figures regarding outline of water works in both Tokyo Metropolitan Government Bureau of Waterworks and Dhaka WASA are shown in Table 3.12-1. These two capitals have same served population of water supply as approximately 12,500,000.

Table3.12-1 Figures Regarding Outline of Water Works in Both Capitals of Japan and Bangladesh

Items	Tokyo Metropolitan Government Bureau of Waterworks	Dhaka WASA
Established year	1890	1963
Served population	12,550,000(2009)	12,500,000
Number of Connections	683,000(2009)	280,000+Public standpipes 1,643
Source water	Surface water (98%) Groundwater (2%)	Surface water (13%) Groundwater (87%)
Average water supply quantity in a day (m^3/day)	4.334 million (as of 2008)	1.849 million
Average water quantity in a day per capita (Litter per capita)	345	169
Unaccounted for water (%)	4.5 (as of 2008)	30-35
Network distance (km)	25,823 (as of 2009)	2,664
Emproee/1,000 house connections	0.60	13.60

Source: Website of Tokyo Metropolitan Government Bureau of Waterworks and Dhaka WASA

(2) Pourashava

There are 300 or more Pourashavas in Bangladesh and a lot of visited Pourashavas by JST are proceeded the water supply projects under financial assistance by ADB. Water supply works managements in these Pourashavas are performed in the comparatively good condition.

These ADB projects were started from 2006-10 and main activities in the project are following:

1) Improvement of quality and increase of quantity of water supply

2) Improvement in community awareness linking proper hygiene, sanitation and health

3) Improvement of capacity of Pourashavas to implement, operate, manage, and maintain water supply and sanitation investment

4) Improvement of capacity of DPHE to plan, design, supervises, monitor, and provide technical assistance to local water utilities

ADB prepared the performance criteria for evaluation of performance of Pourashava to progress at the Phase2. According to evaluation result, ADB judged that the project can progress to Phase2 and this evaluation process has good effect for project execution and staffs of Pourashavas. Performance criteria consisted of 13 items.

Many of Pourashavas are using only groundwater as the source of water supply. Several Pourashavas

except one Pourashava which supply water with excess of iron content beyond the water quality standard without removal of iron from the groundwater source, has no iron removal plant. As a result, inside of distribution pipes is clogged with oxidized iron. Seemingly, iron concentration of groundwater tends to rise with lowering of groundwater level.

Water supply time is 7 to 12 hours in a day in an area of Pourashava. Some homes have elevated tanks (Ex.GAZI Tank 500,750,1000L) on the roof to prepare when water supply stop.

According to the cause of lowering of groundwater and aggravation of groundwater quality, it is becoming difficlt that it is dependent on groundwater as source water like former. Therefore, source of water supply tends to be shifted to surface water source.

The contamination of the river water around big cities and Pourashavas is getting worse. The main factors of contamination of river water are as follows:

1) Inflow into the river of untreated industrial waste water which increased with economic growth

2) Inflow into the river of untreated domestic wasted water which increased by population centralization to cities

In a certain pourashava, it is becoming difficult to carry out the water intake of the raw water of good water quality and sufficient amount from near river of Pourashava during the dry season. Depending on the location of river, distance of raw water transmission may be set to 20km or more.

The water-resource potential of water supply in Bangladesh needs to be grasped by survey of location of river and annual change of water level, possible intake water amount, and water quality of river, on the assumption that intake point is river.

Narsingdi is one of Pourashavas which JST visited. Design of conventional water treatment plant which uses surface water as raw water in Narsingdi is planned by ADB and DPHE. In the plan of this project by ADB, water coverage is expanded to 90% from 31% according to increase in the amount of water production. (It is based on results of hearing to the Project Director of DPHE)

O&M conditions of equipment in well facilities and iron removal facility in Pourashavas are good in general. The reasons of good O&M condition of equipment in general are as follows:

1) The facilities are working normally

2) There is no serious damage on the basis of appearance

3) The operation records of equipment are recorded and kept

Only recently water flow meters were installed into the discharge pipe from well pumps and this flow meter is operating normally. By grasping of discharge water quantity from wells, distribution water quantity management came into force.
In Chandpor Pourashava, water treatment plant of conventional rapid sand filter type is working and operation of water treatment facility is conducted normally in general. However, it cannot be said that total management of the water treatment plant including not only facility operation but water quality control, is under appropriate condition. In total management of the water treatment plant, adjustment, control and monitoring of coagulant dosing and periodical examination and monitoring of water quality.

Current outline information of visited Pourashavas is shown in Table 3.12-2; this information is collected by hearings and according to the national census figures. Official figures of population are according to the national census results in 2001. JST collected the figures of population in Pourashavas through hearing because that there is a big difference in the present population and the population of the national census results. Population in the present has been surveyed by each Pourashava according to hearing survey. However methodology of this population survey was not available, population in the present is shown as reference value.

Table3.12-2 Current Outline Information of Visited Pourashavas

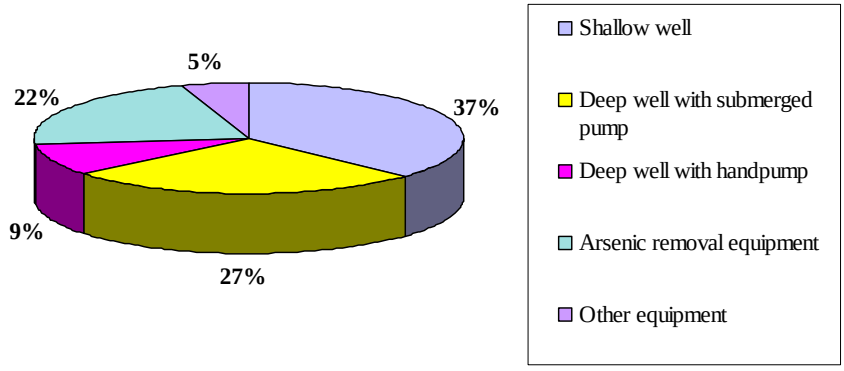
Name of local city (Pourashava)		Population (persons)	Household (house)	(km^2) Area	Served population (persons)	Water supply quantity in a day (m^3/day)	Water source
Narisindgi	Census (2001)	124,204	26,150	9.14		—	—
	Interview Survey(2010)	128,783	—	10.32		2,457	Ground water
Brahmanbaria	Census (2001)	129,278	22,455	17.58		—	—
	Interview Survey(2010)	—	18,026	—		4,320	Ground water
Noakhari	Census (2001)	75,956	13,279	15.88		—	—
	Interview Survey(2010)	197,000	—	17.11		3,720	Ground water
Gajipur	Census (2001)	122,801	26,891	49.32		—	—
	Interview Survey(2010)	310,000	—	48.50	74,270	4,496	Ground water
Tongi	Census (2001)	283,099	67,655	30.06		—	—
	Interview Survey(2010)	650,000	—	32.36		30,600	Ground water
Comilla	Census (2001)	166,519	32,002	11.47		—	—
	Interview Survey(2010)	200,000	—	—		5,500	Ground water
Chandpur	Census (2001)	91,390	17,506	10.59		—	—
	Interview Survey(2010)	250,000	—	9.14	120,000	7,700	Ground water, Surface water
Shariatpur	Census (2001)	41,310	8,321	25.50		—	—
	Interview Survey(2010)	42,000	—	24.70		2,000	Ground water

(3) Rural Area

Water works operation in rural area is conducted by DPHE. DPHE manages technical assistance to NGO, CBO, and each household in rural area through the network of branch offices in each district. General condition of water supply methods are shown as follows and DPHE does not manage directly about water works operation in rural area.

In many rural areas, water supply is mainly conducted by use of the hand pump and water source is groundwater. In some area, water distribution is performed through the network piping and water distribution area through network piping is very restrictive. It was confirmed by JST's site survey that there is trend of lowering groundwater level and high iron content in groundwater. Condition of high iron content was confirmed as brown colored water and contained oxidized iron particles by visual observation of water in a cup of glass. Groundwater with high iron content is used by hand pump without iron removal.

Major use rate of well class and utilized technology to water supply in rural area is shown in Figure3.12-1.



Reference: SDP

Figure 3.12-1 Type of Wells and Treatment Equipment in Rural Areas (2005)

As arsenic contamination situation in rural area, it is required to use uncontaminated groundwater taken from deeper aquifer or surface water. However, where uses of both cannot be applied, arsenic removal equipment is applied.

The current situation in target areas regarding arsenic removal equipment is confirmed by JST as follows:

There are 2 kinds of arsenic removal equipment; these are family use and community use equipment. The community use equipment is managed by NGO or VBO and O&M expense is collected from customers. In Nosherpur village, Hajigonji upazila, Chandpur district, where "READ-F" one of arsenic removal equipment is applied for community use by a private company. This company control water quality with the equipment. CBO collects the expense of 10 taka per month per family, and operate and maintain this equipment under the guidance of the private company. In Muradnagar upazila, Comilla district, where "SIDKO" one of arsenic removal equipment is applied as community use equipment and water supply is carried out by temporal water supply under management by CBO. Water quality of personal water source should be grasped by DPHE. Many personal wells exist in a large area. Hence, it is actual current situation that DPHE conducts water quality examination only when the request of examination of water quality is made.

Figure 3.12-2 "READ-F" (which is one of arsenic removal equipment for community use)

Figure 3-12-3 "SIDKO" (which is one of arsenic removal equipment for community use)

Current conditions of water distribution by network pipings in rural area are mentioned as follows:

In the area where water distribution by network pipings is carried out under assistance by WB, O&M activities of water distribution by network piping in rural area are conducted by NGO and CBO with water tariff collection. In case of the above area, NGO takes part in the planning from beginning in many cases. The plan of the water supply service is carried out as condition for performing collection

of water tariff and NGO undertakes the central roles such as awareness to the customers and system construction. Existing hand pump can be used together with water distribution by network pipings, however, people seem to use mainly iron removal treated water distributed by network pipings because water tariff is fixed. As a result of hearing in a rural area, people use only water distributed by network piping for all in-house works and the volume of their use can be estimated as about 50 to 80 L/person/day.

According to the hearings in some rural areas in Satkila of Gazipur district, people lived in the area where the Government prepared deep well. They explained that this well was constructed because neighboring leaders appealed to DPHE, however, the actual process was uncertain. Such areas can be seen all over the country. Some do not have any water sources near by, and some receive water from remote schools and public facilities for free. It can be not realistic to construct network pipings and wells for each household because people cannot live in some areas permanently. It is necessary to examine water distribution from public wells by DPHE. Also some people use pond water for domestic water and even for drinking water in poverty groups.

As a result of hearing to DPHE, people in the coastal areas use pond water because they cannot use groundwater of which the salinity concentration becomes high by seawater intrusion. In some areas, even the salinity concentration of pond water becomes high because of cyclone.

Other cases of water supply in rural areas are shown in Table 3.12-3.

Table3.12-3 Situation of Water Supply in Rural Areas

Area (data collection method)	Difficulty
Kachua, Chandpur district (site survey)	(A) People use arsenic affected water from shallow wells (arsenic concentration is uncertain) (hearing). (B) Water for irrigation is groundwater from deep wells which is not arsenic affected. Network piping of this water is partially constructed because people do not agree to the tariff collection (water for irrigation is used only during the dry season and users pay for it). (C) Periodical monitoring of water quality is not implemented and there is not any data of each handpump.
Laksam, Debidwar, and Bancharampur in Comilla district (hearing to NGO in Comilla)	(A) Seasonal fluctuation of groundwater level is large and water production during the dry season is small. (B) Groundwater is arsenic polluted. Some people utilize arsenic removal equipment, however, they do not maintain appropriately, such as water quality check and filter change because of low awareness on water quality, difficult maintenance method, high maintenance cost, and so on. (C) Well water is colored (observation survey). (D) Periodical monitoring of water quality is not implemented and there is not any data of each handpump.
Kilpara, Gazipur district (site survey)	(A) Seasonal fluctuation of groundwater level is large and water production during the dry season is small. (B) Well water is colored (observation survey). (C) Periodical monitoring of water quality is not implemented and there is not any data of each handpump.

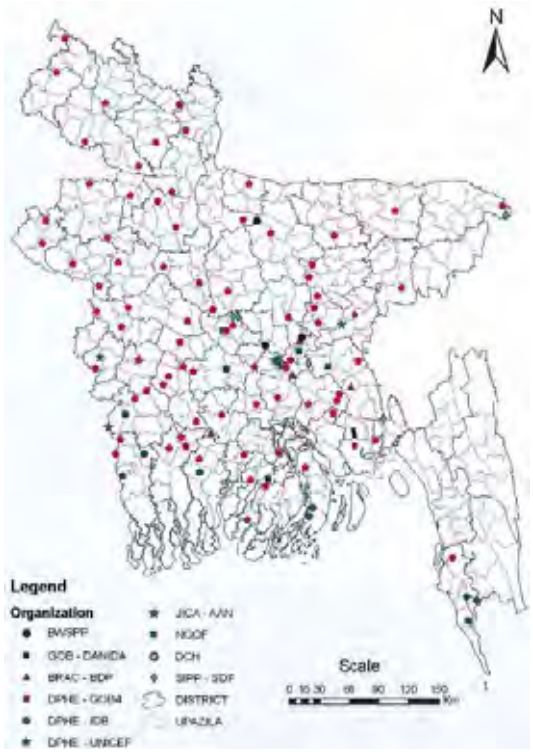
Water source in rural areas can be groundwater as in the past and present because of the technical and economical constraints, although the Government plan indicates the water source conversion to surface water instead of groundwater. SDP shows 40% as the target of water distribution by network piping in rural areas by 2015 and they have a perception as follows:

- Technical and management support of DPHE is necessary because network piping is a new technique. And technical supervision of DPHE is also necessary for several years after construction
- It is required that implementing agency shall be changed to local governments gradually (local

governments shall be main provider of water supply service).

SDP does not show their strong intention to convert the water source to surface water instead of groundwater, however, they precede the construction of network piping with their budget and donor's support. Promotion of network piping makes it possible to unify water sources, which means to unify water quality management. And safe water supply shall be improved by appropriate water quality management at the unified water source although validation and realization of the target value of piping network need to be examined.

DPHE and JICA policy advisor of arsenic pollution prevention implemented the Survey for Evaluation of the Performance of Village Piped Water Supply System in 2008. Among 132 points of network piping constructed by the Bangladeshi Government, donors and NGO, 120 facility were the target facilities of this survey (8 facilities: not started, 4 facilities: under construction). The detail of the target facilities is shown in Figure 3.12-4. The network piping facilities constructed by RDA was out of the scope because they were for both irrigation and drinking water. Among all target facilities, 86 facilities (about 70%) were constructed by DPHE GOB-4[4].



Organization/Project	No.
DPHE GOB-4	86
GOB-DANIDA	3
DPHE-UNICEF	7
SIPP-SDF	4
DPHE-IDB	6
BWSPP(IDA-DPHE)	3
BRAC-BDP	5
NGOF	4
JICA-AAN	1
DCH	1
Total	120

Reference: DPHE & JICA, "Report on Evaluation of the Performance, Village Piped Water Supply System, (120 Scheme)

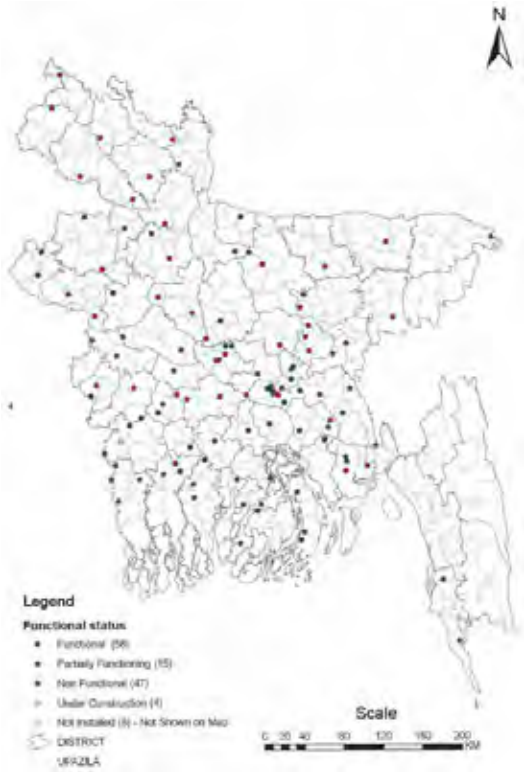
Figure3.12-4 Target Network Piping Facilities for Evaluation in 2008

Figure 3.12-5 shows the operation situation of network piping facility of each organization/project: Several facilities by DPHE GOB-4, DPHE-UNICEF, BRAC-BDP and NGOF are not operated: About 50% of the facilities (42 facilities) by DPHE GOB-4 are not operated. The main reasons of the suspension are inappropriate management, lack of materials for maintenance, inappropriate maintenance, low willing to pay of residents, utilization of other water sources, and so on. In the

[4]Names of Organization/Project mentioned in Figure 3.12-4 are abbreviations and the explanation of each name is as following (From now on, this report uses these abbreviations)."DPHE GOB-4": Project with the fund of the Government of Bangladesh, "GOB-DANIDA": Project of the Government of Bangladesh supported by DANIDA, "DPHE-UNICEF": Project of DPHE supported by UNICEF, "SIPP-SDF": Social Investment Program Project (SDF is the implementation agency), "DPHE-IDB": Project of DPHE supported by IDB, "BWSPP (IDA-DPHE)": Bangladesh Water Supply Program (Support for DPHE by a substructure of WB (IDA), "BRAC-BDP": BRAC Development Programme (by BRAC), NGOF: NGO Forum for Drinking Water Supply and Sanitation, JICA-AAN: Project by JICA and Asia Arsenic Network AA, "DCH": Project by Dhaka Community Hospital

communities where network piping facilities were constructed by DPHE GOB-4, the facilities were regarded as the asset of the Government maintained by the budget of the Government.

Table 3.12-4 shows the comparison of construction conditions by organization/project: Number of the minimum household in SIPP-SDF and BWSPP cases is relatively large because a part of initial cost is supported by implementation agencies (sponsors) and it is necessary to pay back with water tariff during the operation. The ratio of community sharing for initial cost in DPHE GOB-4, DPHE-IDB and BWSP cases is greatly small, however, this ratio in other projects are more than 5%. Management in SIPP-SDF and BWSPP cases is by sponsors and communities, management in BRAC-BDP is by implementation agencies which do not share the initial cost (providers), and management in all other projects are by communities.



Organization /Project	Operating	Partially operating	Suspension	Total
DPHE GOB-4	29	15	42	86
GOB-DANIDA	3			3
DPHE-UNICEF	6		1	7
SIPP-SDF	4			4
DPHE-IDB	6			6
BWSPP(IDA-DPHE)	3			3
BRAC-BDP	4		1	5
NGOF	2		2	4
JICA-AAN	1			1
DCH	1			1
Total				120

Reference: DPHE & JICA, "Report on Evaluation of the Performance, Village Piped Water Supply System, (120 Scheme)

Figure3.12-5 Operation Situation of Target Network Piping Facilities for Evaluation in 2008

Table 3.12-4 Construction Conditions of Target Network Piping Facilities for Evaluation in 2008

	DPHE GOB-4	GOB-DANIDA	DPHE-UNICEF	SIPP-SDF	DPHE-IDB	BWSPP (IDA-DPHE)	BRAC-BDP	NGOF	JICA-AAN	DCH
Selection criteria	at least 1 point in highly arsenic affected district	village with arsenic affected water and insufficient water in the coastal districts	village with highly arsenic affected water	village with highly arsenic affected water	village with arsenic affected water and insufficient water in the coastal districts	lack of safe water, more than 250 households, 70% of villagers agree to the service	village with highly arsenic affected water	village with highly arsenic affected water	village with highly arsenic affected water	village with highly arsenic affected water
Consumption volume (L/person/day)	25	10	8 - 9	20	7	67	30	44	10	8 - 9
Target number of household	130 - 1,685	150 - 300	105 - 590	510 - 1,000	40 - 100	612 - 1,113	200 - 2,000	100 - 200	313	120
Construction cost (taka)	160,000 - 5,947,979	420,000 - 840,984	1,200,000 - 3,100,000	6,588,970 - 8,000,000	379,258 - 462,000	2,201,000 - 11,124,998	754,000 - 4,400,000	300,000 - 380,000	1,400,000	200,000

	DPHE GOB-4	GOB-DANIDA	DPHE-UNICEF	SIPP-SDF	DPHE-IDB	BWSPP (IDA-DPHE)	BRAC-BDP	NGOF	JICA-AAN	DCH
Average ratio of community sharing cost (%)	0.96	5	16.2	5.75	0.4	0	5.4	5	5	20
Management agency	community	community	community	sponsor, community	community	sponsor, community	provider	community	community	community
Number of facility	86	3	7	4	6	3	5	4	1	1

Reference; DPHE & JICA, "Report on Evaluation of the Performance, Village Piped Water Supply System, (120 Scheme)

It seems to be difficult to achieve the target by NWMP related to network piping in rural areas by the domestic budget in Bangladesh. However, successful results can be seen in construction by BWSPP of WB. Based on their various trial and errors to select the target area and to modify the cost sharing ratio, they succeeded to construct 21 facilities and expanded. And person in charge of BWSPP in DPHE has an intention to expand the facility by PPP system. In HYSAWA project by DANIDA, the same methodology as BWSPP is applied for the network piping facility in rural areas. Water distribution by network piping in rural areas has high cost of construction and difficulty in maintenance, however, such unified water source is very important to keep safe water and to protect residents' health. From now on, the expansion of network piping facility by PPP system shall be promoted with donor's support for the appropriate facility arrangement including unified water quality management, which needs expertise and experiences.

(4) Slum Area

The number of slum area is about 4,000 in Dhaka and increasing from the old Dhaka. Water supply method is various in slum areas. As a result of the site survey, it was a common situation that water tariff was included in the house rent and an owner of slum area provides one water supply facility for several households. Some owners provide own wells. The water was pumped up from the aquifer under the colored river basin (Figure 3.12-7). During the dry season, water is supplied by water tank truck because of the low groundwater level. And some owners extended the network piping provided by Dhaka WASA and paid tariff to Dhaka WASA. In this case, owners do not have any financial burdens because they collect house rent (about 2,000 taka/household). However, Dhaka WASA loses the profits because most of this water is Non Revenue Water.

