WATER SUPPLY AND SANITATION CONDITION OF SELECTED POURASHAVAS IN THE COASTAL REGION

BY

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DECLARATION

This is to certify that the thesis entitled as " Study on Water Supply and Sanitation Condition of Selected Pourashavas in the Coastal Region " has been carried out by Syed Nesar Ahammed in the Department of Civil Engineering, Khulna University of Engineering and Technology, Khulna, Bangladesh. The said thesis work has not been submitted anywhere for award of such type of degree or diploma.

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APPROVAL

This is to certify that the thesis submitted by Syed Nesar Ahammed, Roll No. 991004 entitled as " Study on Water Supply and Sanitation Condition of Selected Pourashavas in the Coastal Region" has been approved by the Examination Committee for the partial fulfillment of Master of Science in Civil Engineering, Department of Civil Engineering, Khulna University of Engineering and Technology (KUET), Khulna, Bangladesh in April, 2008.

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DEDICATION

TO

MY TEACHERS

and

ENGINEERS *who dislike corruption.*

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ABSTRACT

In context of water supply condition, the water supply system (WSS) in the four Pourashavas (PSs) namely Bagerhat PS, Barguna PS, Patuakhali PS and Bhola PS under the study area is based on ground water source. In the study area, there is a treatment plant in Barguna PS based on surface water source which is seldom used due to heavy operation cost and only Patuakhali PS serves 24 hours water supply with metering system to measure water consumption. The nos. of present WS connection are 4100, 2110, 2240 and 2545 with the daily quantity of supply water in M^3 are 4400, 2550, 2000 and 4550 respectively in the said four Pourashavas. The estimated monthly cost for water consumption is 303 Tk /HH in Patuakhali PS which is 1.5 to 4 times as compared to other three PSs namely Bagerhat, Barguna and Bhola because of metering system.

The data and information regarding water supply issues in the study area reflects the practical condition such as ; the average range of water delivery or consumption is 0.90 to 1.77 M^3/HH/day where the highest value is in Bhola PS, the average length of supply pipe 19.97 M/HH, the yearly average increase of water supply connection ranges 6.3% to 14.42% in the area where water supply network is available and the highest value is in Bagerhat PS, the average supply water coverage based on household nos. ranges 13% to 73% and the coverage based on service area ranges 60% to 75% where the highest coverage for both the cases is in Bagerhat Pourashava. The inhabitants without WS connection depend on river, pond, community hand tube well (HTW) or own HTW for their daily usage of water. There is no monitoring step for water quality status in the study area. Twelve water quality parameters were tested in the Laboratory under the study among those, five (Turbidity, TDS, pH, Iron & Manganese) were found satisfactory in all PSs, four (Color, Hardness, Alkalinity & Chloride) were found satisfactory in different three PSs, two (SS and TC) were not satisfactory in all PSs and one (FC) was not satisfactory in three PSs. That is, no Pourashava possesses the BDWQS in full swing.

In context of Pourashava sanitation issues in the four PSs under the study area, solid waste disposal task is not performed accordingly and pollutes the environment, the provision to supply sanitary latrines (rings, top slab with pan) on free of cost is available in all PSs, the regular activities conducted by Pourashava health section are (a) action for national vaccination to the children, (d) TT vaccine for mothers' care, (c) conducting National Days and campaign, (d) action against mosquitoes and (e) supply ARV to dog bitten person. The following data also reflects the complementary status on sanitation issues such as ; the quantity of solid waste collection or disposal is 64% of daily generation, the average solid waste generation in the study area ranges 0.135 to 0.15 Kg /capita /day, the coverage of sanitary larine in the study area ranges 95% to 100% which is satisfactory.