Figure3.12-6 Water from Extended Network Piping of Dhaka WASA

Figure3.12-7 Pumping Water from Aquifer under Polluted River Basin

3.13 Problems on Water Service Facility

Problems on water service facility are different by each facility.

(1) Dhaka WASA

PROBLEM 1: During the dry season, the quality of raw water (river water) is deteriorated and inadequate coagulation-sedimentation blocks the filtering pond and inhabitated filtering produces impurities water.

Dhaka WASA has 4 purification plants; Saidabad plant, Chandnighat plant, Godnile plant and Shonakanda plant. Site survey and hearing were implemented in Saidabad plant, Chandnighat plant and Godnile plant.

Table3.13-1 Operation of Each Purification Plant

	Design Water Volume (m^3/day)	Coagulation Sedimentation Method	River for Water Intake
Saidabad plant	225,000	Pulsator	Shitalakshya River
Chandnighat plant	39,000	Horizontal Sedimentation Pond (baffle plate)	Buriganga River
Godnile plant	45,000	Horizontal Sedimentation Pond	Shitalakshya River

Dhaka WASA has the limit of treatment capacity by the low quality of river water during the dry season. It is necessary to control pH as 7.0 to 7.5. For treatment of high pH raw water (more than 8.0) with Aluminum Sulfate, however, polymer coagulant (Max Flock"T") was simultaneously used as coagulant aid at the site. (A local engineer explained that simultaneous use of coagulant aid was much expensive). pH control with acid is not recommendable for developing countries because careful use of dangerous agents is required such as sulfuric acid. Therefore, in case of raw water with high turbidity and high pH, local workers put the minimum volume of polymer coagulant, and clean the pond properly on the assumption of deteriorating coagulation sedimentation. In Chandnighat plant, coagulant aid is used, but engineers clean the sedimentation pond 3 to 4 times a day in case of the low quality water during the dry season. And they explained that they change filter media (sand) of all the ponds every year because filers were not recovered by their operation as mentioned above.

Figure3.13-1 Receiving Well in Chandnighat Plant

Figure3.13-2 Sedimentation Pond in Chandnighat Plant

Figure3.13-3 Baffle Plate Sedimentation Pond in Chandnighat Plant

PROBLEM 2: There is no pre-treatment facility for the high concentration of Ammonia Nitrogen (NH4-N) of raw water in the dry season

In the dry season, it is necessary to take measures for the high NH4-N concentration (10 to 25 mg/L), however, all purification plants do not have pre-treatment facility. Without pre-treatment of NH4-N, the ratio of chlorine pre-injection would be tremendously high and disinfection byproduct would increase. There is no water quality standard for drinking water at present in Bangladesh, so it should be prepared in the future. Note that pre-treatment facility will be constructed in expanded area of Saidabad plant (under construction with DANIDA support (water quality data is shown in Table 3.3-1).

PROBLEM 3: Maintenance of chlorine dosage needs a special care.

As a result of hearings, local engineers should request professional makers to maintain chlorine dosage because they cannot maintain by themselves and even procure components domestically. Actually maintenance of chlorine dosage needs professional knowledge and experiences because gaseous chlorine is toxic gas. In Japan, engineers cannot operate and maintain such facility without a special license.

This problem is common in developing countries. According to the capacity of the plant and usability of agents, it is possible to use other chlorine agents, such as bleaching powder and sodium hypochlorite, instead of chlorine gas.

Figure3.13-4 Steel Cylinder Bottles of Chlorine in Chandnighat Plant

Figure3.13-5 Chlorine Dosage in Chandnighat Plant

PROBLEM 4: Insufficient power supply leads frequent power outage. Water supply is often suspended by power outage.

85% of water supply is by deep wells and not all deep wells equip generators. Power supply situation in Bangladesh is very poor and power outage happens frequently. Number of water tank for network piping is not sufficient and water supply is suspended from the wells without generators during power outage. Moreover, it is possible that the water in network piping can be polluted by contaminants from outside because the pressure in the pipe becomes low by frequent water-steeling.

(2) Local Cities (Pourashava)

PROBLEM 1: Groundwater level of deep wells becoming lower and lower every year.

Site survey was implemented in Narsingdi, Brahmanbaria, Noakhali, Gajipur, Tongi, Comilla, Chandopur and Shariatpur. Among them, groundwater level continues to lower year by year (1.0 to 1.5 m/year) and the iron concentration tends to increase (1.0 to 7.7 mg/L) in Narsingdi, Brahmanbaria, Noakhali, Gajipur and Tongi. And in Noakali, seawater is intruded (10 to 30 mg/L). It is also affecting the lowering groundwater level that the groundwater is utilized for both water service and irrigation.

PROBLEM 2: Iron concentration in ground water tends to increase in some areas. Iron promotes to block strainer in deep well, but many deep wells do not equip iron removal facility.

Iron concentration tends to increase (1.0 to 7.7 mg/L) in Narsingdi, Brahmanbaria and Noakhali. Iron removal facilities were confirmed only in Noakhali (supported by DANIDA). Iron affects on color of water, and cause blockage in the pipe. These impacts on water quantity and quality lead to low willingness to pay. Regarding conversion of water source, the cost of raw water transmission is very high because of long distance to the river.

Figure3.13-6 Iron Removal Facility in Noakhali (Oxidation Ditch)

Figure3.13-7 Candidate for Water Intake of River in Noakhali (7km from the city central, low volume in the dry season)

PROBLEM 3: Network piping is constructed, but the service area is limited. In many cities, water meter for each household is not installed and water tariff is fixed. Renewal of distributing pipes and installation of water meters are being implemented with ADB support.

There are 5 points to cycle for the sustainable water supply service; (1) Maintain water quality as safe and appropriate, (2) Supply stable water quantity, (3) Installation of water meters, (4) Collection of water tariff according to the use of water and (5) Improvement of water service (water quality, quantity, service area and water tariff). The present water service in Bangladesh is not adequate because they do not satisfy the above 5 points. Points (2), (3) and (4) are being implemented with ADB support.

(3) Rural Areas

PROBLEM 1: Periodical maintenance is not implemented for arsenic removal equipment

Figure3.13-10 Arsenic Removal Equipment for Household of Each Makers

In Bangladesh, only approved arsenic removal equipment is permitted for use. Products of 4 makers; ALCAN, READ-F, SONO and SIDKO, are generally utilized. There are two types of arsenic removal equipment; for community and for household. The equipment for household is relatively popular, but it has a problem of maintenance. For example, under the program of DART (Deployment of Arsenic Removal Technology) more than 1,600 arsenic removal equipments were installed in Bancharampur of Comilla district. A branch office of DPHE explained that filter media was not changed among most of the equipments. Residents seem not to have any information how to change. Even filter media of the equipment in a branch office to DPHE had never been changed since it was installed. It is impossible to monitor several thousands of equipments. It is desirable to install equipments for community as much as possible, and to establish operation and maintenance system by CBO.

And the arsenic removal equipment should be used at deep wells, Pond Sand Filters and in the areas which have no alternative water sources because treatment method for removed arsenic is not established.

PROBLEM 2: Ratio of water distribution by network piping is low. Water is directly used for drinking without iron removal equipment

In rural areas, water distribution by network piping is not popular. People mainly take water from shallow handpump or deep wells. So some people directly drink water which iron concentration is high. High iron concentration in water is not harmful for human health as arsenic, however, it is not safe water and it is desirable to remove iron. One of the solutions is network piping, which matches the development plan of DPHE and is useful. Water tariff (ratio in family budget) should be examined because ability to buy of residents in rural areas is lower than that in city areas.

PROBLEM 3: Maintenance of Pond Sand Filter is not appropriate.

People have no choice but using pond water in the areas where wells are affected by seawater intrusion and any surface water is available nearby. In these areas, Pond Sand Filter (hereinafter referred to as PSF), one of the biological treatment filter systems, is applied and it produces good quality water under appropriate maintenance. However, maintenance burden is relatively large, such as periodical filter cleaning and filter media change, and it is difficult to use sustainably without good operation system. In the site survey, situation of PSF was not observed, but it was found that part of PSF was not working from hearings. General problems of PSF are insufficient volume of pond water during the dry season and limit of treatment of water during the rainy season. Mobile purification system is possibly appropriate for such pond water.

3.14 Problems on Operation and Maintenance in Local Cities and Rural Areas

(1) Local Cities

PROBLEM 1: It is not adequate to comprehend operation and maintenance fee for the facility, such as production and supply volume, production cost per unit water volume, and so on.

Not all purification plants equip flow meters, and installation ratio of water meter is not 100%. In case of fixed water tariff, supply volume and revenue water volume are not found clearly. Therefore it is

impossible to calculate the production cost (cost per unit water production) and the accurate value of non profit water.

PROBLEM 2: Ratio of water tariff collection is low. It is difficult to raise water tariff.

Iron concentration of drinking water standard in Bangladesh is set as 1.0 mg/L. Even though the concentration is lower than the standard level, disinfection by chlorine can produce colored water and iron smell. Water supply hour is about 7 to 8 hours per day and is not sufficient. Such inadequate water quality and insufficient water quantity affects low awareness of consumers to pay for supplied water. This tendency is not strong in Gajipur and Tongi, which are satellite cities of Dhaka, because residents are relatively rich, water quality is good, and severe penalty imposes on unpaid consumers in these areas. In Chandpur, the water quality problem is not serious because 60% of water supply is surface water. As same as Gajipur and Tongi, the operation situation is good. These 3 cities have an intention to change from the fixed water tariff into the metered rate tariff.

Table 3.14-1 shows the site survey result of operation and management situation in local cities. Some production costs were calculated by JST.

Table3.14-1 Site Survey Result of Operation and Management Situation in Local Cities

Local City (Pourashava)	Water tariff (taka/m^3 ,or taka)	Unpaid ratio (%)	Operation cost (taka /month)	Revenue (taka/month)	Water production cost (taka/m^3)	Water supply hour (hr/day)	Number of member (person)
Narsingdi	8 at a metered rate	15-20	300,000	217,000	4.1	7	19
Brahmanbaria	5-6 at a metered rate (under adjustment)	79	300,000	167,000	2.3	8	20
Noakhali	7 at a metered rate	7.65	430,000	—	4.0	12	21
Gazipur	1/2 inch; 140 at a fixed rate for household 1/2 inch: 280 at a fixed rate for commercial use	15	367,000	435,000	1.5	4	14
Tongi	1/2 inch; 20 at a fixed rate for household (60% raised from January 2010)	15	1,125,000	2,217,000	1.3	—	26
Comilla	1/2 inch; 125 at a fixed rate for household 3/4 inch: 300 at a fixed rate for commercial use	20-40	Water tariff covers only operation cost (no revenue)		—	7	16
Chandpur	1/2 inch; 125 at a fixed rate for household 3/4 inch: 400 at a fixed rate for commercial use	20	1,354,000	1,396,000	5.8	20	54
Shariatpur	1/2 inch; 100 at a fixed rate for household	25	165,000	75,000	2.75	9	12

(2) Rural Areas

PROBLEM 1: People use possibly arsenic affected water without any analysis.

Typical unsafe water in Bangladesh is arsenic affected water. The following checks and cares are necessary to use such water:

- Investigation of the arsenic concentration
- Treatment to lower arsenic concentration under the standard level, or Avoidance of water with high arsenic concentration
- Confirmation of treated water or raw water in which the arsenic concentration is under the standard level

Figure3.14-1 Analysis kit made in UK

At present, DPHE does not have any management system on water quality. And it can be said that water quality for private well water in rural areas are not checked. People in rural areas request the owner or the related agency to investigate the arsenic concentration. DPHE should know the water quality situation of each personal well, however, they just respond the requests and investigate for value because of the large number of wells.

Under such circumstances, the present analysis cost is about 50 to 100 taka per 1 sample. This is the one of the reasons that people use arsenic affected water without water quality check. Therefore, it is required to develop the analysis kit that the cost should be less than 10 taka per 1 sample and the handling should be easy. At the same time, people is required to change their mind, such as they should understand the danger to drink the arsenic affected water and the necessity of self defense to confirm whether to drink the arsenic affected water or not.

PROBLEM 2: Most of people do not have willingness to pay water tariff.

Water distribution by network piping has just started. And it can be said that people do not have any idea about water tariff because they use groundwater by handpump. In the area where BWSPP constructed network pipings, BWSPP involves NGO members, especially those who lived in this area, in order that residents understood the necessity of water tariff. On the other hand, half of network piping facilities, which was constructed by the Government budget, are suspended because of the lack of appropriate maintenance. One of the reasons is that residents regarded these facilities as the asset of the Government maintained from the budget of the Government. Another reason is that the service quality is neither adequate nor balanced to water tariff.

As a result of hearings, the average income in rural area is about 5,000 taka and the water tariff is about 100 to 150 taka. If the limit to pay is about 4% of disposable income, the present value is affordable. However, it is still difficult to collect the tariff and the community-based support by NGO is necessary. It is one of the important problems to collect water tariff in order to expand the network piping.

3.15 Problems on Water Resources by Areas

The possibility and the problem of groundwater and surface water development based on the hearing results and collection data of WASAs and Porashavas where JST could visit during field survey are summarized as shown in Table.3.15-1.

(1) Groundwater

1) Water Source of WASA

a) In Dhaka WASA, 83% of water supply depends on groundwater. In the pipeline water supply area,

it is reported that the water level of the dry season is falling to 65m in the second aquifer to the depth of 300m, and the water level decline of 2 to 3 m is advancing for the year by competition of private wells, industrial wells and commercial wells, etc. The groundwater level fall in the water supply area of Dhaka WASA is serious so that it is shown in Figure.3.14-1 some groundwater level monitoring data of BDWB.

Within present water supply area, the development of water resources is difficult, and also it is necessary to conduct the groundwater development in the third aquifer deeper than 200-300m of depth or the development in some exterior areas out of the present water supply area and to examine water conveyance. The development of the third aquifer and the development of external Manikganji District, etc. are planned.

In addition, in the present condition, the water quality of underground water supplies is made good, and does not pose a problem (Refer to Table.3.14-2 water quality data).

b) In Khulna WASA, 99% of water supply depends on groundwater. The water quality of underground water supplies does not pose a problem. Moreover, though influenced by salt water ascension, surface water (river water) is used slightly.

2) Water Source of Pourashava

The underground-water-supplies situation of Porashava by results of hearings is as follows:

a) By competition of the water-for-agricultural-use well, the drawdown of groundwater table is mainly caused in each of the following Porashavas: Tongi, Gazipur, Narsingdi, Brahmanbaria, Noakali, Comilla, and Chandpur Porashavas.

In these Porashavas, the water supply situation by the shortage of amount of water has been tight. In particular, in Tongi and Gajipur, since the increase in population of the Dhaka suburbs is rapid, and the distance of surface water resources is very long, the development of water resources is very serious. In Gazipur, though it is not as Dhaka WASA, the groundwater level falls below sea water leve1, and the fall tendency is explained to go on every year. It is said that Tongi is still more serious.

Moreover, in Narsingdi, the fall of the quantity of yield by superannuation of wells, the clogging of screen by high iron concentration, etc. has been a problem.

The water resources development based on a synthetic plan including surface water development is required. In addition, to develop groundwater resources, it is necessary to perform groundwater development in deeper aquifers, or development of the exterior of the preset water supply area and water conveyance. Table 15.1-1 shows possibility and problem of water resource development of WASA and Porashava, and Table 15.1-2 shows water quality of groundwater (mainly the second aquifer) and surface water.

b) In respect of the water quality of groundwater supplies, arsenic contamination is not reported in the deep wells which reach the second aquifer by Porashavas within field survey.

Rather, iron concentration is high at following Porashava: Narsingdi, Brahmanbaria, Noakali, Comilla, and Chandpur Porashavas. And it is considered as the problem (Table 3.14-2 refers to Noakhli PWSS Data of water quality data, and the hearing result in Pourashava).

Although iron removal equipment is working in Noakali and Chandpur (part) among them, water supply is performed in the state of high concentration in other Porashavas.

Table 3.15-1 Possibility and Problem of Development of Water Supply Resources of WASA and Porashava

WASA/ Pourashava		Dhaka WASA	Khulna WASA	Tongi	Gzipur	Narsingdi	Brahmanbaria	Noakali	Comilla	Candpur	**Shariatpur**	**Gopalganji**
Water Supply Resource		Groundwater 83%、River Water 13%	Groundwater 99%、River Water 1%	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	River Water 60%, groundwater 40%	Groundwater	River Water
Water Supply Facility		Purification facility 4, Production well 546, Pipeline 2,664km	Simple purification facility 1, Production well 54, Hand pump well 9,900	Production well 23, Pipeline 110km, Hand pump well 475	Production well 8, Pipeline 27.9km, Hand pump well 415, Public water tab 10	Production well 8, Pipeline 27.9km	Production well 7, Pipeline 32.3km	Production well 6, Pipeline 102.7km, Iron removal facility (Aeration + Filtration)	Production well 12, Pipeline 32.3km, Partly iron removal facility	Purification facility 3, Partly iron removal facility		Purification facility
Water Supply Quantity		1,961,000m3/ day	95,000m3/ day	30,600m3/ day	4,490m3/ day	2,457m3/ day	4,320m3/ day	3,702m3/ day	5,500m3/ day	7,730m3/ day	2000m3/ day	14,000m3/ day
House Conection		282,691	15,290	8,595	2,385	2,246	2,230	2,151	4,978	5200		
Water Supply Ratio		38%	38%	35%	24%	31%	12%	17%	15%	20%		
Water Quality	Situation	River water; Deteriolate, Contamination, Groundwater; good	River water; High salinity (Feb.-May), Groundwater; good	Good	Good	High iron content	High iron content	High iron content, high salinity	High iron content	High iron content	Good, Arcenic at shallow portion	Good
	Concent-ration	No data	Salinity of river water; max 10,000**ppm**	No data	Water quality data available	Iron; 0.6-1.2 mg/L	Iron; 1.2-5.8 mg/L	Iron; 0.6-3.5mg/L, Clorine; 15-300mg/L, Arcenic; 0,00-0,02mg/L	No data	Iron; 5.0-7.8mg/L (by interveiw)	No data	
Groundwater Level	Dry Season	2nd aquifer; 65m, 3rd aquifer; 35m	No data	73m	21-24m	18-21m	7m	2.5-4.0m	10-12m	8-9m	No data	
	Decline	2-3m/ year	No decline	3m/ year	1.5m/ year	1m/ year	1-1.5m/ year	1m/ year	0.3m/ year	Decline	No decline	
Predicament Situation of Present Water Resources		Remarkable decline of groundwater level, Under regulation of well drilling, Necessity of surface water and groundwater development at outside area	High salinity content (Feb.-May) and increase tendency every year	Remarkable decline of grandwater level, No surface water resources in the vicinity due to high contamination	Decline of grandwater level, No surface water resources in the vicinity due to high contamination	Decline of grandwater level, High iron content, Not available deep groundwater with low yield and iron contamination	Decline of grandwater level, High iron content, Old well facility, Mutual interferance with agricultural wells, Nonpayment of charge owing to bad quality	Decline of grandwater level, High iron content, Contamination of agricultural water by discharge after iron removal	7 hours water supply, 61% water supply ratio, 51% in dry season	4 hours water supply, 57% water supply ratio, Predicament of quantity by population increase		
Needs for Development		Production well at expansion area, 2 new purification facilities, Groundwater development pan in Manikganji	Expansion of purification facilities (Under F/S by JICA)	Securement of surface water resource, Appricationof water harvesting	Securement of water resource, Deep well construction, expansion of pipeline, Water meter installation	Water supply for surface water intake and purification facility	Promotion to ADB 2nd stage project, Installation of Iron removal facilities, Possession of water quality analysis equipment	Extension of pipeline 40km, Water supply by surface water intake from canal and purification facility	Extension of 10 production wells, Surface water intake and construction of purification facilitiy	Extension of 10 production wells and 33km pipeline、2 elevated tanks, Iron removal facility, Extension of purification facility		
Groundwater Development	Possibility	Development of 3rd Aquifer (Depth 300m and more) and groundwater resouces in other District and water conveyance	Withdrawal of deep aquifer, Development of groundwater at outside area and water conveyance	Difficulty of development in vicinity of water supply area due to excessive pumping, Posibility of groundwater development in northern part of District	Difficulty of development in vicinity of water supply area due to excessive pumping, Posibility of groundwater development in northern part of District	Difficulty of development in vicinity of water supply area due to excessive pumping, Posibility of groundwater development in northern part of District	Difficulty of development of water supply area due to low yield, Posibility of groundwater development at vicinity area or in northern part of District	Difficulty of development of water supply area due to low yield, Posibility of groundwater development at vicinity area or in northern part of District	Posibility of groundwater development at vicinity area	Posibility of groundwater development at vicinity area	Posibility of 3rd aquifer development in water supply area or 2nd aquifer dvelopment at vicinity area	Sufficiency by present intake volume
		○	○	▲	▲	▲	△	△	○	○	○	-
	Problem	3rd aquifer development; Under monitoring, Groundwater development at external area; Under negociation with Donar	Necessity of investigation for water resource development	Necessity of investigation for water resource development	Necessity of investigation for water resource development	Necessity of investigation for water resource development	Necessity of investigation for water resource development	Necessity of investigation for water resource development	Situation of decline of groundwater level is not so serious compering oter Pourashavas.	Situation of decline of groundwater level is not so serious compering oter Pourashavas.		
Surface Water Development	Possibility	Under planning of 2 purification facilities	Under F/S of water conveyance from Gopalganji and expansion of pulification facility (100MLD)	Remarkable contamination in sorounding rivers, Decline of water level and contamination in dry season in Sitalakhya river	Remarkable contamination in sorounding rivers, Decline of water level and contamination in dry season in Sitalakhya river	Strong needs for surface water intake, Intake from Megna river within 1km, Aveilable public land use	Possibility of surface water development, Within 3km up to Titas river	Strong needs for surface water intake, Reservoir of canal water within 7km, Aveilable public land use	Needs for surface water intake, Within 1km up to Gumati river, Little river discharge in dry season	Easy surface water development, Dakatia river within water supply area	Very far water resource point	
		▲	○	▲	▲	◎	△	△	△	○	▲	◎
	Problem	Long distance water conveyance from Megna river and Padma river, Under negotiation with Donor	Difficulty of water supply during at least 2months due to going upstream of saline water	Necessity of river purification before river water intake	Necessity of river purification before river water intake	Necessity of Feasibility study including river water level, water quality and sedimentation	Necessity of Feasibility study, Low needs for surface water development	Dry up in dry season	Low discharge in dry season			

Possibility Evaluation; ◎: Highly possible, ○: Possible, △: Slightly difficult, ▲: Difficult

Table 3.15-2 Water Quality of Groundwater (Mainly the Second Aquifer) and Surface Water (River, Reservoir, Drainage Canal Water)

No.	Items	Units	WHO guide line value 1998	Bangladesh Standard (ECR-1997)	BWDB Monitoring Data (Well WQ)				Dhaka WASA Data				Narsingdi PWSS Data						Noakhali PWSS Data	
					Dhaka	Dhka	Dhaka	Gazipur	Chandnigad WTP		Burigonga River Intake Point	Shitalakhya D/S Intake Point	Meghna River (Bank Side)	Meghna River (Middle of Stream)	River (Maghna 1, Haridoa 2)	Pond (2 samples)	Drain (3 samples)	Hand Tube Well (4 samples)	Production Well (PTW-1,3,4,5.6.7)	Production Well (PTW-2)
					Lalbagh GQ2654054	Sabujbagh GQ2650102	Sabujbagh GQ2654054	Gazipur Sadar GQ3386052	Intake Point	Delivery Point										
	Date of test				2000/3/16	2000/3/16	2000/3/16	2000/3/15	2010/4/13	2010/4/13	2010/3/8	2010/3/1	2010/2/10	2010/2/10	2006/5/14	2006/5/14	2006/5/14	2006/5/14	2004	2004
1	pH		6.5 - 8.5	6.5 - 8.5	7.8	6.5	7.8	7.1	8.1	8.1	8.2	8.2	7.6	7.6	7.4-7.6	6.8-7.4	6.8-7.2	6.8-7.2		
2	Turbidity	NTU	5	10					44.6	16.2	32.5	16.2	1.0	1.0	22-23					
3	Color True (Pt Co Unit)	mg/L	15	15					100	20	90	70								
4	Conductivity	µS/cm	-	-					1040	1101	1141	859	261	261.0	360-820	540-840				
5	TDS	mg/L	1000	1000					520	552	571	430	130.3	130.3	216-384	330-482	446-2010	198-780		
6	Total Hardness	mg/L	-	500					190	210	170	280	42	42	20-22		2.9-4.3	30-90		
7	Dissolved Oxygen (DO)	mg/L	-	6.0									6.0	6.0		6.0-6.5				
8	Salinity	$^0/_{00}$	-	-									0.1	0.1						
9	Alkalinity	mg/L	-	400					148	120	160	167								
10	Sodium	mg/L	200	200	3	2.6	3	2												
11	Potassium	mg/L	-	12	1.7	2.8	1.7	3												
12	Calcium	mg/L	-	75	50	50	50	34												
13	Magnesium	mg/L	-	35	8.5	15.6	8.5	11												
14	Chloride	mg/L	250	150-600	4.7	4	4.7	3.2	470	360	450	260	15	15	6-7			20-210	15-20	300
15	Residual Chloride	mg/L	0.6 - 1.0	0.2					-	0.3	-	-								
16	Carbonate	mg/L	-	-	0	0	0	0												
17	BiCarbonate	mg/L	-	-	196	228	196	160												
18	Sulfate, SO4	mg/L	250	400	1.5	1	1.5	0	33.7	38.1	32.7	32.4								
19	Nitrate - N	mg/L	50	10	0.9	0.9	0.9	0.7	0.6	1.7	2	1.9								
20	CarbonDioxide	mg/L	-	-	40	80	40	50												
21	Phosphate	mg/L	-	6					-	-	> 6.5	-								
22	Ammonia -N	mg/L	1.5	0.5					25	4.95	25	9.11								
23	Iron, Fe	mg/L	0.3	0.3-1.0	0.09	0.05	0.09	5	0.598	0.374	0.005	0.275	0.3	0.3	0.3-0.6			0.6-1.2	0.62-1.35	3.52
24	Manganese, Mn	mg/L	0.4	0.1	0.12	0	0.12	0	0.323	0.311	0.481	0.08	0.02	0.02	< 0.01			<0.1-0.1		
25	Arsenic, As	mg/L	0.01	0.05					0	0	0	0	< 0.001	< 0.001				< 0.01-0.02	0.00-0.02	0.011
26	Aluminium, Al	mg/L	0.2	0.2					-	0.131	0	-								
27	Chromium +6	mg/L	0.05	0.05					0.004	0.002	0.004	0.001								
28	Zinc	mg/L	3	5					-	-	0.114	-								
29	Boron	mg/L	0.5		0	0	0	0												
30	Silica	mg/L	-		12	45	12	75												
31	Fluoride	mg/L	1.5	1.0	0	0.1	0	0.35												
32	Total Coliform	N/100m	0	0					-	0	-	-	0	0	0-20			0-3		
33	Fecal Coliform	N/100m	0	0					-	-	-	-	0	0		15-25	120-360			

Remarks; the collection data based on a field survey is arranged.

3) Hydraulic Constant of Aquifer

The results of the trial calculation of the hydraulic constant of the second aquifer of Porashavas from which details data were obtained are shown in Table.3.15-3.

The transmissivity of the aquifer is 717 to 2,117m2/day, and the hydraulic conductivity is 4.15x10-4 to 1.23x10-3 m/sec, and it indicates high capacity of the yield. The pumping duration is 6 to 11 hours, and the average yield are 307-661m^3/day per well.

In addition, in Narsigdi, as described 2)a), the yield capability of production well is falling from the condition at construction (Transmissivity; 1,287m2/day, Hydraulic conductivity; 7.45 x 10-4 m/sec, Yield; 536 m^3/day) to the present condition (Transmissivity; 717 m^2/day, Hydraulic conductivity; 4.15 x 10-4 m/sec, Yield; 307 m^3/day). The O & M work including use of PVC screens, periodical and continuous well washing, re-drilling in case of yield decline and so on is required.

Table 3.15-3 Groundwater Resource of Porashava and Trial Calculation of Hydraulic Constant of Aquifer

Item	Unit	Gazipur	Narsingdi	Brahmanbaria	Noakali
Drilling diameter	"	22	27	28	24 / 12
Well diameter	"	16 / 6	16 / 6	16 / 6	14 / 6
Total Depth	m	80-182	120-140	140-182	245-273
Groundwater level	m	21-24	25-30	7 (average)	2.5 - 4.0
Yield	m^3/day	562 (average)	307 (average)	617 (average)	661 (average)
Pumping duration	hr	11	8	7	6
Drowdown	m	15	10-20	15 (average)	25 (presamption)
Thickness of aquifer	m	20 (presamption)	20 (presamption)	22 (average)	41 (average)
Transmissivity	m^2/day	2117	717	1486	1581
Storage coefficient	-	0.001 (presamption)	0.001 (presamption)	0.001 (presamption)	0.001 (presamption)
Hydraulic conductivity	m/sec	1.23×10^{-3}	4.15×10^{-4}	7.82×10^{-4}	4.46×10^{-4}

4) Arsenic Contamination of Shallow Groundwater Resource

Pollution distribution of shallow aquifer is shown in Section 3.8.3. As alternative water resources of an arsenic contaminated area, the dissemination of the deep wells withdrawal from the second aquifer and also the third aquifer, and public water tap system, and furthermore the measure which prevents the secondary contamination by mixture of shallow groundwater with arsenic pollution and deep groundwater are required.

(2) Surface Water (River water)

1) Use of Surface Water Resource

Water supply using surface water (river water) resource is conducted below.

i) Dhaka WASA (13% of the present water supply, 4 water purification plants) 、
ii) Khluna WASA (1% of the present water supply, 1 simple water purification plant)
iii) Candpur (60% of the present water supply, 1 water purification plant)
iv) Gopalganji (100% of local water supply, 1 water purification plant)

In Dhaka WASA, A plan to conduct intake from Meghna River and Padama River and long-distance water conveyance, and build two water purification plants in the water supply area is considered. In Khluna WASA, F/S (feasibility study) of the extension of water purification plant is carrying out now. Moreover, at Narsingdi, there is a strong request of intake from Meghna river and water purification plant construction because of the fall of a groundwater water level, the fall of quantity of withdrawal groundwater, the low yield of the third aquifer of the deep portion by exploratory wells investigation and so on.

Although the detailed examination of water level, water discharge, water quality at intake place based on detail monitoring including erosion and sedimentation monitoring of the river is required, Since Meghna river and Padama river have enough amount of water and water quality is also comparatively good, in WASA s and Porashavas along those rivers, a possibility that surface water (river water) can be used is high.

Dhaka WASA has basic data for detail examination, and the water level and fluctuation of main rivers are shown in Figure.3.15-1. The difference of water level in the dry season and the rainy season is 5 to 7.5m in Padma River, 3.5 to 5m in Meghna River, and 4.5m in Sitalakhya River (near Dhaka and upper part in 2008). Moreover, the fluctuation of discharge is 53,000 to 89,000m^3/sec in Padma River, 4,000 to 8,200m^3/sec in Meghna River, and 4,000 to 8,200m^3 in Sitalakhya River. (near Dhaka in 2008/ Minimum discharge is not shown.). As shown in Figure 3.15-1, some data of water fluctuation are missed. Periodical data collection by Dhaka WASA is necessary for detail examination.

The water quality data of a river is shown in Table.3.15-2 and Figure.3.15-2. In the river near Dhaka, ammonia, phosphorous and manganese concentration exceed the standard. It is thought that the pollution tendency of urban-areas' rivers is shown. On Sitalakhya River, salt concentration is sometimes high exceeding the standard, and there is a tendency which increases gradually with age. TDS and EC may also exceed the standard temporarily and the tendency for transparency to fall in many years past is accepted. Moreover, iron concentration may exceed the standard temporarily. A temporary increase in iron concentration is accepted also on Padoma River.

2) Surface Water Intake

In the place where is provable of occurrence of erosion or sedimentation, and remarkable change of water level, it is thought possible to excavate a large shaft 10m and more in diameter near river side as an intake facility in which the device to improve permeability to bring easily river water is installed. However, after conducting the detail geological and hydrogeological investigation such as permeability of riverbed sediment and river side formation, and the examination of plan and design at candidate location is required.

(3) Overall Problems in Water Resource Development Plan

1) Water Resource Development Master Plan

The water supply master plan which includes water resources development in 3WASAs is advanced individually. In Pourashavas, they do not have any water supply master plan, and also do not have any schedule to formulate master plan. There are many places which make groundwater as a main water resource in Pourashava, and in many Pourashava(s) water supply situation is getting worse due to groundwater level fall etc.

The development of deep groundwater such as the third aquifer, groundwater resources development of the outside of the present water supply area range or an area besides within the District, and water conveyance from a water resource development area to the local city water supply area is required

Since there is no arrangement of the underlying data of a proposed development site which should be referred to by development project decision and it is not formulated a water resources development plan and a water supply master plan, there is a tendency to become claptrap in the request for donor projects, such as needs for ADB's project, or needs for water supply development/ maintenance in this field survey, etc. As a preceding work stage for formulation of the water supply master plan according to every Pourashava or area, the data arrangement based on basic investigation of the deep groundwater resources of national base, the formulation of the deep groundwater development master plan, the formulation of whole District water supply overall plan including surface water resources development plan are required.

2) Management of Superfluous Pumping and Planless Development of Groundwater

As the greatest cause by which the underground water supplies in Pourashava are getting worse due to a groundwater level fall etc., the superfluous withdrawal by competition of the well for agricultural

use is mentioned. In the larger cities, the excessive withdrawal by competition of the well for industrial or commercial use causes a problem. Although the regulation for construction of deep well is conducted by the license application system by Dhaka WASA, it is not performed by other WASAs and Pourashavas.

The regulation of groundwater withdrawal by the license application system is required. By a well inventory registration system together with a well drilling approved system, A duty of submission of the basic data of the well drilled such as well completion dimension and specification data (total depth, diameter, installation of screen and casing, gravel packing, grouting etc.), and data including lithology, groundwater level, aquifer capability, hydraulic constant, and water quality is imposed, and the recording of well inventory and the input in the database are conducted simultaneously. The formulation of groundwater development plan, the operation and management of groundwater supply facilities, and the future regulation of groundwater withdrawal become easy by the serial input and accumulation of deep well data at the existing database established and advanced by a JICA specialist.

Generation of the secondary contamination, which arsenic contamination blends to deep groundwater, such as the second aquifer, is reported by the defect of well drilling technique and completion specification of the deep well, an approval/ registration system by the technology and capability examination of deep well drilling organization needs to be installed.

Moreover, in water quality analysis, there is also a report that the judgment of arsenic contamination may be avoided by substitution of the sample water of some well drilling company. Concerning the procedure for approval of deep well drilling, for license of drilling company and for registration of completed well, it is thought that establishment of the well drilling management system carried out through the registered well drilling management engineer which received official approval by success of official capability examination, and the management association, which conducts manager's certifying examination and registration, and holds short-term education course of the new technology for manager's cultivation instruction and registration extension is effective. Collection of registration fee and registration renewal charge, and education school income can perform establishment of these new systems, and management and maintenance.

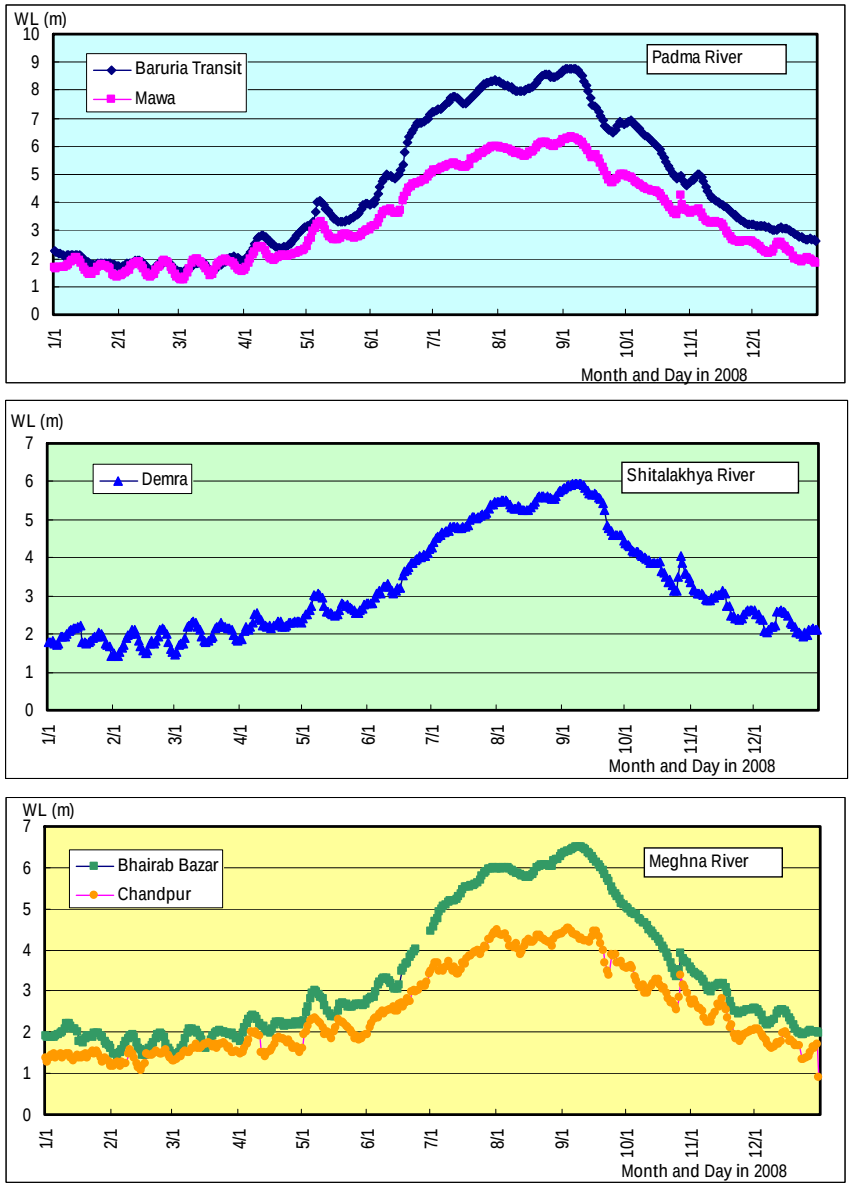


Figure 3.15-1 River Water level and Discharge of Main Rivers in 2008 (Graph display using purchased BWDB monitoring data)

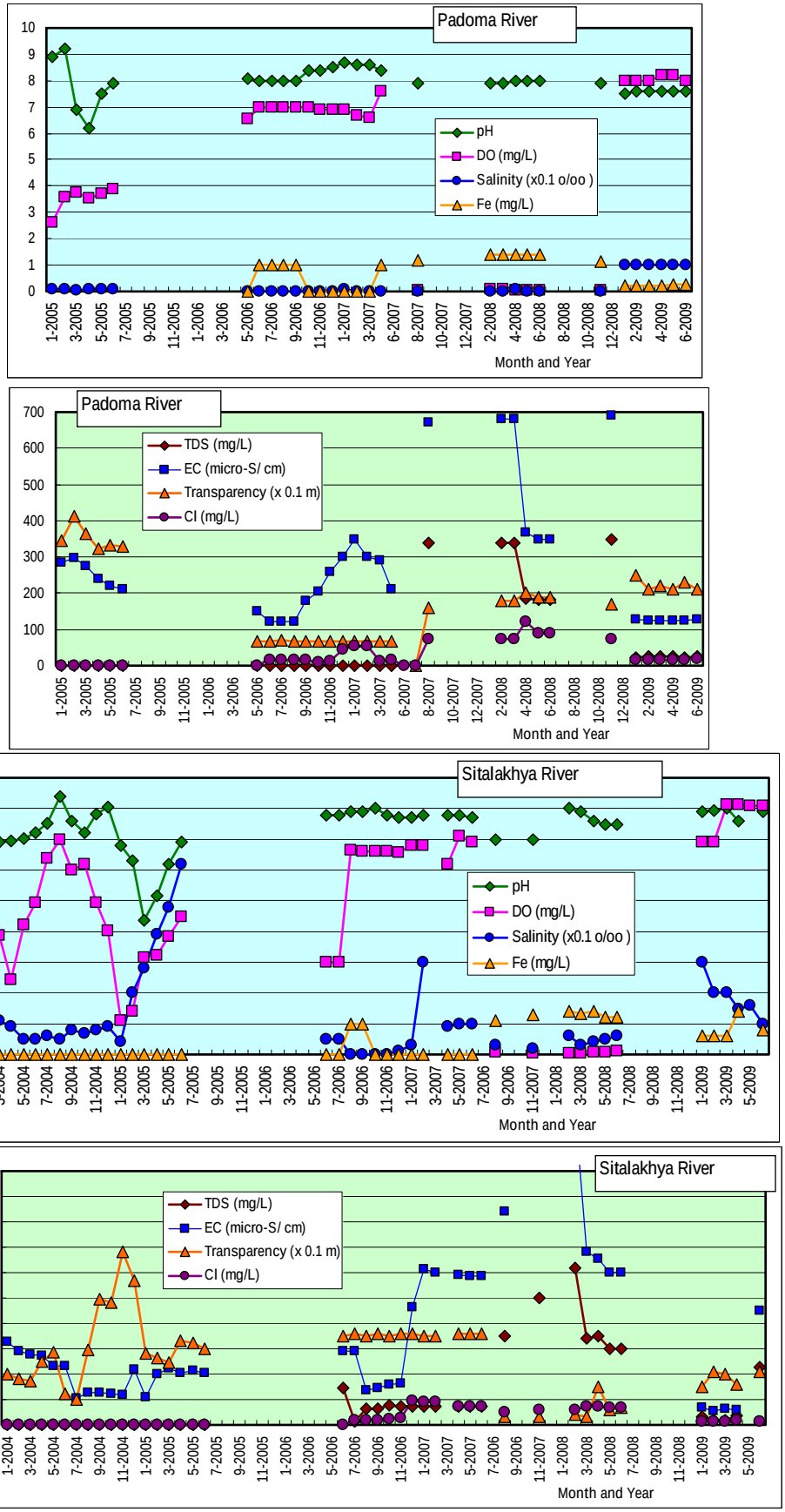


Figure 3.15-2 Water Quality of Main River in 2004 to 2009
(Graph display using purchased BWDB monitoring data)

3.16 Summary of Present Issues on Water Works

As explained above, present issues on water works in Bangladesh can be categorized as following four points:

(1) High level plan and policy

1) Master plan for water works

- Construction of water supply facility for Pourashavas and development of water sources are being mostly impossible according to the increase of demand. In order to realize them efficiently, middle and long term plans should be prepared and projects with the high priority should be started.
- The important point is to identify the future policy and the priority of development, and to make management plans and financial plans systematically based on the priority. Master plan beyond the boundary of administration is one of the options. It is effective to include private-sector vitality utilization plan into Master plan because Bangladesh tries to introduce PPP from now on.
- Therefore, Master plan is expected to be prepared to construct/rehabilitate facilities intentionally.

2) Drilling permission system

- Drilling regulation for deep wells is not established except for Dhaka. Pumping control by drilling permission system for deep wells is not implemented.
- It is reported to expand secondary arsenic pollution by a lack of appropriate technique and facility for deep wells
- Moreover, some people shirk their responsibility by replacing samples secretly. This situation is caused by the present system that construction cost is not paid until attaining the water quality standard and water sample is submitted by a construction company.
- Therefore, it is necessary to review and revise the drilling permission system fundamentally.

3) Drainage control for public waters

- As seen in the river near Dhaka City, regulation for domestic and industrial waste water is not observed although regulations related to environment are prepared.
- Strengthening regulations should be effective to keep good water quality for water works.