The questionnaire survey conducted among 750 households out of 38,166 in the four PSs on all relevant issues regarding water supply and sanitation condition has explored the peoples' perception (PP) which should not be considered for the entire study area. Regarding water supply condition, according to PP, 35% respondents depend on Pourashava supply water and 23% households installed HTW in their houses with own cost. Regarding sanitation condition, according to PP, 29% respondents expressed "poor consciousness" of Pourashava inhabitants on solid waste disposal and 31% respondents expressed "not satisfactory" on solid waste management status in Pourashava. As per PP, 22% households connect their latrine direct into drain. According to PP, 49% children were attacked by common diseases during the year 2004 due to pollution of water and solid waste. In context of disturbance by mosquitoes, 96% respondents expressed "much disturbance" and 35% of them mentioned the period for almost the year.

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GLOSSARY

Pourashava :	Pourashava is a Bengali term which refers as Municipality.
Kacha drain :	Kacha drain is the earthen drain which is free from any engineering materials. It may be man made or created naturally.
Lakh :	Lakh is a quantitative unit equals to one thousand hundreds.
Nalas :	The term *nalas* is the plural form of *nala* which indicate the branches of canal or narrow canal that covey water.
Pacha Dighi :	Dighi is a defined as the water reservoir which possesses much more depth and area rather than a normal pond. Pacha Dighi is such a reservoir situated at 16 Km from Bagerhat district city.
Basti :	It is the dense slum community influenced by a leader with poor environmental and living condition.

ABBREVIATION AND ACRONYM

ADAB	Association of Development Agencies of Bangladesh
AE	Assistant Engineer
ARV	Anti Rabies Vaccine
Avg.	Average
BD	Bangladesh
BDS	Bangladesh Standards
BDWQS	Bangladesh Drinking Water Quality Standards
BOD	Biological Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BW	Brick Work
CA	Coastal Area
CBO	Community Based Organization.
CI	Conservancy Inspector
CHTW	Community hand tube well
DCE	Department of Civil Engineering
DPHE	Department of Public Health Department
Dia.	Diameter
DM	Draftsman
DNA	Data not available
DO	Dissolved Oxygen
DPHE	Department of Public Health Engineering
ECR	Environmental Conservation Rules
EPI	Extended Program of Immunization
FC	Fecal Coliform
FY	Fiscal Year
GW	Ground Water
Gov.	Government
HI	Health Inspector
HTW	Hand Tube Well
HH	Household

KCC	Khulna City Corporation
KUET	Khulna University of Engineering and Technology.
LGED	Local Government Engineering Department
MCL	Mean Sea Level
MLSS	Member of Lower Subordinate Staff
MSU	Municipal Support Unit
MSW	Municipal Solid Waste
N /A	Not applicable
NEMAP	National Environmental Management Action plan
ND	Not detectable
NGO	Non Government Organization
No. / Nos.	Number / Numbers
NRPL	National Resource Planners Limited
NTU	Nephelometric Turbidity Unit
OTW	Own tube well.
PP	People's Perception
PRSP	Poverty Reduction Strategy Paper
PS / PSs	Pourashava / Pourashavas
PS SW	Pourashava supply water
PW	Production Well
PWS	Pourashava Water Supply
RCC	Reinforcement Cement Concrete
RMSU	Regional Municipal Support Unit
RNA	Record not available
RP	Respondents' perception
R /P	River /Pond
S (WS)	Superintendent (Water Supply)
SAE	Sub–Assistant Engineer
SC	Specific Conductance
SDC	Sanitary and Drainage Condition
SI	Sanitary Inspector
STIDP	Secondary Towns Infrastructure Development Project

STIFPP	Secondary Towns Integrated flood Protection Project
SW	Supply Water, Solid Waste
SWMP	Solid Waste Management Program
TC	Total Coliform
TH	Total Hardness
TT	Tetanus Toxoid
TP	Test Parameter
TW	Tube Well
TNP	Test not performed
Tk.	Taka
UMSU	Urban Management Support Unit
WASA	Water and Sewerage Authority.
WA	Work Assistant
WB	Water Bill
WEDC	The Water, Engineering and Development Center
WHO	World Health Organization
WQP	Water quality Parameter
WS	Water Supply
WSS	Water Supply System
XEN	Executive Engineer
Yr. / Yrs.	Year / Years

UNITS OF MEASUREMENT

m^3	Cubic Meter
cum	Cubic Meter
cm	Centimeter
Inch.	Inches
ft	feet
lpcd	Liter per capita per day
Mld	Million liters per day.
Mm^3	Million cubic meters.