(2) Water source, quantity and quality

1) Urban areas

- In the south coastal area, a lot of wells suffer from seawater intrusion constantly. And it is difficult to reserve sustainable water source in dry season because river and pond water suffer from seawater intrusion by cyclones. Therefore, the water source shall be saline surface water.
- The groundwater level is declining every year because people have relied on groundwater for irrigation and living water for a long time.
- In order to convert water source from groundwater to surface water, there are many issues, such as construction, operation and maintenance of new purification facility, increase of O&M cost, and so on. Therefore, it is necessary to construct surface water purification facility, to develop human resources for O&M, and to make effort for the cost reduction of O&M.
- It is difficult to use surface water in Dhaka City, and its surrounding cities and industrialized cities because water pollution progresses by domestic and industrial waste water. For surface water in such areas, water quality improvement is necessary.

2) Rural areas

- Sanitation management is inappropriate in some cases where water source is a reservoir without any purification, such as excretion contamination. In case of PSF in reservoir, water volume is insufficient in the dry season.

(3) Implementation systems, organizations and their ability/capacity in water works sector

1) Urban areas

- Water supply quantity is insufficient because water supply facility construction/rehabilitation does not catch up with the rapid population increase.
- Appropriate income by water tariff collection is not expected because of the fixed price of water tariff and unsatisfactory service (high iron concentration and limited hours of supply). It is required to improve the service quality, to change the tariff collection system (metered rate), to raise public awareness and to collect the tariff efficiently.

2) Rural areas

- Most of people in rural areas use handpump well and/or small reservoir. Water supply by network piping is not developed very much because of lack of power supply. However, water supply by network piping is one of the most effective methods for sustainable supply of safe and sanitary water. For areas where people use small reservoir, simple suspended solid removal device shall be effective.
- Concerning water supply facilities, NGOs implement community-based activities and support CBOs from the very beginning stage to operate and maintain the facilities, and to collect water tariff. Continuously, this cooperation between CBO and NGO for water works is necessary.
- Some people still use arsenic affected water as drinking water without any check and treatment. They seem to lack of awareness for the arsenic effect on human health. One of the reasons that people use arsenic affected water directly is the high price of water analysis (50 to 100 taka by simple analysis kit, 100 to 400 taka by professional analysis institution). Therefore, it is required to develop more affordable analysis kit for people in rural areas.

(4) Public awareness

- In both urban and rural areas, it is an issue that residents have low awareness to pay for supplied water. This issue is caused not only by resident side, but also by supplier side because of inappropriate service (limited service time, quality, etc.) and lack of activity for raising public awareness. In rural areas, it is clear that residents have low awareness for water quality because they use arsenic affected water.

3.17 Review of Preliminary Project Plans

In Preparatory Work in Japan, preliminary project plans were elaborated without any information of needs and water works situation in Bangladesh mainly from the viewpoint as how to apply Japanese technology (See Section 2.3). Here, JST summarized the needs of Bangladeshi side, and current situation and issues revealed in the site survey as Table 3.17-1. Then Preliminary Project Plans were reviewed and selected 16 Preliminary Project Plans by JST as shown in Table 3.17-2.

Table 3.17-1 List of Each Target Area's Situation

City/District		WASA/District		Issue							Countermeasure										Note
		Porashava	Union /Village	Seawater intrusion	Arsenic	Others	Decline of groundwater level	Low coverage ratio	O&M	Slum	M/P	Development of groundwater	Development of surface water	WTP	Distributed WTP	Network Piping	Simple treatment	Sanitation facility	CD	Public awareness	
Dhaka	Dhaka	DWASA				○	○						○		○				○		
		DCC								○							○	○		○	
	Gazipur	Gazipur						○					○								
			Sripur													○		○			
	Munshiganji		Keranjganji																		Success example of PPP
	Narsingdy	Narsingdy		○		○	○						○								
	Shariatupur	Shariatupur		○									○								
Chittagong	Bramanbaria	Bramanbaria			○							○	○			○				○	
	Chandpur	Chandpur		○	○						○	○	○							○	
			Kachua		○						○	○				○				○	
	Noakhali	Noakhali		○							○		○								
	Comilla	Comilla			○						○	○	○							○	
			Barua		○						○	○				○				○	
Khulun	Khuluna	KWASA				○			○				○	○					○		

Table 3.17-2 List of Project Plan

Project plan name (tentative)			Outline	Related Preliminary Project Plan No.
Urban Area	1	Project for construction and maintenance of middle-sized water supply facility in Dhaka	・ Plan and construction of water works facility (purification plant, distribution pond, network piping, door-to-door water supply) ・ Capacity development of operation and maintenance ・ Filtration device without filter media change	3-1
	2	Project for purification of water quality in canal in Noakhali	・ Purification agent ・ Purification blocks	
	3	Pilot project of filter treatment for saline water with natural energy utilization in coastal areas	・ Experiment of filter treatment ・ Performance confirmation of temporal use of RO filter ・ Establishment of RO filter operation and maintenance system ・ Reservation of spare parts supply route ・ Utilization of natural energy (solar and wind power)	3-4, 3-5, 6
	4	Project for surface water supply in local cities in the service areas of Dhaka and Chittagon	・ Plan and construction of water source facility (surface water) ・ Plan and construction of water works facility (purification plant, distribution pond, network piping, door-to-door water supply) ・ Capacity development of operation and maintenance ・ Filtration device without filter media change	2, 3-5, 4-2
	5	Project of surface water development and water supply in cities in Gazipur and Tongi	・ Establishment and operation of regional association ・ Plan and construction of water source facility (surface water) ・ Plan and construction of water works facility (purification plant, distribution pond, network piping, door-to-door water supply) ・ Capacity development of operation and maintenance	2, 3-5, 4-2
	6	Project of expansion and rehabilitation of facilities for surface water utilization in Chandpur	・ Plan and construction of water source facility (surface water) ・ Plan and construction of water works facility (purification plant, distribution pond, network piping, door-to-door water supply) ・ Capacity strengthening of operation and maintenance ・ Filtration device without filter media change	2, 3-5, 4-2
	7	Project of expansion of surface water utilization in Shariatpur	・ Plan and construction of water source facility (groundwater) ・ Plan and construction of water works facility (distribution pond, network piping, door-to-door water supply) ・ Capacity development of operation and maintenance	4-2

Project plan name (tentative)			Outline	Related Preliminary Project Plan No.
Rural Area	8	Project for groundwater supply for drinking and irrigation in arsenic affected areas	・ Installation of public water faucet ・ Connection of door-to-door water supply ・ Raising public awareness ・ Construction of water works facility (tank for drinking and irrigation, network piping)	3-6
	9	Project for rural water supply with PPP system (volume 1*[1])	・ Plan and construction of water source facility (groundwater) ・ Plan and construction of water works facility (distribution pond, network piping, door-to-door water supply) ・ Capacity development of operation and maintenance	3-6
	10	Project for rural water supply with PPP system (volume2*[2])	・ Plan and construction of water source facility (groundwater) ・ Plan and construction of water works facility (distribution pond, network piping, door-to-door water supply) ・ Capacity development of operation and maintenance	3-6
	11	Project for safe water supply in areas without water supply service	・ Purification of reservoir ・ Water supply by mobile treatment device and its dissemination ・ Coagulant for simple treatment + mobile treatment device	3-8
Master Plan	12	Project for Master Plans for water supply in districts	・ Survey for social and economic condition ・ Survey for natural condition ・ Survey of actual situation of water supply facility ・ Survey for water utilization ・ Survey for water source potentials ・ Demand estimation ・ Master Plan for water supply, etc.	4-1
	13	Project for establishment of management system for well list and drilling permission in Bangladesh	・ Introduction of drilling permission system (registration tax) ・ Obligation to submit drilling well list (formatted record) ・ Preparation of well list management manual and establishment of registration for list management experts ・ Establishment of license system for drilling techniques and management (registration tax, interview for extension) ・ Establishment of punishment system for contractor and owner without permission ・ Preparation of well list database	4-2
	14	Project for survey to strengthen regulation on industrial waste water	・ Establishment of control system to regulate industrial waste water	6

Project plan name (tentative)			Outline	Related Preliminary Project Plan No.
Research	15	Project of development support of water quality analysis kit for arsenic pollution prevention	・ Implementation of pilot projects for development and dissemination of simple field analysis kit ・ Utilization of technologies developed in the arsenic pollution prevention program ・ Raising public awareness	6
	16	Project of development support of arsenic removal methodology	・ Cooperation development of removed arsenic with Bangladesh (makers of removal devices)	6

Note: As for Related Preliminary Project Plan No., reference shall be made to Table 2.3-1.
*1: Ratio for initial cost sharing by private sector: 50%
*2: Ratio for initial cost sharing by private sector: 50%

CHAPTER 4 ACTIVITIES OF PRIVATE COMPANIES AND NGOS

4.1 Legal Framework on Activities of Private Companies and NGOs

The followings are major regulations to be followed by the private companies and NGOs in Bangladesh:

4.1.1 Private Companies

In Bangladesh, several regulations are set for private companies, such as trade control regulations, custom system, foreign exchange control system, regulations on foreign capital, incentives in foreign capital, tax system, employment of local staff, procedures for incorporation of foreign companies and so on. For details, reference shall be made to homepage of Japan External Trade Organization (JETRO) as http://www.jetro.go.jp/ pwrld/asia/bd/ and other pages.

4.1.2 NGOs

In Bangladesh, there is a system of registration for NGOs, depending on their field of activities as shown in Table 4.1-1.

Table 4.1-1 Registration Agency, Regulations and Type of NGOs

Registration Agency	Regulations	Type of NGOs
Department of Social Welfare, Ministry of Social Welfare	Voluntary Social Welfare Organizations (Registration and Regulation) Ordinance 1961	Nonprofit, voluntary organizations
Registrar of Joint Stock Company, Ministry of Commerce.	The Societies Registration Act 1860 or the Companies Act 1994	Nonprofit, voluntary organizations Nonprofit companies
NGO Affairs Bureau, Prime Minister's Office	The Foreign Donations (Voluntary Activities) Regulation Rules, 1978 The Foreign Donations (Voluntary Activities) Regulation Ordinance, 1978	NGOs receiving or operating foreign donation
Department of Women's affairs, Ministry of Women Children Affairs.	By- Laws of the Division	NGOs working with women's development and run exclusively by women as members of the executive board and the general body
Directorate of Registration, Ministry of Law, Justice and Parliamentary Affairs.	The Trustees Act 1882	Organization ready to donate properties and resources of its own for social work

Most of local NGOs are registered with the Department of Social Welfare. First, organization name is checked to avoid duplication of the registered name. After that, information like the objectives, address, work area, work plan, finances, founder members, and bank accounts is asked for the registration. Department of Social Welfare reported that the number of registered NGOs was 50,997 as of July 2009, of which 23,280 NGOs did not carry out any activities even though they received assistance from the government.

NGOs receiving or operating on any foreign donation shall register with NGO Affairs Bureau (NGOAB) based on the following regulations:

- 「The Foreign Donations (Voluntary Activities) Regulation Rules, 1978」
- 「The Foreign Donations (Voluntary Activities) Regulation Ordinance, 1978」

Registration fee should be paid. The fee is 10,000 taka for Bangladeshi NGOs and 1,500 US$ for the International NGOs. Received foreign donation is reported to Bangladesh Bank and NGOAB via banks in which the registered NGOs have accounts. Those staffs, who are not Bangladeshi nationals, and are engaged in voluntary activities, shall submit their particulars such as nationality, period of stay and supervisory agency, etc. to NGOAB.

There are 2,506 registered NGOs (2,278 local NGOs and 228 international NGOs) as of March 2010. The number of approved projects is 861 and the amount of donation on commitment basis is 611 million US$[1]. There are 17 registered Japanese NGOs including Asian Arsenic Network, AMDA, OISCA and Shapla Neer.

When Foreign NGOs assist NGOs in Bangladesh, the NGOs receiving donations shall be registered with NGOBA. The foreign NGOs shall submit the project proposal and implementation plan to NGOAB for obtaining approval.

The registered NGOs shall submit accounting report in every six months (July-December and January-June). The registered NGOs are obliged to be biannually audited in line with the provisions of "Bangladesh Chartered Accountants Order, 1973", and to submit the audited accounting report to NGOAB.

4.2 Constraints on Activities of Private Companies and NGOs

4.2.1 Private Companies

(1) Japanese-affiliated private companies in Bangladesh

According to the results of the Survey[2] by JETRO, the following points are raised as issues of business management in Bangladesh:

- Difficulties of on-site financing (no Japanese bank, frequent delay of L/C settlement by banks including foreign banks)
- No consistency in standards like tax rate applied, duty item numbers and assessment percentage
- No appropriate and transparent operation of deemed taxation to investing companies
- Complication, delay and no transparency of custom clearance procedures
- Lack of electricity
- Difficulties in local procurement of materials and parts (excluding textile industry)
- Increase in wages of labors
- Insufficient development of infrastructures and instability of political and social situation

This survey result also reports that Japanese-affiliated private companies regard India, China and Bangladesh as hopeful new markets although they have the issues mentioned above.

(2) Private companies related to water sector in Japan

In addition, the following matters are raised as constraints on investment in water business in Bangladesh in a hearing from Japanese companies:

- It is very difficult to establish O & M systems which enable them to continuously use facilities and equipment introduced.
- There are limited information on the existence of local partners and their capability.
- Export control rules could be an entry barrier for some manufacturers which products fall

[1] source: statistics of NGOAB

[2] Survey on Actual Conditions of Business Activities by Japanese-affiliated Firms in Asia and Oceania, JETRO, March 2010

into controlled items.

- Considering management contract, business cannot be realized if customers do not pay for bills.
- Quality control of raw water is very difficult because quality of water sources is not good and the quality could vary seasonally.

As for establishment of O & M systems, physical development is included in the scope of foreign assistance under the traditional cooperation scheme, while O & M is responsibility of the recipient countries. However, inclusion of O & M for a certain period in the scope of foreign assistance makes it possible to establish O & M systems for the facilities and equipment introduced, and contributes to fosterage of local business partners in Bangladesh.

4.2.2 NGO

Under the PPP scheme applied for water supply services in Bangladesh, service providers like NGOs bear a part of initial investment cost and recoup the investment cost from charge collection. If they do not have enough money for the investment, they need to seek loan from a bank. However, a local NGO pointed out that it is not easy for NGOs to get loans from banks because of low valuation to profitability of water supply services. Entry into businesses that require high rate of initial investment cost is not easy for the bodies that have insufficient financial sources and difficulties in getting loans from financial institutions. In addition, it is also very difficult to achieve successful outcome of the business in rural area unless the service providers earn residents' trust. It might be possible for NGOs to fall into difficulties in the business operation itself because organizing villagers and consensus building through participatory method takes time and no payment is usually made during the period of the survey. Therefore, promotion of NGOs' entry into PPP projects of water supply sector requires measures such as allowing advance payment, setting relatively high rate of advance payment, letting down the rate of initial investment cost for service providers in proportion to conditions at site and technical level, and flexibility in operating payment conditions.

With regard to Japanese NGOs, it can be assumed that there are some NGOs that do not show positive intent to enter into activities that recoup investment cost from charge collection, like PPP scheme of water supply sector, because that does not conform to their vision as non-profitable organization. In addition, as described in the section on legal framework, NGOs receiving foreign donations and carrying out voluntary activities in Bangladesh are obliged to register with NGOAB. In registration, it is required to pay registration fee and establish a local office. That cost could be one of the constraints for Japanese NGOs. Payment of project cost would not be appropriately made, owing to problems of governance and capacity of the government. It also might interfere with scheduled progress of projects. It can be inferred that entry into project in which project fund is paid through government agencies is difficult for NGOs that do not have sufficient financial sources.

4.3 Regulatory Framework of Public-Private Partnership (PPP) in Bangladesh

The regulatory framework of PPP in Bangladesh is presented in Table 4.5-1. The target of these frameworks includes NGOs.

Table 4.3-1 Framework of Bangladesh PPP

Framework	Responsible	Year	Summary
Private Sector Power Generation Policy	MPEMR	1996	Introduction of IPP through BOO
Infrastructure Development Company Limited (IDCOL)	ERD	1997	Institution to finance PPP project to promote private sector involvement (established by WB support and funded by donors)
Investment Facilitation Center (IIFC)	ERD	1997	Institution to provide expert to relevant government organizations regarding project

Framework	Responsible	Year	Summary
			formulation, project design, technical support (established by WB support)
Private Sector Infrastructure Guidelines (PSIG)	Cabinet	2004	Definition of Infrastructure PPP, framework, implementation procedures
Investment Promotion and Financing Facilities (IPFF)	Central Bank	2007	5 year term institution to promote and finance (established by WB support)

Source：Invigorating Investment Initiative through PPP, MoF, June 2009

On the other hand, the Government of Bangladesh proposes the following sectors as promoted infrastructure development by PPP.

(1) Electricity and energy, (2) Transportation, (3) Drinking water and sewage, (4) IT, (5) Air transportation and sightseeing, (6) Industry, (7) Education and research, (8) Human health, (8) Housing, etc.

Especially the sector of electricity and energy is the highest priority sector and has many achievements. The sector of drinking water (water supply) of this sector has small achievements.

4.4 Water Sector PPP Projects in Bangladesh

There exist only some PPP projects of water sector in Bangladesh.

- Water treatment plant and industrial drainage treatment plant in EPZ: Bangladeshi private companies operate through BOO (JST confirmed 5 sites)..
- BWSPP by WB: Bangladesh NGOs and other agencies operate in 21 areas through BOO(started from 2004).

Table 4.6-1 shows the comparison of network piping projects in rural areas in Bangladesh under PPP schemes of Social Investment Program Project (SIPP, started from 2003) and BWSPP (revision of SIPP project). SIPP by SDF is a pilot project that the implementing agency shared a part of the initial investment and operated after the construction.

Table 4.4-1 Comparison of Network Piping Projects in Rural Areas

	Network piping project under PPP scheme		
	Bangladesh Water Supply Program Project (BWSPP)		Social Investment Program Project (SIPP)
Responsible agency	DPHE		SDF
Donor	WB		WB
Implementing agency	NGO (HFSKS, etc.) Private owners		NGO (Brotee, Buro Tangail, GK, HFSKS, MACCA and Mothers' Society)
Number of projects	21		6
Water supply method	Network piping (groundwater)		Network piping (groundwater and surface water)
Investment ratio	<Beginning> Government: 50% Implementing agency: 40% Residents: 10%	<Present> Government: 70% Implementing agency: 20% Residents: 10%	Government: 50% Implementing agency: 40% Residents: 10%
Payment method	Government pays back to the implementing agency after the completion of construction		Government pays back to the implementing agency by the installment payment according to the bench mark
Water tariff	Collection (different according to the pipe size and household type)		Collection (different according to the number of household member)
Operation	Implementing agency (about 15 years after the construction)		Implementing agency (about 15 years after the construction)

Problem	・ Number of connections cannot be increased so much because some households who do not connect the pipe borrow from the connected water pipe. ・ The investment ratio of the implementing agency should be set carefully because the implementation agency should be responsible for all cost at the beginning of the service. ・ The service shall be suspended if the water tariff cannot be collected.	・ In some cases, the financial situation is severe because the implementing agencies share 60%. ・ The payment method should be examined because the conditions are different between groundwater and surface water. ・ The service shall be suspended if the water tariff cannot be collected.

Note: Investment ratio is the value to the water supply service, which includes all cost for the initial facility construction.

In the case of BWSPP, the investment ratio of the implementing agency was set as 40%, but it was decreased as 20% because the number of connection was not increased. BWSPP applies the proposal system by community- based NGO, so plan making and consensus building are possible to be reflected to the community needs. At first, WB had planned 300 sites for BWSPP, however, it decreased as 21 sites. From a result of hearing from Project Manager of BWSPP in DPHE, the progress of BWSPP is as follows:

> SIPP required the sponsor and CBO to bear the initial investment cost up to 50%. Due to this initial heavy cost, only 6 areas have started whereas 300 areas were expected. Based on this lesson learned, the initial bearing cost of sponsor and CBO was reduced as 30% in BWSPP. As a result, 21 areas undertook the business under this scheme (JST visited Kerajigonji and confirmed the smooth and sustainable implementation of the project.) Project Manager of BWSPP in DPHE has an intention to expand to 300 more areas in near future.

At the time of hearing from Project manager of BWSPP in DPHE by JST, the progress evaluation mission of WB was not implemented. So it is not sure that WB will apply the above intention or not.

"Dhaka Water Supply and Sanitation Project", ADB project to support Dhaka WASA that started in December 2007, envisaged a scheme of O&M management contract with private sector as a pilot project by selecting one zone of Dhaka WASA jurisdiction area. However, according to the project director of Dhaka WASA, the scheme has been suspended because of strong opposition of the union fearing the unemployment. The same things occurred in Dhaka City Corporation. Therefore, this PPP Project is suspended and the review is started.

Additionally, there are other water supply projects in rural areas with donor's support. HYSAWA by DANIDA implements a water supply project in the north-west areas and south coastal areas through a local NGO which has a nationwide network. In HYSAWA projects, community shares 20% of the investment cost for the construction of water supply points, and operates the facility. The project is implemented on the basis of unions (governmental body) and NGO supports both unions and communities. Regarding the network piping, Request for Expressions of Interest was announced on a newspaper in April 2010. The explanation shows the cost sharing with private sector, collection of the cost through the operation, and other conditions similar to BWSPP.

And the Government of the Netherland implements "Water, Sanitation and Hygiene (WASH) Programme" for 150 villages through BRAC, which is a local NGO. Regarding the water supply projects, the target areas are 35 villages and community should share 5% of construction cost. On the contrast of HYSAWA by DANIDA, the WASH projects are implemented on the basis of NGO for raising public awareness, establishment of implementation committee and guidance of operation. Operation of the facility is implemented by the community committee and technically supported by the engineers of NGO's local office. Regarding the network piping in rural areas, a person in charge of WASH programme indicates that the O & M after the programme shall be a problem in case of the operation by the community committee.

4.5 Water Business of Bangladeshi Private Companies

The hearings and site survey by JST revealed that Bangladeshi private companies have been dealing with wide range of water business such as sale of simple coagulants, sale of PET-bottled drinking water, drinking water treatment and supply in the rural area, industrial water treatment and supply in the EPZ, and sale of arsenic removal device.

(1) Sale of PET-bottled Drinking Water

- JST confirmed that about 35 companies were dealing with this PET-bottle water selling business.
- The price was around 13 taka/liter although the price was various among manufactures.

(2) Industrial Water Treatment and Supply in the EPZ

- At least 2 Bangladesh companies were dealing with the business.
- The company constructed and operated the plant with capacity of 600m^3/hour in the Chittagon EPZ.
- The water price was around 20taka/m^3.

JST visited 3 Bangladeshi companies and conducted hearings to the top management in order to judge whether the companies are capable for the O&M of water treatment plant from the managerial and technical view point in case of cooperation with Japanese companies. D-Water TEC Ltd and FACILITIES CONCERN have already had connections with Japanese companies. These Japanese companies introduced these 2 companies and Dhaka WASA introduced Sigma Pumps Ltd to JST (See the company summary in Table 4.3-1). Actually 2 companies among 3 are doing or will do water business in the EPZ.

Table 4.5-1 List of Hearing from Bangladeshi Private Companies

Company Name	D-Water TEC Ltd	FACILITIES CONCERN	Sigma Pumps Ltd
Foundation	1994	1985	1998
Business Activities	1. Development and sale of water-purification device for domestic and industrial use 2. Engineering for treatment plant of water, sewerage and industrial waste water 3. O&M of the above facilities	Facility planning/designing/construction	1. Drilling of deep well 2. Designing and construction of treatment plant of water, sewerage and industrial waste water 3. O&M of water treatment plant
No. of Employee	410（including part-time） among them, 30 are engineers	65 among them, 45 are engineers	250 among them, 35 are engineers
Business Experiences	1. Awarded BOO contract for groundwater treatment plant in Chittagon EPZ 2.Awarded BOO contract for waste water treatment plant in Dhaka EPZ 3. Development and sale of high level water-purification device to private companies 4. Marketing and sale of simple coagulants manufactured	1. A lot of partnership experiences with foreign companies in implementation of projects 2. Owing the import license for machinery and equipment enables smooth procurement of foreign made parts when necessary. 3. Experiences of training and supervising operators after the hand-over of water treatment plant	1. A lot of partnership experiences with foreign companies (from Germany, US, Netherlands, Taiwan and India since 1996) 2. Currently 2nd year of O&M business of water treatment plant in Karnaphuli (purification and distribution of groundwater) 3. Awarded BOO contract for water treatment plant in Comilla EPZ (expected to start in November 2010) (purification and distribution of groundwater) 4. Awarded BOO contract for water treatment plant in Adamjii EPZ (purification and

			distribution of groundwater) 5. Awarded contract for construction of surface water treatment plant in Barisal city (traditional rapid filtration system (1,150m^3/hr), designed by DPHE with the Government budget) 6. A lot of well drilling experiences for private companies

In the EPZ, there are factories of various sectors. Particularly the factories such as dying and chemical-related require high level of water quality for manufacturing use. In response to this, some EPZ (Chittagon, Kurnaphulli, Adamjii and Commila) decided to construct its own groundwater treatment plant and supply directly to factories. As shown in Table 4.3-1, D-Water TEC Ltd and Sigma Pumps Ltd were already awarded 30 years BOO contract for O & M of the water treatment plants. On the other hand, FACILITIES CONCERN has a big concern to such markets in consideration of their experiences as shown in Table 4.3-1. The companies have only few years of experiences that also not for water treatment business in the EPZ; however all top management has a strong will to expand their business in this sector as well as PWSS for local cities based on their technical and financial capability.

The companies' O&M experiences are only of the conventional plants. They expect to learn new O&M technology and know-how from another type of plants to be constructed by foreign companies. Considering the above mentioned, these companies might be good candidates for the foreign companies that seek partner in Bangladesh.

(3) Sale of Arsenic Removal Device

JST conducted hearing from Brota Services International, a private sales company of arsenic removal device.

The company sells the device of Read-F that adopts Japanese technology. The company, supported by NGO, deals in community type of device as well gives training how to maintain the device and manage tariff collection. The device is designed to enable the re-use of the resin that absorbs the arsenic. The resin can be recycled if the arsenic removing factory starts operation. Obviously this will reduce the replacement cost of resin; however the factory has not started yet.

Figure 4.5-1 Community Type of Device

Figure 4.5-2 Arsenic Removing Factory for Re-use of Resin

4.6 Activities of Local NGOs

As mentioned in Section 4.1.2, the number of NGOs registered with NGOAB is 2,506 as of March 2010, of which 2,278 NGOs are local ones. Some of them have a nationwide network and others are community-based. Hearings to major NGOs, which implementing activities in water supply sector, was carried out in the Survey. Table 4.4-1 shows the contents of their activities

Table 4.6-1 Major NGOs Implementing Activities in Water Supply Sector and the Contents

NGO	Bangladesh Rural Advancement Committee (BRAC)	Brotee	Hilful Fuzul Samaj Kallyan Sangstha (HFSKS)	NGO Forum for Drinking Water Supply & Sanitation	Projukti Peeth (PP)	Rural Community Development Society (RCDS)
Location	Nationwide	Baroghoria Union, Nawabganj Upazila, Chapai Nawabganj District	- Feni Sadar Upazila, Feni District - Duptara Village, Araihazar Upazila, Narsingdi District - Fatenagar Village, Keraniganj Upazila, Dhaka District	Nationwide	Laksam Upazila, Debidwar Upazila, & Bancharampur Upazila, Comilla District	Sachar Union, Kachua Upazila, Chandpur District
Outline of Activities	- Implementation of "WASH（water, sanitation and hygiene）Programme" funded by the Dutch Government - Operation of 5 schemes of piped water supply sistems, of which 2 shemes include irrigation water supply. In addition, 1 scheme is under construction. - Monthly water charge is 70 Taka for the first tap and 30 Taka foe the second.	- Implementation of rural piped water supply under Social Development Foundation（SDF） - SDF bears 50 percent of construction cost, and the remaining is shared by NGO and community. - Monthly average water chare\ge is about 150 Taka per household.	- Implementation of rural piped water supply under Social Development Foundation（SDF） - They are also engaged in 3 schemes of the rural piped water systems under BWSPP funded by the World Bank (1 scheme under construction) - Collecting monthly water charge from users (The charge per household depends on area and connection plan contracted.).	- Implementation of "NGO & Civil Society Network" funded by DANIDA and "Community-based Arsenic Mitigation Project" funded by DFID - Implementation of arsenic mitigation funded by EU	- Distribution of arsenic removal filters for household use and insllation of community-type arsenic removal system under the DART project funded by UNICEF - Installation of deep tube wells, Tara pumps and ring wells under the Sanitation, Hygiene and Water Supply Programme funded by UNICEF - Proposing installation of piped water systems in their target areas to UNICEF	- Installation of multiple use water supply systems (irrigation water supplied through canals and drinking water supplied by water tank and distribution pipes in dry season) funded by ADB
Features	- 5 percent of cost sharing by community is the general principle. Water charge is not collected from the poor.	- They constructed the rural piped water systems utilizing river water and currently operate the systems.	- They operate a number of the rural piped water systems utilizing PPP scheme under the several projects.	- They have 14 regional offices and provide services in collaboration with over 800 partners in the country.	- It is planned that users association collects water charge 10 Taka from each household on trial and the collected charge is spent fro electricity bills.	- Charge for irrigation water supply is collected, but agreement over the charge collection for drinking water supply has not been reached.

Piped water supply systems are being implemented as rural water supply project utilizing PPP system in the country. Hilful Fuzul Samaj Kallyan Sangstha (HFSKS) has an active presence in PPP projects and is engaged in a PPP project of renewal energy (photovoltaic power generation) in rural area in addition to water supply under the PPP system. They points out the following issues with regard to the fund disbursement by BWSPP:

- BWSPP is to contribute 70% of the construction cost. However, in reality, the sponsor NGO must bear all the initial expenditure and claim BWSPP share for reimbursement after the completion of construction.
- The flow of reimbursement documents from a person in charge to the next person within BWSPP is extremely slow, and the sponsor NGO has to spend enormous time and efforts for the reimbursement procedure.
- Full amount of reimbursement is seldom made.

Brotee operating the single system using surface water (river) under the rural water supply project utilizing PPP system, pointed out that SDF scheme was not suitable for the piped water system of surface water on the terms of payment although it could be used for the cases of deep tube wells. As points to be improved, they also indicated that the scheme should have been flexibly operated and donor should support such a pilot project.

Besides, the multiple use of groundwater applied by RCDS is an example for promotion of rural piped water supply system development. Adoption of the system is promoted by Rural Development Academy (RDA), a public academic and research institution located in Bogra District. They develop the model projects which provide training and microfinance for income generation, management services by private operator to recover the investment cost through long-term operation, and multiple use of groundwater for irrigation and drinking. RDA concluded that multiple use of water improves profitability of water supply services, income generation by technical training and microfinance makes it possible to provide water supply services to more residents, and the business can be sustained, through their activities (source: RDA, Multipurpose Use of Water Resources).

Finally, based on the findings above, JST compiled the following points for selection of water supply utilizing PPP system with NGOs in rural area:

- For implementation of water supply business, it is necessary to reach the agreement with residents and to provide the reliable service, especially for collection of water tariff. Therefore, it is important to establish the relationship of mutual trust with residents.
- Cheaper and small system installation is suitable for rural area because the supplied population is small and rural households are less able to pay. Private companies would not find it attractive.
- Rural water supply systems implemented under the PPP system in the country are not traditional systems like hand-pump but piped water supply systems which is considered as "new technology" in the country, If the following issues will be solved, it is one of the attractive points for NGOs that they can continuously obtain financial sources of their activities for a long period.

Therefore, PPP system like BWSPP funded by WB, in which NGO is a main implementation agency, would work on rural water supply with a coalition of private sector. In this case, it will be a merit for the Government of Bangladesh to expand the coverage area of network piping with private finance. Japanese private companies and NGOs also can involve this PPP system of BWSPP. However, the long term operation is inevitable because the implementing agency should collect the cost of investment and O&M. And, BWSPP has other risks, such as number of connection cannot be increased so much because some households who do not connect the pipe borrow from the connected water pipe, the large investment ratio of the implementing agency oppresses on its financial situation, and the service shall be suspended if the water tariff cannot be collected. NGOs which have the experience of the PPP projects indicated the following points to be improved as follows:

- To establish the terms of payment suitable for each water source (Steps of facility construction depends on water source.)
- To set the lower rate of cost sharing based on conditions of water supply area and technologies applied, compared to the current system rate of 30 %
- To make it flexible to operate the scheme, for example simplification of payment process within the government authority and application of contingency for price escalation of construction materials

According to hearing from NGOs and the DPHE officer in charge of BWSPP, the crucial obstacle for NGOs was not the approach, which was to utilize investments from the private sector and to recover them by the tariff collection through a long term operation, but the investment ratio (40% at the beginning of BWSPP was too big for NGOs) and the difficulty of the access to a bank loan. Therefore, it can promote the entry of NGOs, which have much interest of this kind of PPP, that the conditions of a bank loan on water supply service by PPP system are eased.

It is important that users or implementing agencies have responsibility of ownership for sustainable operation of water supply facility. PPP by BWSPP scheme is one of examples to realize it. Some NGOs show their interest in the scheme that brings them regular income for a long term of 10 to 15 years. It can be assumed that the number of NGOs, which have willingness to be engaged in the rural piped water supply by PPP system, would increase if initial investment cost is reduced, reimbursement

is rapidly processed, and project scheme is flexibly operated on the basis of the experience of SIPP and BWSPP.

CHAPTER 5 PROJECT PLANS AND DRAFT COOPERATION SCENARIOS

5.1 Outline

5.1.1 Needs of Bangladeshi Side and Application of Japanese Technology

According to the site survey, current situation and issues on water supply sector in Bangladesh are categorized into (1) High level plan and policy, (2) Water quantity and quality and (3) Implementation system, organization and ability/capacity. In terms of high level plan and policy, the Government of Bangladesh has NWMP, however, it just mentions the future policies without any practical project implementation plans. And Master Plans are prepared only in a part of water supply agencies. The issues are un-planned and ineffective development, and lack of overall drilling permission system, uncompleted drainage control for public water, etc. In relation to water quantity and quality, water source conversion is possible in limited areas although dependency on groundwater is generally high and excess pumping is occurred in many places. The issues in rural areas are inappropriate quality of groundwater and pond water by seawater intrusion and high tide. The issues in urban areas are river water quality degradation and lack of sufficient water. Especially in coastal areas, the issue is surface saline water in the dry season by seawater intrusion. With regard to implementation system, organization and ability/capacity, issues on implementation system, organization and ability/capacity are various and a lot of supports are necessary, the technical and financial ability of implementation agencies are generally low and even implementation and O&M system is not established in some areas.

JST regarded the solution of these issues as the needs of Bangladeshi side, and examined how to apply Japan's technologies for the needs. Then, the prioritized technologies were selected as RO filter treatment system, Filtration device without filter media change, Purification blocks and Coagulant for simple treatment + mobile treatment device.

Project Plans were examined with utilization of the results of existing programs by other donors, in order to meet the policy, situation and issues of Bangladeshi side and to avoid the existing donors' activities.

As a result, prioritized project plans were determined as Pilot project of RO filter treatment for saline water with natural energy utilization and Project for surface water supply in local cities. JST prepared Draft Cooperation Scenarios and Draft TORs as references for business of Japanese private companies in Bangladesh.

Bangladeshi market is generally new to Japanese private companies and they have neither idea on situations nor business base in Bangladesh. Therefore, in order to open up a new market in Bangladesh with their products, it is desirous for Japanese companies to find out experienced local partners, who own sufficient experience and technology in water supply sector and deep knowledge and know-how on local market, for business tie-up in terms of fabrication and sales of products and O&M and to acquire know-how on local business activities. Three (3) local companies, which JST had visited for interview survey, have excellent management and influential power to local market and are desirous to formulate business tie-up with Japanese companies. It will be advisable to identify local business partners including the above three companies through consultation with JETRO Dhaka Office and/or Japanese trading companies, which operate business in Bangladesh.

Japanese companies are advised to build up their cost competitiveness of their products in local market after achievement of price down through technology transfer to local partners. Such successful business accomplishment will lead to business development of Japanese companies in surrounding countries. In consideration of intrusion of cheap products from China and so forth, it is preferable for Japanese companies to urgently develop competitive products and technologies in Bangladesh.

5.1.2 Results to Each Object in the Survey

Outline of results to each object in this Survey is as follows:

Objective (1): The specified projects (ODA, Public-Private Partnership Project, Private project) applying Japanese technology and experiences, targeting in urban and rural areas, are proposed, and the methods of the project formulation are organized

In Preparatory Work in Japan, the policy and objectives of Bangladesh were confirmed and the existing information and projects were reviewed. Possible technologies were identified by hearing from Japanese private companies. Then JST selected target sites for the site survey, prepared 18 preliminary project plans and categorized as ODA, Public-Private Partnership Project and Private project.

In Study in Bangladesh, the site survey was implemented after confirming the needs of Bangladesh side, existing project directions and opinions of related agencies in Bangladesh. JST reviewed and selected 16 Preliminary Project Plans (5 for Master Plan, 8 for urban areas and 3 for rural areas). According to the high possibility of realization, JST prepared 7 Project Plans.

Among these 7 Project Plans, JST finally prepared 2 Prioritized Project Plans by examination of issues and matching with Japanese technologies for each Project Plan.

Objective (2): In terms of formulation of Master plan and development of regulation framework, information required for promotion of private sector involvement and expansion of ODA to wide areas is collected and organized.

In Bangladesh, the high level plans in water sector as NWMP and SDP only deal with the future policies without any actual project implementation plans. Master Plans are under preparation only in a part of water supply agencies. It is necessary to formulate Master Plans and Development Plans. On the other hand, although the competitive technologies owned by Japanese companies are RO filter treatment system, rapid sand filtration system and so on, such equipment can only be one of the component unit in required water supply facility for improvement of water supply works in Bangladesh. Therefore, it is not easy for Japanese companies to sell their product alone in areas where there is no water supply system in Bangladesh. For business activation and promotion in Bangladesh by Japanese companies with such competitive technologies, it will be preferable to let them concentrate on their own business activities of fabrication and sales of products. Such situation can be accelerated by joint operation of ODA donors in terms of project implementation for institutional improvement, construction of infrastructures and capacity building of staff in local water works authorities.

Japanese companies shall list up potential local companies for business tie-up by analyzing the information on matters of local laws and regulations, taxes and labor collected from JETRO Dhaka office and Japanese trading companies, etc. who are running their business in Bangladesh. Local partners for business tie-up shall be selected by evaluating their capabilities in the field of finance, marketing, and technical level through hearings and factory tests of basic technical level. After conclusion of business tie-up relation with local partners in the form of technical tie-up or formation of joint venture company, Japanese companies shall confirm local availability of required materials and parties for procurement of such materials, and then fabricate their products locally by dispatching Japanese engineers to Bangladesh for technical supervision followed by design, processing, fabrication and performance test. Opening up of sales clients in Bangladesh shall be reliant to marketing power of local partners. For pursuing financial sound local business operation in Bangladesh, Japanese companies shall take such strategy as to promote reception of business order of provision of O&M services together with delivery and installation of products. In the provision of O&M services, Japanese companies shall endeavor to human source development for O&M services, stabilization and improvement of quality of their services to be provided under technical and financial support of Japanese companies. It is also necessary to incorporate project cost required for support of soft component as well as the cost for installation of water supply facility for realization of effective

collaboration of ODA projects and business activity by Japanese companies.

Objective (3): Based on the proposed projects as stated in (1), Draft Cooperation Scenario is prepared for the next five years.

Regarding to 2 Prioritized Project Plans as following, Draft Cooperation Scenarios were prepared for 5 years.

- Pilot project of RO filter treatment for saline water with natural energy utilization (application of RO filter treatment system)
- Project for surface water supply in local cities (application of Filtration device without filter media change)

5.1.3 Contents of this Chapter

Survey results, mentioned in the previous chapters, are compiled into the groups; urban areas, rural areas, and Master plans and legal frame work. And 7 project plans are selected (referred to as Table 5.3-1) and categorized as follows:

(1) Prioritized Project Plan: Technology and experiences of Japanese companies and NGOs can be applied as much as possible.

(2) Project Plan with suggestion of additional study: Technology and experiences of Japanese companies and NGOs (especially hard component) can be applied, but the project has a lot of issues to overcome.

(3) Project Plan with suggestion for a long term: Technology and experiences of Japanese companies and NGOs (especially soft component) can be applied, but the project has a lot of issues which needs a long term to overcome.

Consequently, the following 2 Project Plans of category (1) are prioritized, and Draft Cooperation Scenario and Draft TOR of each plan are prepared.

- Pilot project of RO filter treatment for saline water with natural energy utilization
- Project for surface water supply in local cities

Clause 5.3.3 explains how to apply Japanese technologies, what kind of conditions are necessary for each Prioritized Project Plan.

5.2 Process to Formulate Project Plans and Draft Cooperation Scenarios

In the preparatory work in Japan, preliminary project plans were prepared based on the national policy of Bangladesh and the hearing from Japanese companies. These preliminary project plans were fundamentally reviewed in order to reflect the site survey results (present situation and specific needs in Bangladesh), and to apply Japanese technology and public-private partnership as much as possible. The basic process is shown in Figure 5.2-1.

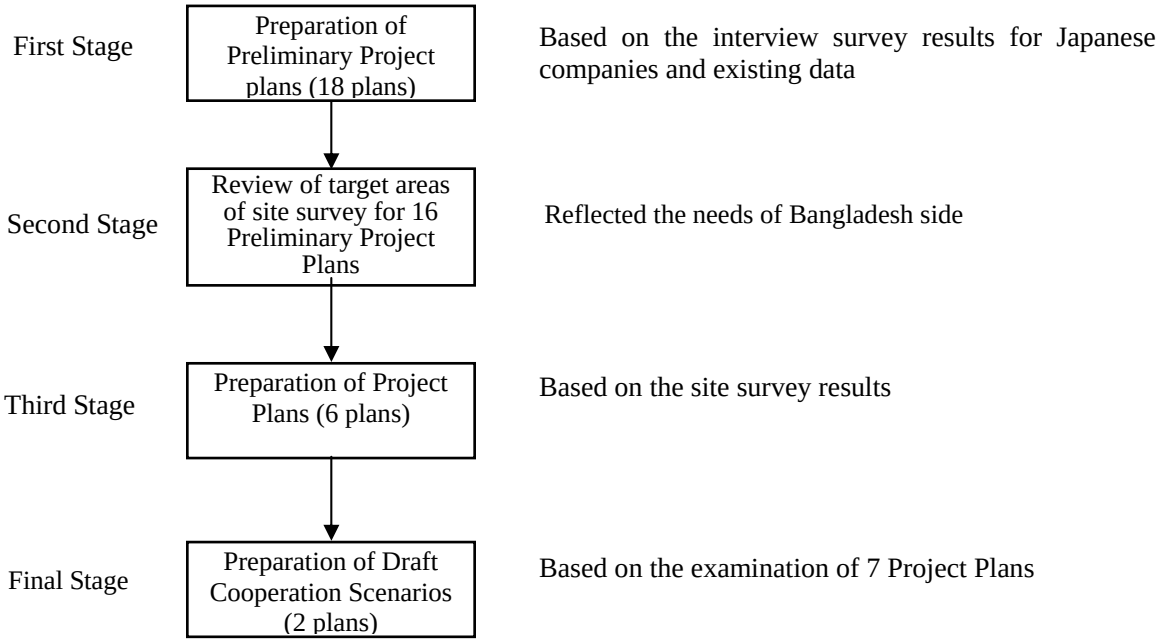


Figure 5.2-1 Process to Formulate Project Plans and Cooperation Scenarios

5.3 Preparation of Project Plans

5.3.1 Preparation Method of Project Plans

Preparation of Project Plans was made focusing on those being able to effectively utilize the technology and experience owned by Japanese companies and NGOs out of 16 draft Project Plans formulated in consideration of needs of Bangladesh. Competitive Japanese technologies and experiences in Bangladesh are summarized as follows based on the findings in Clause 2.2.4: Summary of present situation and issues is shown in Section 3.16.