CHAPTER I
INTRODUCTION

1.1 General

Like most other developing countries in the world, Bangladesh is lagging behind in health and living environment. It has been estimated that over 2.5 billion people in developing countries are at risk from a variety of diseases of which 80% can be related to the inadequate supply of water and the unsafe disposal of waste (Amzad, 1999). Bangladesh has experienced an extremely rapid growth in urban population and the population is more than 28 million (Census, 2001). There has been a phenomenal increase in the level of urbanization and urban growth of Bangladesh for the last three decades. In 1974, the urban population was only 8.78% of the total population while the percentage increased to 23.1% in 2001 and it is estimated that 38.2% of the total population will live in urban areas in 2020 (ADB /SUGR, 2005). A recent survey report conducted by ADB states that 60% of urban population are poor and 40 % are hardcore poor. The rapid growth of population causes a lot of stress to the urban management authority as well as the central government to deliver the basic services like water supply, transport network, drainage and sewerage system, sanitation, garbage disposal, street light etc. to the urban citizens.

In the context of Water supply in urban areas in Bangladesh, only 44% of the urban people are served with tap water supplied by the Pourashavas. Rest percentage of the people are to depend on different sources like - tube wells (shallow/ deep), ponds, canals, rivers etc. to meet their daily demand which are sometimes harmful to health and somewhere insufficient and expensive as well.

In Pourashavas, large fractions of the people live in slum and they are placing serious pressure on urban land and utilities. Environmental concerns and related problems are now threatening urban development as local, national, international and planetary issues. The study on Urban Poverty conducted by ADB states that sanitation condition in the slums are not satisfactory at all, with only 20% of households having access to sanitary latrine. About 22% of households use municipal bins and 38% use ground pits for garbage disposal. The collection rate of municipal solid waste is 40% (Amzad, 1999)

It is often found that the water supply and sanitation system does not run in sustainable condition due to various ill reasons. Lack of effective operation and maintenance is an important reason. Community participation in operation and maintenance in water supply and sanitation system is an important tool for attaining long-term sustainability. This study has been undertaken with a view to establish the baseline condition and to investigate how the community participation can help to attain the sustainable Water supply and Sanitation services covering with drainage and garbage disposal situation in the study area.

1.2 Objective of the Study

The main objectives of this research study in the selected Pourashavas namely Bagerhat, Barguna, Patuakhali and Bhola are stated as follows :

a) To review the existing condition of Pourashava water supply covering with supply system, demand and delivery, cost for consumption.

b) To determine the quality of the Pourashava supply water.

c) To study the existing sanitation condition covering with the drainage system, solid waste disposal, health and hygiene.

d) Finally, to provide recommendations for sustainable and standard practice on water supply and sanitation services in the study area.

1.3 Study Area

The research study was conducted in selected four district level Pourashavas from the coastal region of Bangladesh. They are Bagerhat Pourashava situated in Khulna division, Barguna Pourashava, Patuakhali Pourashava and Bhola Pourashava in Barisal division. A geographical map of Bangladesh is located in page no. 5 showing the four districts Pourashava. In addition, the base maps of the four Pourashavas are under the study area are placed in pages 6, 7, 8 and 9 respectively.

The basic information of the four Pourashavas under study area is stated in the Table 1.01.