(1) Hard technologies:
   1) River water purification
   2) RO Filter treatment system
   3) Rapid sand filtration system
   4) Mobile water treatment facility combining flocculation agent

(2) Soft technologies:
   1) Project for improvement of rural water supply by PPP
   2) Well registration

Based on the above, applicability of Japanese technologies to the issues to be solved in Bangladesh is studied in Clause 5.3.2. Six (6) Project Plans have been selected with reference to the above technologies and experience and needs of Bangladesh.

5.3.2 Application of Japanese Technology and Utilization of Water Works System in Bangladesh

Although JST collected applicable Japanese technology in preparatory survey in Japan, some of them are found out not to meet the needs of Bangladeshi side and actual situation. However, several new techniques, which were not expected in preparatory survey, have a possibility to be applied on the basis of the site surrey results. Examination to apply Japanese technology is explained as follows:

(1) Water purification

River water pollution is serious in Dhaka and other cities by domestic and industrial waste water without any treatment according to urbanization and population increase. Effective counter measures, such as to construct sewage system and to enforce regulation for industrial waste water, are not expected to be quickly realized because it takes time and money. Pre-treatment facility is also effective, but it is not appropriate for small purification plants because of the limit of budget and human resource. In Japan, there are excellent technologies for river water purification, such as conversion from concrete embankments for flood control into rich-in-nature revetments. As explained in 2.2.4, the applied technology requires no further maintenance after installation of water purification blocks in rivers and can maintain purification function almost indefinitely, thus it is advantageous in Bangladesh in terms of reduction in O&M cost to alleviate financial burden of Bangladesh.

This technology can be applied at medium and small cities like Noakhali with small canals and rivers to be utilized for surface water intake but with problem in water quality.

(2) RO filter treatment system

Salination of the underground water and surface water caused by seawater intrusions often occur in Bangladesh especially in the southern costal area. Currently, about 200 million people are facing with the water source salination problems. Desalination process is necessary to convert saline water to drinking water. Currently, the most common method for seawater desalination is RO（reverse osmosis）filter treatment system. Every year, especially in the dry season, the seawater intrusions often occur caused by the sea surface elevations, and the seawater intrusions need to be mitigated to protect residents' life.

RO filter treatment systems had not been introduced to Bangladesh, except emergent usage, because the cost for O&M for the system is high, and also the skilled worker were not available. Recently, there are some plans to introduce the system for the export processing zones (EPZ), explained below.

- A fixed type RO filter treatment system is under construction in the EPZ in Karnaphuli (capacity: 370m^3/hour, water tariff (plan): 11-20 taka/m^3)
- A fixed type RO filter treatment system is under construction in the EPZ in Citation, expected to complete in December 2010 (Capacity: 600 m^3/hour, water tariff (plan):15taka/m^3)

The fixed type RO filter treatment system is a safe and reliable desalination system. However, it is far more costly compared to former rapid sand filtration system, and therefore, reduction of the initial and O&M cost is very important. To cope with these issues, JST consider that establishing a production system for the fixed type RO filter treatment system in Bangladesh is the most effective way, and implement a pilot project to realize it.

This technology can be applied at Barisal city and other similar cities which have plans for conversion of water source to surface water and have restriction of surface water utilization in dry seasons due to seawater intrusion.

(3) Rapid sand filtration system for surface water sources

In Bangladesh, it is assumed that managing the coagulation and rapid sedimentation system appropriately and maintaining good quality of water are difficult. It is important to manage the process and the function of the system, filtering and cleaning, even if the turbidity of the water increases.

The issues about the O&M of the coagulation and rapid sedimentation facility are described below.

- Keeping the condition of the filter material, filter pond, stable and reliable water quality
- Maintaining the filter material reducing the loads, and saving the consumption of the filter

materials

- Saving the consumption of the water for cleaning the filter

The special cleaning filter system, developed by a Japanese manufacturer, is a very suitable system for the conditions mentioned above. The specifications of the facility are explained below. The manufacturer is an attendant of the "Seminar on the waterworks in Bangladesh" and they are positive to provide service in Bangladesh.

- Though the manufacturer has not exported the facility yet, they have installed 70 units in Japan.
- The products are small scale water purifying facilities 3.8m^3/hour (91.2m^3/day) to 61.5m3/hour (1,476m^3/day)
- Basically, the facility requires a coagulation and sedimentation facility, and it is able to intake 30 degree turbidity water.
- The manufacture's business is specifically manufacturing, and they need to corroborate with plant providers to provide services for Bangladeshi enterprises.
- It is necessary to establish a local production, maintenance service and procurement system in Bangladesh to enable the cost reduction.

This technology can be applied at cities like Noakhali, Comilla, Brahmanbaria, Muradnagar, etc., which are probable for surface water utilization.

(4) Mobile Water treatment facility combining flocculation agent for simple treatmen

In some agricultural villages, there are some areas where residents have to use ponds for water source. Generally such residents are in the low income group and water tariff could be a great burden for them. This situation is similar to the situation under disaster in Japan, so the Japanese emergency water supply devices can be applicable for these areas, such as mobile water purifying system.

This technology can be applied at southern agricultural area, which use ponds of saline water for water source.

5.3.3 Selection of Project Plans

Table 5.3-2 shows the result to select Project Plans among Preliminary Project Plans (mentioned in Section 3.17) based on the examination in Clauses 5.3.2 and 5.3.3.

Although establishment of water works association was one of the candidate plans, it has been already implemented among existing agencies to exchange and share the information and technologies. Therefore, JST did not examine it further.

Table 5.3-1 List of Project Plans

Project Plan name (tentative)			Sector	Advantage for Japanese companies
Prioritized	1	Pilot project of RO filter treatment for saline water with natural energy utilization	Urban area PPP	RO filter treatment system
	2	Project for surface water supply in local cities	Urban area PPP	Free of filter media change
Suggestion for additional study	3	Project for water quality purification of canal	Urban area ODA	Embankment with water purification block

Project Plan name (tentative)			Sector	Advantage for Japanese companies
	4	Project for improvement of rural water supply by PPP	Rural area Private sector	
	5	Project for safe water supply in network piping in areas without water supply service	Rural area PPP	Coagulant for simple treatment + mobile treatment device
Suggestion for a long term	6	Project for establishment of management system for well list and drilling permission in Bangladesh	MP study ODA	

5.3.4 Issues and Solutions of Prioritized Project Plans

The background and solution of each prioritized project plan is as follows:

(1) Project No. 1: Pilot project of RO filter treatment for saline water with natural energy utilization

1) Present situation and issues in areas other than target areas of site survey

It is said that the water salination, both underground and surface water, is occurring more frequently affected by the salt-water intrusion in the dry season. Also, according to the information from DPHE, two million residents living in the coastal area of Bangladesh are facing the problem of water salination. Barisal City is one of those cities which are located in the coastal area and facing the problems caused by the salt-water intrusion. According to the national census, the population of Balisal was 345,000 in 2001, and it is going to increasing up to approximately 450,000 by 2010 (assuming 3% increasing rate). Water-supply ratio, which is approximately 20 % in 2001, is predicted to be approximately 15 % in 2010.

The water for the daily life of the residents in Pourashavas is supplied from the waterworks, partly available, and handpump shallow well. Recent years, because of the drawdown caused by the natural aged degradation, the underground water is in short supply. Therefore, the government has made a plan to reduce the dependency on underground water, and change the water source to surface water. However, surface water is not available in Barisal city in the dry season because of the salt-water intrusions. Improving the quality of raw water by desalination is an argent issue.

2) Project Description

The fixed type RO filter treatment systems are not popular in Bangladesh because it involve high initial and O&M cost, and the ability of the O&M staffs for the equipment was not sufficient. However, the fixed type RO filter treatment systems are necessary for desalination for the coastal area of Bangladesh so that they can utilize surface water efficiently in the future.

It is desirable that the O&M skills for the fixed type RO filter treatment systems to be transferred to the local staff in the future. It may enable widespread use of the fixed type RO filter treatment systems with the energy saving generator, and cost reduction for the coastal area.

3) Consideration

Through the experimental operation of the fixed type RO filter treatment systems, it is possible to prove the effectiveness of the system and to establish an operational base which is suitable to Bangladesh. To realize this idea, a demonstration experiment of the fixed type RO filter treatment systems, supported by the fund from the government of Japan, is desirable. Reduction of the operation cost for the fixed type RO filter treatment systems is expected through the technical transfer.

(2) Project No. 2: Project for surface water supply in local cities

1) Present situation and issues

Most of the cities JST visited use underground water for water source for water works. Except a few local cities, the iron removal facilities were not installed. So, though the iron content was exceeding the standard value, water was supplied without iron removal process. As a result, the water pipes were clogged by the oxidized iron, and the density of the iron content tends to increase following the drawdown of underground water. Using the underground water as water source for waterworks is getting more difficult because of the drawdown of underground water and the deterioration of water. The water source for water works would be changed to surface water. If there is a river which can supply sufficient amount of good quality water nearby, it is relatively easy to convert the water source. The waterworks JST visited supply water for 7 – 12 hours a day.

The actual operations of the facilities at the local cities, mainly deep wells, including some iron removal facilities, are good in general, maintained good appearances and functions. The water meters are set on the pipes from the well pumps, and utilized to manage the amount of the water usage. Also, in Chandpur, a purification plant utilizing the coagulation sedimentation Process is operated, and the facility is kept in good working condition. However, the operation and management for the coagulation sedimentation process is insufficient because water quality test is not conducted.

Issues relates to the enterprises for waterworks in local cities.

- Drawdown of the groundwater level caused by the natural aged degradation (Common)
- High concentrations of salt (Noahkari)
- Arsenic contamination (Murudonagaru)
- Clogged well strainer and the water distributing pipes by oxidized iron
- Water supply restriction (7 to 12 hours/day)
- Lack of the human resources who have experience on the coagulation sedimentation process for surface water
- Financial base of the enterprise for waterworks, collection of the water tariff, is fragile.
- Frequent power stoppage

2) Project Description

Converting the water source from ground water to surface water is the basic direction to solve the current issues and problems. The rapid sand filtration system is a typical and widespread method for the water purification facility. However, so far, most of the staff working for the enterprises for waterworks does not have experience of the rapid sand filtration system. Therefore, after converting the water sources, it is difficult for them to maintain the system appropriately. Also, compared to the well pump water supply system, the rapid sand filtration system is more costly due to the water purification process. Several conditions, described below, are needed to be fulfilled to realize the smooth conversion of the water sources.

a) Required quality and amount of the water is supplied

b) Appropriate operation and maintenance for the facility for the rapid sand filtration system are conducted without trouble.

c) The burden for the O&M staff of the facility is as light as possible.

d) The O&M cost for the facility is as low as possible.

In the developing countries, regarding the rapid sand filtration system, the element a) mentioned before tends to be prioritized more than b) and c). In this case, facility tend to be damaged, and

sometimes has difficulty to achieve a). The same situation could happen for Bangladesh too, and to avoid it, appropriate design and construction to achieve b) c) and d) are essential. Fulfilling b) c) and d), a) must be aimed to achieve, and fulfilling all a), b), c), d), stable quality and amount of water supply service would be realized. This achievement would encourage waterworks users to pay water tariffs, and support introducing appropriate tariff system.

With these situations in mind, especially unit-type rapid filtration system system without large land acquisition would be easy for the municipalities which are going to convert water sources from groundwater to surface water. And this project intends to implement the technical transfers for appropriate O&M by these municipalities. In addition to this, it will aim at realizing fewer burdens, low cost, easy to operate facilities, and sustainable enterprises which can provide stable service.

3) Consideration

There are a lot of achievements of both rapid sand filtration system and its unit type in Japan. However, demonstration experiment at the site is necessary for the filter exchange-free type because there are no achievements of this type in abroad.

Pourashavas's management system, both the operation of rapid sand filtration system and water tariff collection system, are weak, and to strengthen Pourashavas's waterworks service, introducing Japanese models which already proved its efficiency: less burden, low cost and easy to operate, is effective. For the future business, it is necessary to examine how to produce locally and to establich a competent system for the cost-competitiveness in Bangladesh

(3) Project No. 3: Project for water quality purification of canal

In urban areas, such as Dhaka City, river water pollution is a serious problem according to population increase and urbanization because domestic and industrial waste water discharge into the river directly. Effective counter measures, such as to construct sewage system and enforce regulation for industrial waste water, are not expected to be quickly realized because it takes time and money and awareness of private companies should be raised. Pre-treatment facility is also effective, but it is not appropriate for small purification plants because of the limit space, budget and human resource.

In Noakhali, one of local cities, PWSS had an intention to use surface water as water source, however, they determined that near surface water was not appropriate water source because of the pollution by domestic waste water. Therefore they have a plan to take river water from a long distance. They still have a financial issue to construct a control pond because insufficient water quantity in the dry season.

One of the solutions is to install purification blocks. Among several methodologies, biological purification with bacteria could be effective, and have less impact on the environment. Bacillus subtilis var. natto in blocks can increase by the reaction with water, and intake the contaminants.

However, river water purification can be realized with not only this technology, but also other measures, such as strict wastewater discharge control. It also needs detail investigations on water quality and quantity, intake water volume and so on at Noahkali which has plans to utilize small canal as water intake, since small canals and rivers are advantageous in improvement of water purification. Therefore, this Project is not examined further in this Survey, however, interested parties can study further on the feasibility of realization of the Project.

(4) Project No. 4: Project for improvement of rural water supply by PPP

Most people in rural areas use handpump wells for water supply. All target rural areas of site survey, JST confirmed the tendency of groundwater drawdown and insufficient quantity in the dry

season. In some areas, iron could be observed, but people used groundwater without any treatment.

Under this circumstance, projects for network piping construction in several rural areas are promoted. The government shares a part of the initial cost, and NGO and CBO share the rest of it, collect water tariff, and operate the service. This is a typical example of PPP project. The issue is that NGO with little funds cannot participate although the ratio of initial cost sharing for NGO and CBO is changed from 50% to 30%. And it also needs detail investigation on financial analysis, schedule of loan by NGOs, situation of loan in water supply sector, and so on. Therefore, this Project is not examined further in this Survey.

(5) Project No. 5: Project for safe water supply in areas without water supply service

In some rural areas, people have no choice but to use reservoir water for drinking, living, fish cultivation and other purposes. This kind of water quality is not always safe for human health. And power supply is not common in these areas. Solar power supply is effective, but the initial cost is too high for cost sharing among residents. Therefore, purification system should be power supply free. In several areas, PSF system, which utilizes biological treatment without power supply, is introduced, however, water shortage is a typical issue of PSF system because water quantity of reservoir depends on annual rainfall level. One of the solutions is to introduce a mobile purification device. This device has a possibility to sell water. It is much easier than collection water tariff. Water tariff in PSF system area is about 20 taka at maximum, so the price of selling water should be the same level. This Project is expected to be implemented by Private Sector. However, it is necessary to realize local production, to secure the quality of products, to establish a distribution network, to develop human resource, and so on. Also social and economical conditions should be examined in detail. Therefore, this Project is not examined further in this Survey.

(6) Project No. 6: Project for establishment of management system for well list and drilling permission in Bangladesh

1) Present situation

Drilling permission system for deep wells is not established except for the administration area of Dhaka WASA. Well list system for newly drilled deep wells is not established, but Groundwater Circle in DPHE is establishing a database of deep wells with support of JICA experts. This database will be open to the public.

Under this circumstance, deep well drilling is promoted without any plans, and its counter measure is not taken although groundwater level is declining by excessive pumping in many areas. And it is possible to expand secondary arsenic pollution by a lack of appropriate technique and facility. Therefore, well list system for newly drilled deep wells is also highly necessary.

5.3.5 Realization of Each Project Plan

Draft Cooperation Scenarios and Draft TORs are prepared for the following 2 project plans, which have a high possibility of realization. For the rest of 5 project plans, additional surveys are necessary to judge the possibilities of realization.

Pilot project of RO filter treatment for saline water with natural energy utilization

Project for surface water supply in local cities

5.4 Draft Cooperation Scenarios

5.4.1 Pilot Project of RO Filter Treatment for Saline Water with Natural Energy Utilization (PPP Project of desalination in local cities)

(1) Purpose

It aims to make a step to disseminate and expand RO filter treatment system in the coastal areas by performance confirmation of the desalination device with RO filter treatment in coastal areas of Bangladesh, where salinity concentration is high in raw water for drinking. Also it aims to dispel the image that RO filter treatment system is too expensive by reduction of O&M cost.

(2) Background

1) Present situation and issues

In coastal cities, such as Barisal, where population is growing rapidly and quality of water supply service become poor, people cannot stop using groundwater although they have serious problems as groundwater drawdown and seawater intrusion by excessive pumping and seawater level rising.

Even though Bangladeshi Government tries to convert water source as surface water, desalination treatment is necessary for surface water in coastal cities because of seawater intrusion during the dry season.

If people continue to use groundwater, saline of groundwater is inevitable. Therefore, desalination treatment is necessary for utilization either groundwater or surface water.

2) Needs of Bangladeshi side

Under the circumstance as insufficient water supply by groundwater level decline every year, Bangladesh national policy indicates to reduce rate of dependence on groundwater, and to convert water source from groundwater to surface water.

Bangladeshi Government has already recognized the situation in coastal cities, and understood necessity and importance of actions against saline in these cities. As one of the actions, implementation agencies, such as DPHE, held the meeting for "Preliminary Consultation on Coastal Development Strategy" and they confirmed to take measures for reduction of salinity in water and soil by various actions.

At present in Bangladesh, desalination device is installed for only a part of industrial use because of the high initial and running cost, and lack of knowledge for O&M.

Therefore, price-reduction of desalination device is a key point because needs of Bangladeshi side for desalination device is high.

3) Advantage of Japanese technology

There are 3 methods of desalination; Evaporation, Electrodialysis and RO. For Bangladesh, RO filter treatment is suitable because it can directly desalination water with small energy. It is one of the technologies which have advantage for Japanese related industry. The potential beneficiary in coastal cities is estimated as about 200 million people.

In coastal cities, salinity intrusion occurs in about 5 months through a year, so it is not necessary to operate RO filter treatment continuously. It can be possible to reduce O&M cost by longer performance of filters with intermittent operation, simultaneous use of power generation with natural energy, and use of rapid filtration device during the rain season.

(3) Draft Cooperation Scenario

Draft Cooperation Scenario for the improvement of water supply in coastal local cities is as following figure.

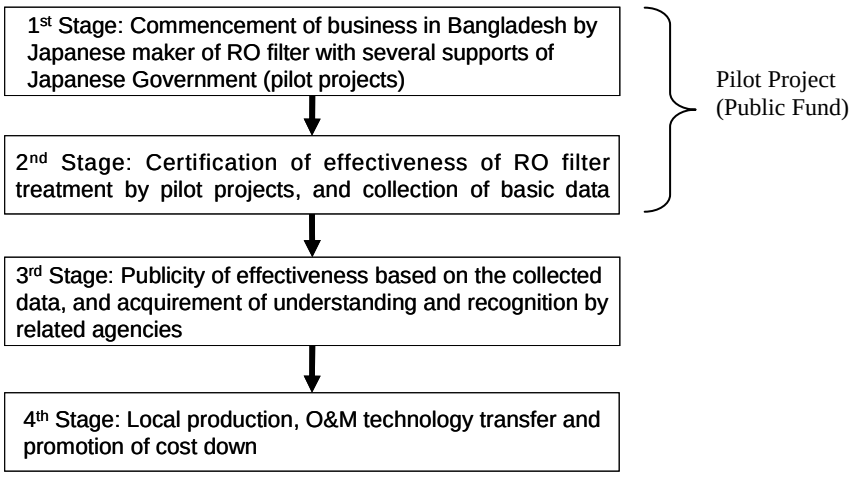


Figure 5.4-1 Draft Cooperation Scenario for the Improvement of Water Supply in Coastal Local Cities

(4) Suggested components

In this pilot project, energy-saving RO filter treatment system with natural energy (solar or wind power) is installed in Barisal City and operated in local cities (treatment volume: 50m^3/day). Implementation of this pilot project will be undertaken by Japanese company under support program of Japanese government. O&M of water supply facility can be undertaken by PWSS of Barisal City, while Japanese company in collaboration with tied-up local companies shall undertake O&M of RO filter treatment system. This O&M service formation enables private service provider can play on-the-job training of O&M staff of PWSS by technology transfer and guidance.

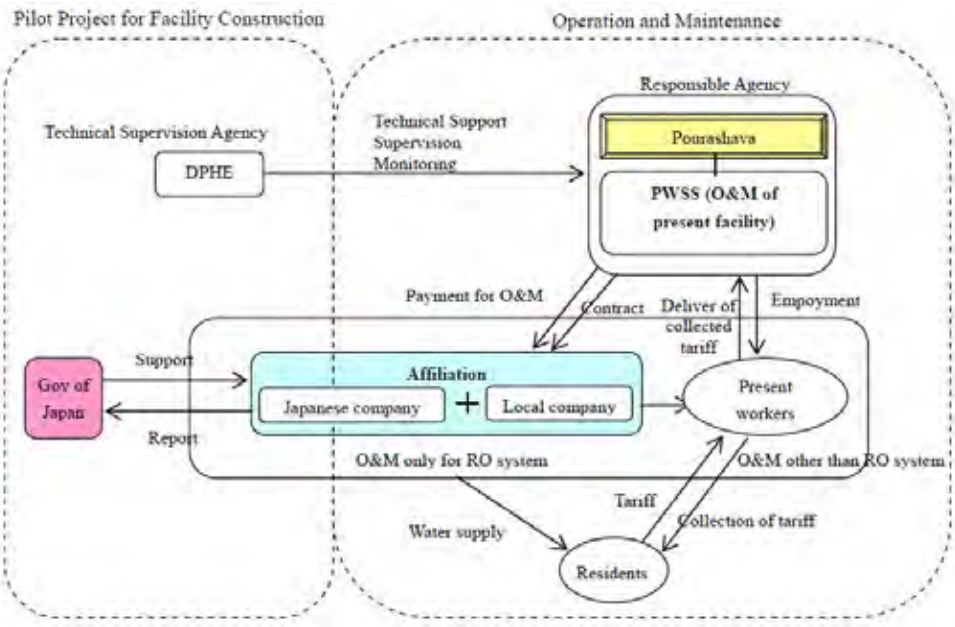


Figure 5.4-2 PPP system among DPHE- Pourashava-Private Sector

Outline of construction work is as follows:

1) Installation works

a) RO filter treatment system: production volume = 50m/day
b) Water intake facility = 1 set

c) Water delivery facility = 1 set
d) Purification facility except for a) = 1 set
e) Power generation facility with natural energy = 1 set

2) Construction works

- Necessary civil, building, mechanical and electrical works and connection of exiting water delivery facility

In the pilot project, the items to confirm are as mentioned in (3).