Table 1. 01 Basic information on four Pourashavas under study area :

Information parameter		Unit	Status in the 4 Pourashavas			
			Bagerhat	Barguna	Patuakhali	Bhola
01	Date of establishment	Year	01 April 1958	23 July 1973	01 April 1892	10 October 1920
02	Area of Pourashava	Km^2	13.72	12.96	26.00	31.48
03	Population at present	Nos.	70,000	37,000	80,000	60,000
04	Tax payee Households	Nos.	5,579	4,706	17,792	10,089
05	Present WS connection	Nos.	4,100	2210	2230	2545
06	Budget for the FY 2007 -08.	Taka	13,58,47,000	17,10,46,000	18,26,28,000	11,75,40,000
07	Expenditure in the FY 2006 -07.	Taka	2,88,97,000	15,34,91,000	10,71,55,000	5,57,80,000
08	Manpower : Sanction : Available : Vacancy	Nos. Nos. –	132 95 28%	154 62 60%	162 115 29%	134 87 35%

1.4 Structure of the Dissertation

The structures of the thesis consists of eight chapters and other relevant contents stated as follows :

Chapter 1 includes the introduction with background of the study, specifies the objectives of the study, study area with basic information and structure of he dissertation.

Chapter 2 is literature review which states the function of Pourashava, describes theoretical background and relevant issues regarding water supply and sanitation services in Pourashava, the action plan of GOB on water supply and sanitation services. Above all, available data and information in context of home and abroad and relevant case study report have been included in this chapter.

Chapter 3 is research methodology that includes location of study area and the steps of methodology with full conception in brief.

Chapter 4 states the existing scenario of the water supply condition practiced in the Pourashavas under the study area. The chapter is arranged with all relevant data and information regarding water supply in the study area based on investigation on the spot and practical work in the field.

Chapter 5 is an important one where the laboratory tested results of collected water samples from the study areas are reported with graphical presentation. The water quality status and seasonal variation is shown for the four Pourashavas and compared to the conventional water quality standards.

Chapter 6 represents the existing condition of sanitation in the Pourashavas covering waste management, drainage condition, sanitary latrine program, and health and hygiene program in the study area. The chapter is arranged based on investigation on the spot and practical work in the field.

Chapter 7 states the people's perception on water supply and sanitation condition explored from details questionnaire survey in the four Pourashavas under the study area. The survey was conducted in random manner with all probable and possible issues covering the objectives of the research study.

Chapter 8 concludes the findings of the study on water supply and sanitation condition with necessary recommendations for the four districts level Pourashavas namely Bagerhat, Barguna, Patuakhali and Bhola in coastal area of Bangladesh.

Appendix is the complementary part of this report that contains the initial data and information of questionnaire survey, test results for water quality parameter (WQP) of water samples on basis of which the thesis report has been prepared accordingly.

Other contents are listed in page VIII with captioned as 'Table of Content' and arranged accordingly at the beginning of this report. The list of references is placed at the end of conclusion from which necessary and relevant information is quoted for the research study.

1.5 Limitation of the Study

The research study was conducted in four selected district level Pourashavas names as Bagerhat, Barguna, Patuakhali and Bhola base on the activities such as literature review, collection of data and information, water sampling and laboratory analysis, questionnaire survey. There is no similar research study conducted before in the study area and so several times field visits was required for conversation with Pourashava personnel and self observation was adopted on the issues regarding water supply and sanitation in the four Pourashavas. However, adequate cooperation was found from Pourashava personnel for data and information and from Pourashava inhabitants for sharing their ideas through questionnaire surveying. The limitations to be faced in accomplishing in this concern are mainly time, distance of the study area and authentic data. There is no practice to preserve data and information in a systematic manner in Pourashava. Therefore, enough time and effort needed to formulate and accumulate the information accordingly. Further, the questionnaire survey was conducted among 750 households only from the four Pourashavas out of 38,166 households in total. So, the results of peoples' perception should not be considered for the entire study area.

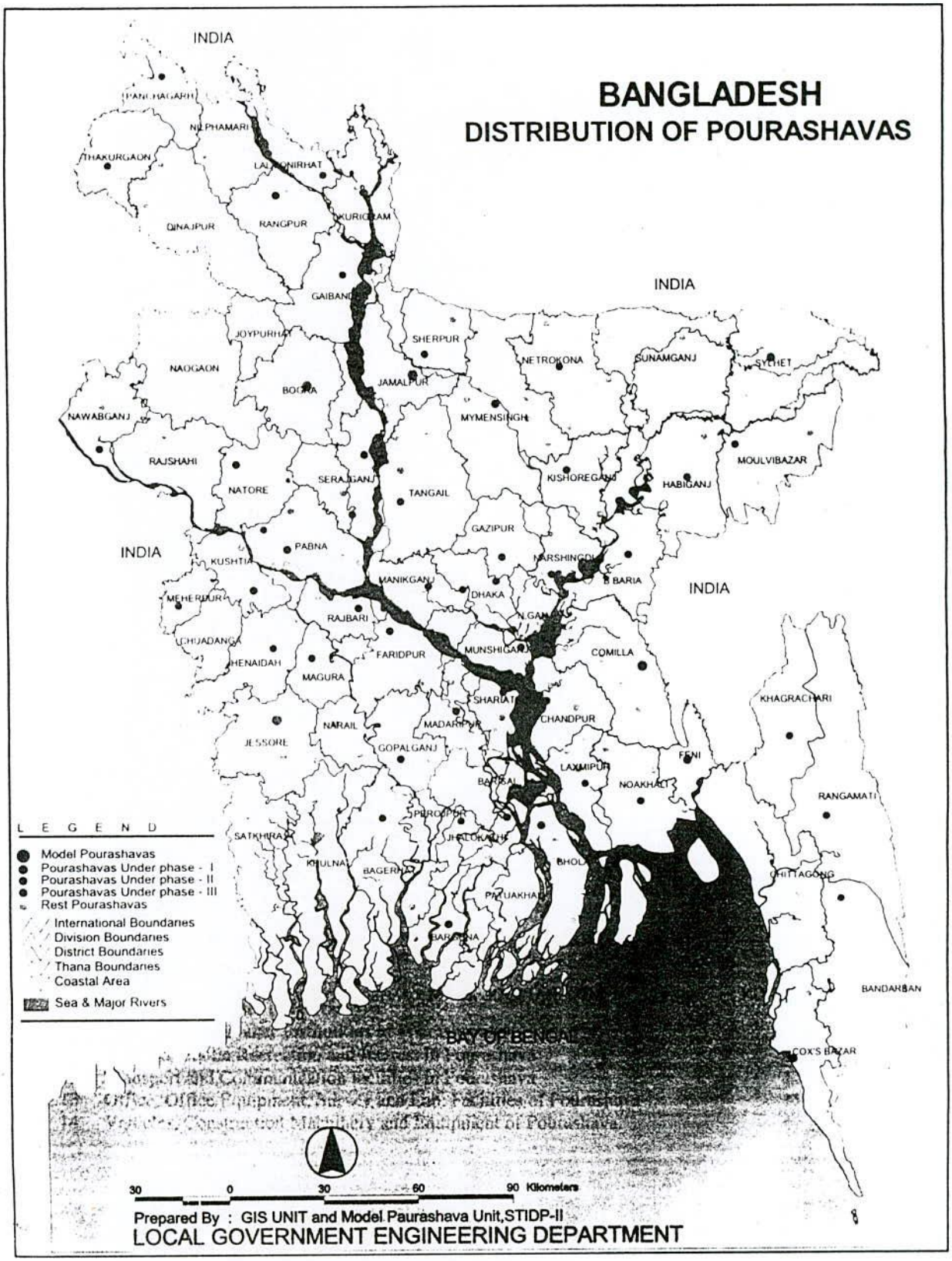


Figure 1.1 Geographical Map of Bangladesh.