The period of this project is 4 years. In the first year, RO filter treatment system is installed and social survey is implemented. From the second year to the forth year, O&M of the device and market research are implemented.

PPP system and outline of the complete image of this project are shown in Figure 5.4-3.

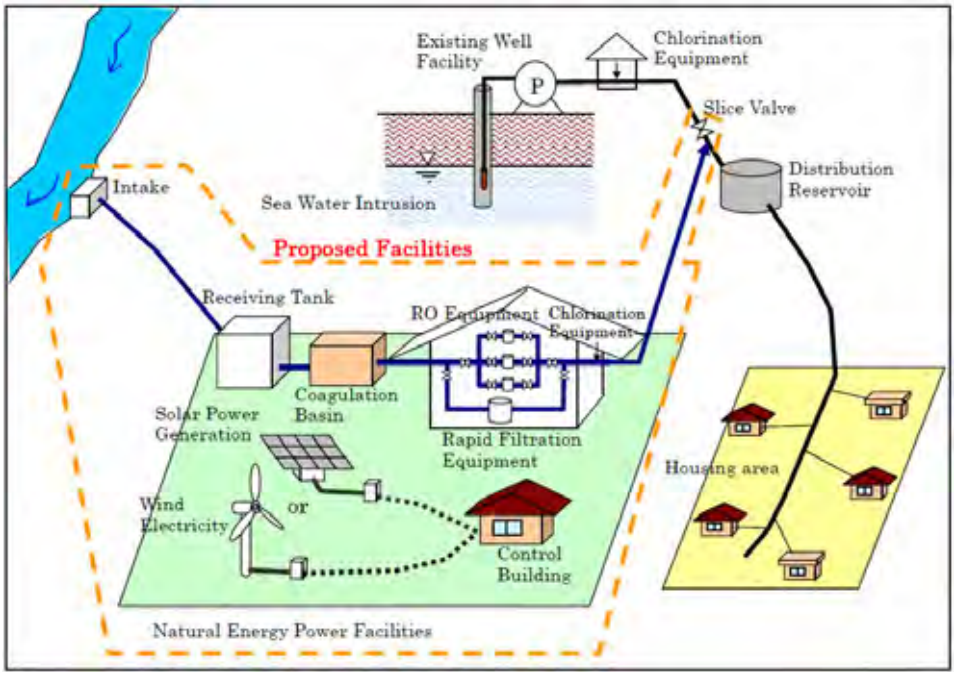


Figure 5.4-3 Complete Image of the Pilot Project of RO Filter Treatment for Saline Water with Natural Energy Utilization

(5) Issues for implementation

The initial cost of this pilot project is relatively high as 150 million yen for water supply for 2,500 people ($50m^3$/day). For future business, the following solutions are necessary:

- To establish the local production system and to reduce the cost
- To procure some parts in Bangladesh or neighboring countries, such as filters, valves and steel products
- To reduce labor cost by employment of local people
- To remodel as the minimum plant

Some Japanese companies reported the initial cost would be reduced as 80% with the above solutions. And the running cost would be also as 80% with the above solutions and utilization of natural energy.

If O&M cost reduction and high public awareness are realized through this pilot project, this

methodology would be an absolute solution for water supply in coastal cities. The beneficiary would be estimated as about 200 million people, but it is unclear because water utilization of these areas needs to be investigated.

The implementation agencies are DPHE and Pourashava. DPHE implements technical support, supervision and monitoring in branches in Pourashavas and rural areas. Each Pourashava has a responsibility of water supply, however, DPHE plays an important role because human resource and techniques are insufficient in each Pourashava. In construction, the implementation agency will be "DPHE-Private Sector". And in O&M, the implementation agency will be PPP system as "DPHE-Purashava-Private Sector".

However, it is difficult to collect water tariff completely. It is desirable to prepare a support scheme as "Output Based Aid" of WB, and to establish and support a local water works company by Japanese ODA.

The most serious risk for the private sector is a failure to collect the initial cost in the future. This issue highly depends on public awareness and willing to pay of beneficiary. Therefore, attitude survey of beneficiary and examination of price setting of water tariff should be included in the pilot project. In order to make the first step, it is effective to utilize various support programs of Japan[4]. As mentioned above, the initial cost of this pilot project is relatively high. So it could be difficult without such support programs of Japanese Government. For the purpose of introduction and sales promotion of RO filter treatment system in Bangladesh, it is also desirous for Japanese companies to be able to receive institutional and financial back-ups by Japanese government for construction of water supply facilities using surface water.

- Initial Cost Simulation

Initial cost simulation for the project of RO filter treatment for saline water with natural energy utilization shows that the lowest initial cost per treatment capacity of RO filter is that with the treatment capacity of 500m^3/day and the scale merit can not be expected for the filter with the capacity more than 500m^3/day as shown in Table 5.4-1.

Based on the payable tariff estimated from disposable income in household spending, it will take about 30 years to recover initial cost for the project with treatment capacity of 500m^3/day. Since the recovery period of 30 years is much longer than the lifespan of RO filter, the initial cost recovery cannot be made without injection of public funds. In equilibrating the lifespan of RO filter and the recovery period of initial cost as 15 years, the deficiency is estimated as shown below.

- Treatment Capacity: 500m^3/day
- Years for recovery: 15 years
- Initial cost: 600 million Japanese yen
- Deficiency: short of 320 million Japanese yen after 15 years' operation (Necessary amount of subsidy)
- Required subsidy rate: 64%

Table 5.4-1 Simulation Result of Investment Recovery of the Project

Treatment Capacity	m^3/day	50	100	200	500	Remarks
Recovery period of 15 years		15	15	15	15	Lifespan of RO filter
Initial Investment Recoverable Amount	1000 yen	18,000	36,000	72,000	180,000	
Initial Investment Amount	1000 yen	100,000	147,000	240,000	498,000	20% reduced cost by local production
Nos. of household for Water Supply	houses	500	1,000	2,000	5,000	5 person/household

[4] One of the implementing scheme is "Water-saving type and environmental harmonized Water Cycle Project" by NEDO, however, its period is by 2013.

Collected Tariff	1000yen/year	2,040	4,080	8,160	20,400	340 yen/household/ month (4% of Disposable Income)
Initial Investment Recovery	1000yen/year	1,200	2,400	4,800	12,000	Interest excluded
Deficient Amount	1000yen	82,000	111,000	168,000	318,000	Required subsidy
Deficiency rate (%)		82	76	70	64	Required subsidy rate
Deficient Amount/Treatment Capacity	1000yen/(m^3/day)	1,640	1,110	840	636	

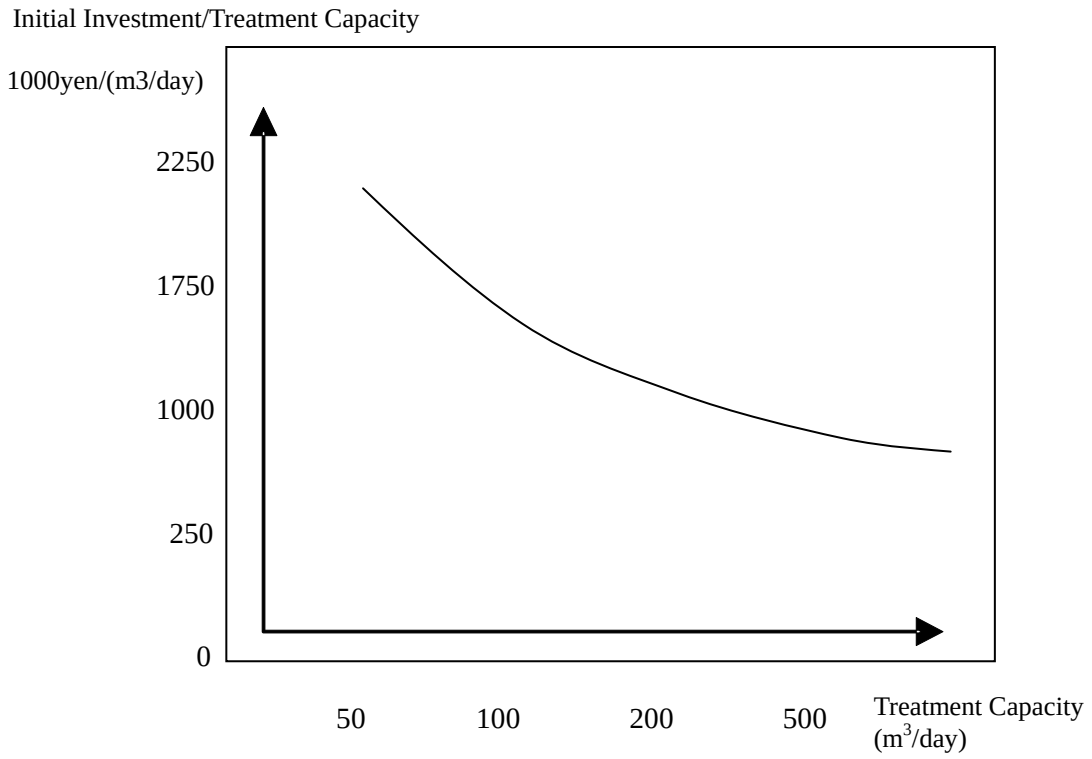


Figure 5.4-4 Relation between Treatment Capacity and Initial Investment Cost

5.4.2 Project for Surface Water Supply in Local Cities (Private Sector Project: Dissemination of Sand Filtration System in Middle and Small Cities)

(1) Purpose

In order to convert water source from groundwater to surface water, purification treatment is newly necessary for safe water supply in local cities in Bangladesh. Purification facility will be small in such cities, so rapid filtration device, which is one of the Japanese technologies, and its market will be expected to be applied. In this project, Japanese and local private companies conclude business tie-up agreement or establish Joint Venture, sell products and provide appropriate O&M service in order to contribute to establish sustainable system in water supply service in Bangladesh. Also this project aims at establishment of equipment's local supply organization and networks by Japanese and local companies after formulation of local standard specification of the equipment based on the proof of performance.

(2) Background

1) Present situation and issues

Most of the cities JST visited use underground water for water source for water works. Except a few

local cities, the iron removal facilities were not installed. So, though the iron content was exceeding the standard value, water was supplied without iron removal process. As a result, the water pipes were clogged by the oxidized iron, and the density of the iron content tends to increase following the drawdown of underground water. Using the underground water as water source for waterworks is getting more difficult because of the drawdown of underground water and the deterioration of water.

The actual operations of the facilities at the local cities, mainly deep wells, including some iron removal facilities, are good in general, maintained good appearances and functions. However, the O&M for the coagulation sedimentation process is insufficient because water quality test is not conducted.

Issues relates to the enterprises for waterworks in local cities.

- Drawdown of the groundwater level caused by the natural aged degradation (Common)
- High concentrations of salt (Noahkari)
- Arsenic contamination (Murudonagaru)
- Clogged well strainer and the water distributing pipes by oxidized iron
- Water supply restriction (7 to 12 hours/day)
- Lack of the human resources who have experience on the coagulation sedimentation process for surface water
- Financial base of the enterprise for waterworks, collection of the water tariff, is fragile.
- Frequent power stoppage

2) Needs of Bangladeshi side

Under the circumstance as insufficient water supply by groundwater level decline every year, arsenic pollution and high iron concentration, Bangladesh national policy indicates to reduce rate of dependence on groundwater, and to convert water source from groundwater to surface water.

Especially it is a basic solution to convert water source. For this conversion, purification facility for raw water (river water) is necessary. Generally, rapid filtration systems are applied. Among them, special cleaning filtration system of Japanese technology is suitable for Bangladesh.

3) Advantage of Japanese technology

It is difficult in developing countries to operate coagulation-sedimentation treatment and to keep its treatment water continuously in good condition for filtration. Therefore, appropriate cleaning is one of the important points for rapid filtration system.

To solve these issues, special cleaning filtration system is developed with the following characteristics. And it is suitable for small size purification system.

a) Filtration performance can be kept sustainably by cleaning filtration layer regardless of the raw water quality

b) Used filter media is not discharged as wastes.

c) Pollution in public water is also reduced because effluent by cleaning is reduced as 30 to 50%.

It could be competitive if Japanese private company can select low cost and low burden system and implement technical transfer for sustainably appropriate O&M.

(3) Draft Cooperation Scenario

In this Project, the special cleaning filter system, developed by a Japanese manufacturer, would be applied in surface water supply facility in local cities. Japanese private company will sell this system,

and provide appropriate O&M service. It contributes to establish sustainable O&M system in Bangladesh. Draft Cooperation Scenario of this Project is as following figure.

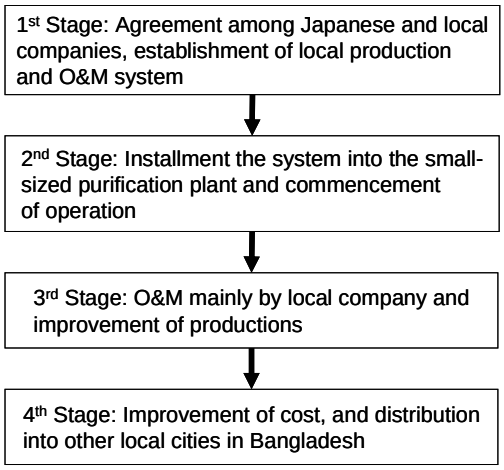


Figure 5.4-5 Draft Cooperation Scenario for Surface Water Supply

(4) Suggested components

This project includes constructing purification facility for raw (river) water and network piping for sufficient safe water supply. At the same time, it implements O&M capacity development in the private sectors which contracts with local cities, and supports sustainable maintenance. Existing O&M staff of Pourashava shall undertake O&M of new water supply facility. The private sector implements the long lump-sum subcontract with each Pourashava for O&M of rapid sand filtration system.

The project period is 5 years. In the first year, Japanese private company establishes the local production and O&M system and suggests representative sites. In the second year, purification plant is constructed and social survey is implemented. From the second year, operation and maintenance is mainly by the local private company. From the forth year, it is promoted to reduce the cost and to disseminate all over the country.

The implementation agency is DPHE. DPHE implements technical support, supervision and monitoring in branches in Pourashavas and rural areas. Each Pourashava has a responsibility of water supply, however, DPHE plays an important role because human resource and techniques are insufficient in each Pourashava. In implementation of this project, the implementation agency will be PPP system as "DPHE-Purashava-Private Sector".

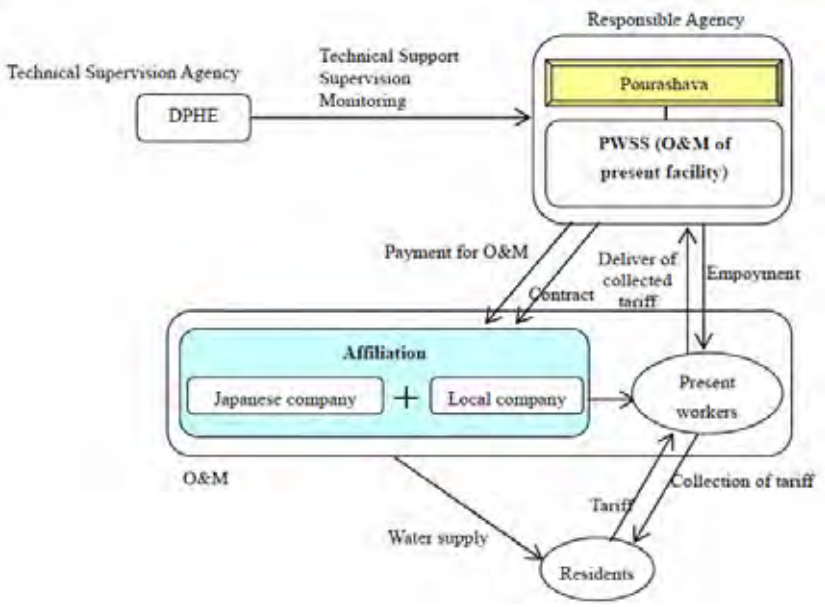


Figure 5.4-6 System among DPHE- Pourashava-Private Sector

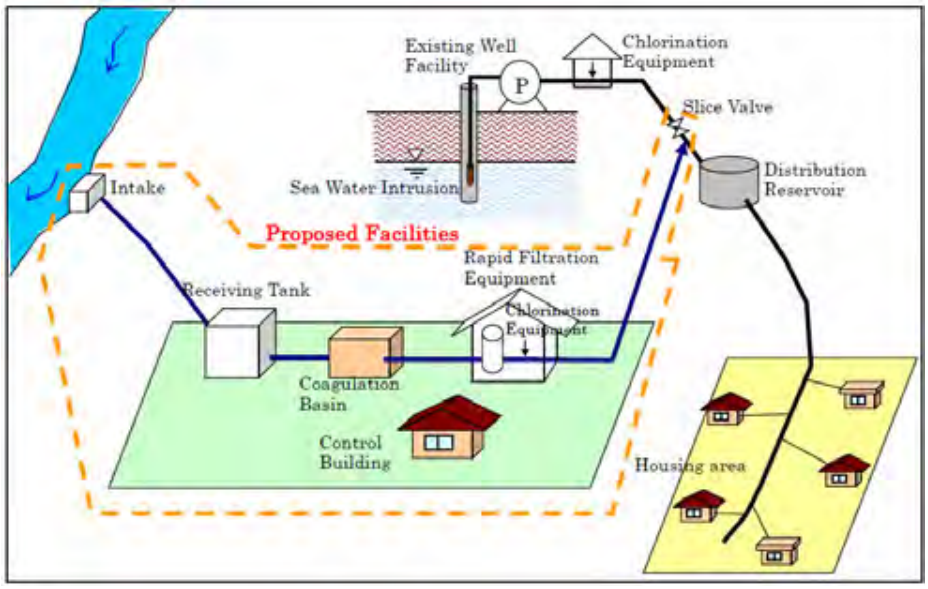


Figure 5.4-7 Complete Image of the Project for Surface Water Supply in Local Cities

(5) Issues for implementation

The most important issue for surface water supply is to secure the stable water source. In Dhaka City, river water pollution is a serious problem according to population increase and urbanization because domestic and industrial waste water discharge into the river directly. In Noakhali, PWSS determined that near surface water was not appropriate water source because of the pollution by domestic waste water. In other local areas, the same problem will be raised near future. Therefore, purification of water source is required for the coagulation-sedimentation filtration system with river water in local cities. It is important to disseminate the effect of this system and to purify the water source at the same time.

In this Project, the cooperation system as Japanese private company and Pourashava is applied. Japanese ODA support is not necessary, however, the Project depends on the financial ability of Pourashavas because generally they have poor financial ability to afford the conversion of water source and construction of many facilities. If their financial ability is not satisfactory, Japanese ODA

support is required. It shall be noted that the maximum feasible scale of water purification system with proposed rapid sand filtration equipment will be approximately for local cities with its' population of 30 to 60 thousand with per capita average daily water supply volume of 80LDC. This means that the water purification capacity of facility with 2,500m^3/day to 5,000m^3/day and 2 to 4 units of rapid sand filtration equipment with 60m^3/h purification capacity.

However, it is difficult to collect water tariff completely. It is desirable to prepare a support scheme as "Output Based Aid" of WB, and to establish and support a local water works company by Japanese ODA.

5.5 Draft TORs

5.5.1 Draft TOR for Pilot Project of RO Filter Treatment for Saline Water with Natural Energy Utilization

(1) Outline

1) Target area: Barisal Special City in Barisal District

2) Facility

a) RO filter treatment system: production volume = 50m/day
b) Water intake facility = 1 set
c) Water delivery facility = 1 set
d) Purification facility except for a) = 1 set
e) Power generation facility with natural energy = 1 set

3) Construction works

Necessary civil, building, mechanical and electrical works and connection of exiting water delivery facility

4) Implementation agency

a) Implementation agency for construction: DPHE
b) Implementation agency for operation and maintenance: Water works department of Barisal City

(2) Purpose

In this project, Water intake facility, water delivery facility, purification facility (including desalination facility) are constructed with utilization of existing facility in Barisal City by PPP support program of Japanese Government. It aims to prove the efficiency of desalination facility, to find the trust of related agencies of Bangladeshi side, and finally to promote and establish business of Japanese makers in Bangladesh.

The period of this project is 4 years. In the first year, each facility is constructed and installed, and connection to the existing piping is implemented. From the second year to the forth year, O&M of the device is implemented. A period of O&M is determined by the general lifespan of RO filter.

(3) Contents

The complete Image of this project is shown in Figure 5.4-2.