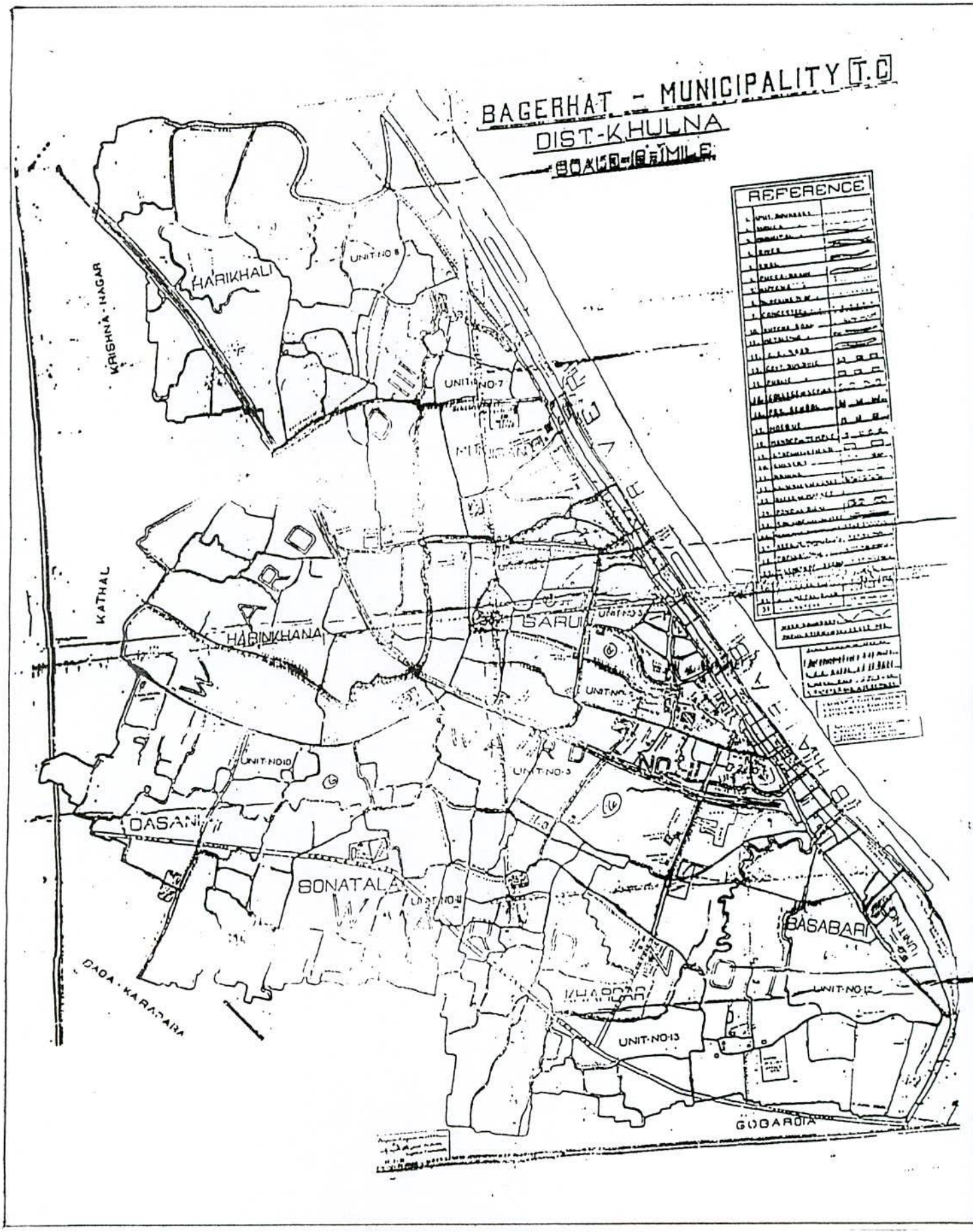


Figure 1.2 Base map of Bagerhat Pourashava.