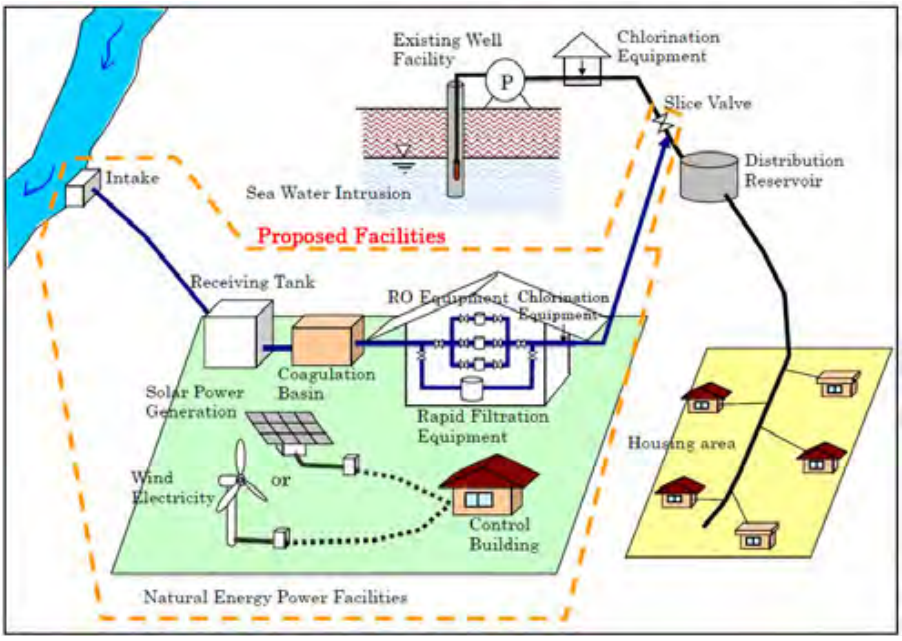


Figure 5.5-1 Complete Image of the Pilot Project of RO Filter Treatment for Saline Water with Natural Energy Utilization

The detail explanation is as follows:

1) Long term intermittent operation of energy-saving RO filter treatment system

Characteristic of groundwater should be considered for operation of RO filter treatment system. During the rainy season, RO filter treatment system should be stopped, and coagulation-sedimentation and sand filtration are operated because the quantity is plenty and salination damage is little. Valves for RO filter treatment system are closed and valves for the bypass pipe are opened. During the dry season, coagulation-sedimentation, sand filtration and RO filter treatment system are operated because the quantity is insufficient and salination occurs. Valves for RO filter treatment system are opened and valves for the bypass pipe are closed. At present, Barisal city has no purification facility because they use groundwater. Therefore, the facilities mentioned above should be constructed newly.

2) Establishment of operation and management system for RO filter treatment system

At the design stage, management system for RO filter treatment system should be examined because RO filter treatment system is not utilized during the rainy season.

3) Technology transfer on O&M to Barisal City by Japanese private company

The important points for training are pressure and infiltrating volume. For example, if infiltrating volume is small compared to the pressure, the reason is degradation of the filter, or clogging. Japanese private company will guide that degradation of the filter can be estimated by the life cycle, and the clogging can be recovered by back wash.

4) Set of O&M cost

O&M cost will be different between the dry and rainy seasons. Therefore, O&M cost of each season should be set based on the performance confirmation.

5) Identification of attitude and financial ability of beneficiary by social surveys

Water tariff is relatively expensive for the low-income group. If some residents reject door- to-door connection, the cost effectiveness can be lower. Therefore, the cost effectiveness should be estimated with the results of social surveys on the attitude and financial ability of beneficiary

6) Determination of the appropriate price of water tariff and establishment of tariff collection

Although the collection of water tariff is directly reflects on the O&M of the facility, expensive water tariff leads residents' rejection of the connection. Therefore, the price of the tariff should be affordable for beneficiary. Regarding to the tariff collection system, it should be examined how and who collects the tariff.

7) Collection of information on local private companies for establishment of spare parts distribution channel

It is required for stable and safe water supply to establish stable distribution channels for spare parts and other materials. For this reason, it is necessary to collect information on the situation of the present distribution channels and related private companies.

(4) Implementation policy and points of concern

1) Implementation policy

a) Basic implementation flow

- First Stage: Japanese makers of RO filter treatment system start business in Bangladesh
- Second Stage: Efficiency of RO filter treatment system is confirmed
- Third Stage: Result of the second stage is publicized for Bangladeshi Government and related agencies to raise their recognition.
- Forth Stage: Technology transfer on production, O&M is implemented in the pilot project, and price-reduction and sustainable business are promoted.

b) First Stage (in the first year)

Japanese makers of RO filter treatment system have no experience of business in Bangladesh and the initial cost is relatively high. Therefore, the business starts as a pilot project of the various PPP supporting programs of Japanese Government.

c) Second Stage (from the second year to the forth year)

During this period, the following works should be completed.

(a) Collection and analysis of RO filter performance data

(b) O&M working contents, cost and development of human resource

(c) Confirmation and establishment of spare parts distribution channel

(d) Confirmation of local production of for RO filter treatment system

(e) Hearing from beneficiary (awareness, ability to pay)

(f) Capacity development of implementation agency in local cities

(g) Determination of the price of tariff and its collection system

(h) Marketing research

DPHE is the implementation agency of construction, and Water works department of Barisal City is the responsible agency of O&M and in charge of tariff collection with the guidance of the private sector after the construction, private sector. DPHE has the same role as their usual task as to implement technical support, supervision and monitoring in branches in Pourashavas and rural areas. In construction, the implementation agency will be "DPHE-Private Sector". And in O&M, the implementation agency will be PPP system as "DPHE-Purashava-Private Sector".

In coastal cities, salinity intrusion occurs in about 5 months through a year, so it is not necessary to operate RO filter treatment system continuously. It can be possible to reduce O&M cost by longer performance of filters with intermittent operation, simultaneous use of power generation with natural energy, and use of rapid filtration device during the rain season.

Pilot project includes confirming lifespan of RO filter, establishing stock method of filers, developing human resources, implementing attitude survey of beneficiary, installing power generator with natural energy, implementing market research for spare parts, and so on.

d) Third Stage (from the second year to the forth year)

Data collected by Second Stage are analyzed and publicized for Bangladeshi Government and related agencies to raise their recognition of effectiveness of for RO filter treatment system by continuous informative activities and propaganda to Bangladeshi Government on effectiveness of the equipment.

e) Forth Stage (from the second year to the forth year)

Technology transfer on production, operation and maintenance is implemented in the pilot project, and price-reduction is promoted.

2) Points of concern

a) Water tariff is estimated as 66 taka/household/month. It is necessary to select carefully the coverage area in Barisal City in order to collect tariff definitely.

b) It is necessary to select public areas for the plant site because of easy land acquisition

c) The initial cost of this pilot project is relatively high as 150 million yen for water supply for 2,500 people ($50m^3$/day). For future business, self efforts by Japanese companies for cost reduction and remodeling are necessary.

3) Environmental and social considerations

The following points are main environmental and social considerations for construction of facilities and land acquisition.

(a) Effects on social infrastructure and service

Implementation of the projects can affect on the existing traffic for schools, hospitals and so on. Careful examination is necessary for making construction plan and options for circuit.

(b) Effects on natural environment

In order to avoid the accumulation of salinity in the sea, effluent from for RO filter treatment system will be discharged in off shore. The countermeasure should be examined to avoid the effects on marine life.

(4) Implementation schedule

The period of this project is 4 years in which for RO filter treatment system is installed, social survey, O&M of the device and market research are implemented.

5.5.2 Draft TOR for Project for Surface Water Supply in Local Cities

(1) Outline

1) Target area: Local City

2) Facility

Local production, sale and operation and maintenance of special cleaning filtration device

3) Implementation agency

a) Implementation agency for construction: DPHE
b) Implementation agency for operation and maintenance: PWSS (Pourashava)

(2) Purpose

In order to convert water source from groundwater to surface water, purification treatment is newly necessary for safe water supply in local cities in Bangladesh. Purification facility will be small in such cities, so rapid filtration device, which is one of the Japanese technologies, and its market will be expected to be applied. In this project, Japanese and local private companies establish Joint Venture, sell products and provide appropriate O&M service in order to contribute to establish sustainable system in water supply service in Bangladesh. Also this project aims to expand this result all over the country and neighboring countries, and to enhance international competitiveness.

The project period is 5 years. In the first year, Japanese private company starts the business and produce devices in local areas of Bangladesh. By the forth year, cost reduction is realized by improvement of device and its operation. After the forth year, it starts to disseminate improved special cleaning filtration device in other local cities.

(3) Contents

The complete Image of this project is shown in Figure 5.4-4.

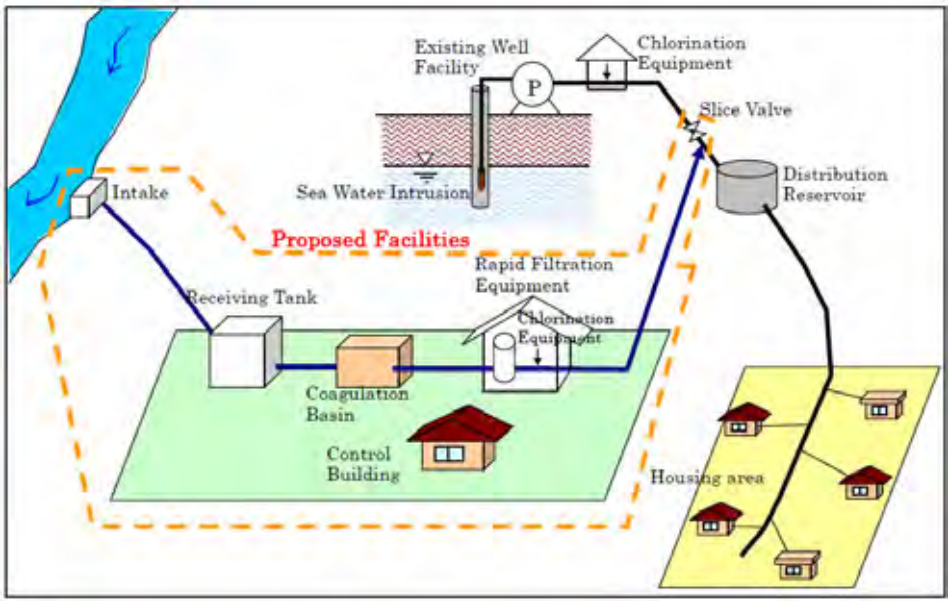


Figure 5.5-2 Complete Image of the Project for Surface Water Supply in Local Cities

The detail explanation is as follows:

1) Improvement of water supply by network piping

Water supply by network piping is improved by the construction/rehabilitation of pipings for the treatment river water purified through the rapid filtration system.

2) Support on water works for workers of O&M in local cities

Private sector develops the capacity on O&M in local cities and supports operation of water works.

3) O&M by the contract

The private sector implements O&M under the long lump-sum subcontract with each Pourashava.

The implementation agency is DPHE. DPHE implements technical support, supervision and monitoring in branches in Pourashavas and rural areas. Each Pourashava has a responsibility of water supply, however, DPHE plays an important role because human resource and techniques are insufficient in each Pourashava. In implementation of this project, the implementation agency will be PPP system as "DPHE-Purashava-Private Sector"

(4) Implementation policy and points of concern

1) Implementation policy

a) Basic implementation flow

- First Stage: Japanese and local companies affiliate and establish the local production and O&M system.
- Second stage: Special cleaning filtration device is applied in a small purification plant with coagulation-sedimentation treatment system and safe water is supplied.
- Third stage: Technology transfer is implemented mainly by a local company. And the local company also improves the device for efficient operation and good effect on environment.
- Forth stage: Improved device is disseminated into small purification plants in other local cities.

b) First stage (in the first year)

In order to apply special cleaning filtration device by Japanese private company, it is important to form an alliance with a local private company initially. At an early stage, the following roles should be completed.

(a) Basic agreement among Japanese and local companies

(b) Detail examination for local production, such as to secure material procurement route, production plant and quality management system, etc.

(c) Establishment of operation system in purification plant

- Training on special cleaning filtration system

Private company provides training for workers in local companies by lecture and field training in Japan

- Training on purification plant

Local companies are received the trainings from local cities and/or WASAs where coagulation-sedimentation treatment system has been already installed. If necessary, training will be implemented with Japanese plant makers.

(d) Suggestion of representative site for purification plant

With Japanese private company, suggestion of plant construction and the representative site is submitted to Bangladeshi Government. As a result of the site survey, the representative areas are local cities in Brahmanbaria, Noakhali, Comila and so on. At present, it is better to select the site in which to secure the surface water easily, and which is the sites with high priority of Bangladeshi Government.

The project requires O&M of the facility under the confidential relationship among DPHE, as the implementation agency for construction, and PWSS, the implementation agency for O&M, and Japanese private company. And Japanese private company needs the support of local private companies to implement business with Bangladeshi Government and public works. Local private companies are expected to implement not only this kind of support, but also improvement of the device cost and O&M.

c) Second stage (in the second year)

Purification plant is constructed only by the budget of DPHE. It is better to construct the plant itself and to utilize the existing network pipings for reduction of the initial cost. In this stage, hopefully

cost-reduction is realized by local production of filtration device. To raise profit, cost-reduction is inevitable. If impossible, this project can be set as non-profit project, however, it depends on the construction budget of Bangladeshi side and policy of companies.

After completion of the construction, water supply service is started based on the basic know how in the first stage. Trainings in the first stage is not enough for actual operation, Japanese private company provides On-the-Job-Training for local private companies and PWSS. Technical cooperation in PWSS and with DPHE is important, however, it can be effective to expand horizontally through the local private companies.

d) Third stage (from the second year to the forth year)

Data collected by Second Stage are analyzed and publicized for Bangladeshi Government and related agencies to raise their recognition of effectiveness of rapid sand filtration equipment by continuous informative activities and propaganda to Bangladeshi Government on effectiveness of the equipment.

e) Forth stage (from the forth year to the fifth year)

Improved device is disseminated into small purification plants in other local cities and industries. In the future, it can be possible to export the device from Bangladesh to neighboring countries, such as India. Regarding to O&M, the same method of the project will be applied.

2) Environmental and social considerations

The following points are main environmental and social considerations for construction of facilities and land acquisition:

(a) Effects on social infrastructure and service

Implementation of the projects can affect on the existing traffic for schools, hospitals and so on. Careful examination is necessary for making construction plan and options for circuit.

(b) Effects on natural environment

In the construction and installation of facility, the counter measure for noise and vibration should be considered. And it is necessary to select the discharge point of cleaning effluent although the effluent volume is reduced as 30 to 50% of existing filtration system.

(5) Implementation schedule

In 5 years, it is realized to produce devices in local areas of Bangladesh, to establish O&M system, to select the plant site, to construct the purification plant, to implement technology transfer, to improve device and its operation, and to start disseminating improved device in other local cities.

APPENDICES

APPENDIX-1

LIST OF COUNTERPART PERSONEL

APPENDIX-1 LIST OF INTERVIEWEE

Bangladesh Central Government

Institutions	Name
Local Government Division (LGD)	
Joint Secretary	Ms. Zuena Aziz
Deputy Secretary (Water Supply)	Mr. Shams Uddin Ahmed
Senior Assistant Secretary	Ms. Syeda Salma Jafreen
Department of Public Health Engineering (DPHE)	
Additional Chief Engineer	Mr. Nurul Islam Khan
Additional Chief Engineer, Planning	Mr. Dewan Naquib Ahsan
Executive Engineer, Computer Division	Ms. Muslema Begum
Assistant Engineer, P&C Division	Mr. Md. Habibur Rahman Talukder
Programmer, Planning Circle	Mr. Md. Shafiqur Rahman
Executive Engineer. (R&D)	Mr. Sudhir Kumar Ghosh
Superintending Engineer, DPHE central laboratory	Mr. Md. Afazuddin Khan
Superintending Engineer(Ground Water Circle) & Project Director (GOB-5)	Mr. Ihteshamul Haque
Deputy Project Director	Mr. Robin Raihan Ahmed
Admin Officer	Mr. Golam Kibria
Local Government Engineering Department (LGED)	
Superintending Engineer(IWRM) & Project Director (SSWRDSP-2)	Mr. Moshiur Rahman
Project Director (UPPRP)	Mr. Ali Ahmed
Bangladesh Water Development Board (BWDB)	
Additional Director General (Operation & Maintenance)	Mr. Md. Mokbul Hossain
Additional Director Genera (Planning)	Mr. M A Taher Khandakar
Water Resources Planning Organization (WARPO)	
Director General	Mr. Dhali Abdul Qaium
Principal Scientific Officer (PSO)	Mr. Saiful Alam
PSU (LGD)	
PD (Deputy Secretary)	Mr. Shariful Alam
Sr. Programme Officer	Mr. Alok Majumder
Senior Sector Adviser (DANIDA: Danish International Development Agency)	Mr. Poul-Erik Frederiksen
BWSPP (DPHE-WB)	
Superintending Engineer and Project Director	Mr. Fariduddin Akhter Khan
STWSSSP (DPHE-ADB)	
Project Director	Mr. S. Shahbaz Hossain
JDCF PROJECT (DPHE-JDCF)	
Superintending Engineer (Planning)	Mr. Monwar Ali
DWSSDP (DWASA-ADB)	
Superintending Engineer	Mr. Mohammad Shah Jahan,
DPHE, Comilla District	
Executive Engineer	Mr. Feiroz Alam Chowdhury
Assistant Engineer	Mr. Md. Shah Alam
Sub - Assistant Engineer	Mr. Md. Shahidul Islam

Institutions	Name
DPHE, Muradnagar, Comilla	
Sub-Assistant Engineer Assistant Engineer	Mr. Md. Golam Mostafa Mr. Kanai Lal Sarker
DPHE, Noakhali	
Executive Engineer Assistant engineer	Mr. Md. Rowshan Alam Mr. AKM Shamsul Haque
DPHE, Gazipur	
Executive Engineer	Mr. Md.Forhad Hossain
DPHE, Chandpur District	
Executive Engineer	Mr. Mr. Mozaffar Ahmed
DPHE, Gopalganj	
Deputy Executive Engineer	Mr. Bidhan Chandra
DPHE, Shariyatpur	
Water Super	Mr. Md. Jahangir Alam

Bangladesh Public Government

Institutions	Name
Dhaka City Corporation	
Chief Slum Development Officer	Mr. Anwar Hossain Patwary
Chandpur Pourashova	
Mayor, Chandpur Pourashova Assistant Engineer Water Super	Mr. Md. Siddikur Rahman Dhali Mr. Asuthosh Datta Mr. Md. Sahab Uddin
Tongi Pourashava	
Chief Executive Officer Superintending Engineer Water Superintendent	Mr. Md. Khairul Ismail Mr. Md. khairul Islam Mr. Md. Anisur Rahman
Brahmanbaria Pourashava	
Water Superintendent Account Officer	Mr. Ataur Rahman Mr. Golan Kawsar,
Noakhali Pourashava	
Mayor, Noakhali Pourashava Water Superintendent Secretary	Mr. Md. Harunur Rashid Azad Mr. Md. Nur Alam manik Mr. Khan Md. Farabi
Gazipur Pourashava	
Mayor, Gazipur Pourashova Water Super	Mr. Md. Abdul Karim Mr. Md. Nazrul Islam
Comilla Pourashava	
Chief Executive Officer Water Super	Mr. Md. Arif Mr. Md. Yousuf
Narsingdi Pourashava	
Executive Engineer Water Superintendent Assistant Engineer Accounts Officer	Mr. Md. Ataur Rahman Mr. Md.Shahidul Islam Mr. Md. Moniruzzaman Mr. Md. Golam Kibria

Institutions	Name
Shariyatpur Parushava	
Mayor, Shariyatpur Pouroshova	Mr. Abdur Rob Munshi
Water Super	Mr. Md. Jahangir Alam
Secretary	Mr. Enamul Huq

Urban Water and Sewerage Corporation

Institutions	Name
Dhaka WASA	
DMD (RP&D)	Dr. Eng. Md. Liakath Ali
Executive Engineer, Saidabad Water Treatment Plant	Mr. S.M. Mostafa Kamal Mazumder
Superintending Engineer	Mr. Abul Hashanat
Superintending Engineer	Mr. Md. Abul Kashem
Deputy Chief Microbiologist	Md. Alamgir Hossain
Chittagong WASA	
Chairman	Mr.A.K.M. Fazlullah
Khulna WASA	
Managing Director	Mr. Md. Abdullah
Deputy Managing Director	Mr. S.M. Jaglul Haider
Deputy Managing Director	Mr. Md. Alimuddin
Deputy Managing Director	Mr. Sk. Md. Moniruzzman
Secretary	Mr. Mofijuddin Ahmed EE

Private Sector

Institutions	Name
D-Water TECH LTD.	
Chairman	Mr. A.I. Joarder
Managing Director	Mr. Jamil D. Ahsan
Chief Technical Consultant	Dr. Raisuddin Miah
Technical Director	Mr. A.A.M. Saiful Islam
Financial Director	Mr. K. Kabir
PQC Japanese standard	
Chairman	Mr. Shibahara Toshihiro
Managing Director	Mr. Akhtaruzzaman
FACILITIES CONCERN	
Proprietor	Mr. Md. Sulaiman
Chief Engineer	Mr. Mir Abdus Salam
SIGMA PUMPS Ltd.	
Chairman	Mr. Syed Md. Kamal
Director	Mr. Md. Mizanur Rahman

NGO

Institutions	Name
BRAC	
Program Head, WASH Program, BRAC	Mr. Milan Kanti Barua
BROTEE	
Chief Executive Officer	Ms. Sharmeen Murshid
Director	Mr. Mahmudul Masud
NGO FORUM	

Institutions	Name
Chief (Arsenic Cell)	Mr. Ahammadul Kabir
HFSKS	
Executive Director	Mr. Refiqul Islam
Rural Community Development Society (RCDS) (Kachua, Chandpur)	
Executive Director Executive Director Upazilla Coordinator	Mr. Sadak Safiullah Mr. Md. Moksadul Alam Mr. Abul Kalam Azad
Center for Integrated Social Development (CISD) (Dhaka)	
Director-Programs	Mr. Nirmal K. Biswas
PLAN	
Upazilla Coordinator - WATSAN	Mr. Proshanto Ranjan Sharma Roy

Aid Agency

Institutions	Name
The World Bank (WB)	
Senior Water and Sanitation Specialist, Water and Sanitation Program, The World Bank	Mr. Abdul Motaleb
Asian Development Bank (ADB)	
Senior Project Implementation Officer, Bangladesh Resident Mission ADB	Mr. Rafiqul Islam

Government of Japan

Institutions	Name
JICA Expert	
Arsenic Mitigation Technical Advisor, Department of Public Health and Engineering Arsenic Mitigation Policy Advisor Local Government Division under Ministry of LGRD & Co-Operative	Mr. Kazuyuki SUENAGA Mr. Masahide SHIMAMURA
Japan External Trade Organization Dhaka Office	
Representative	Mr. Takashi SUZUKI
Embassy of Japan in Bangladesh	
Second Secretary Development Cooperation and Economic Affairs	Mr. Tetsumi TAKAHASHI
JICA Bangladesh Office	
Chief Representative Senior Representative Representative Project Formulation Adviser	Dr. Takao TODA Mr. Shigeki FURUTA Mr. Jin HIROSAWA Mr. Hideki KATAYAMA