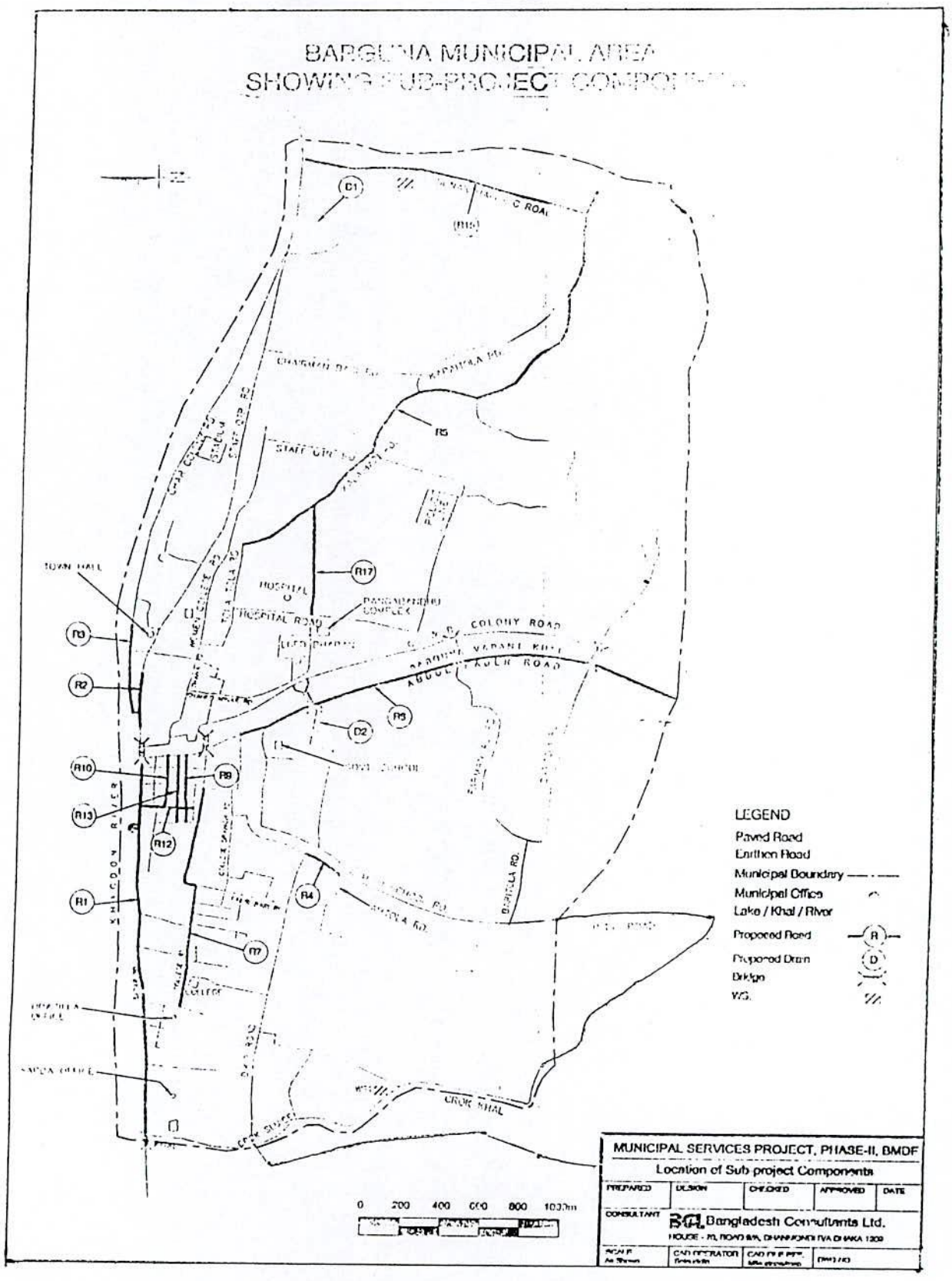


Figure 1.3 Base map of Barguna Pourashava.

Figure 1.4 Base map of Patuakhali Pourashava.

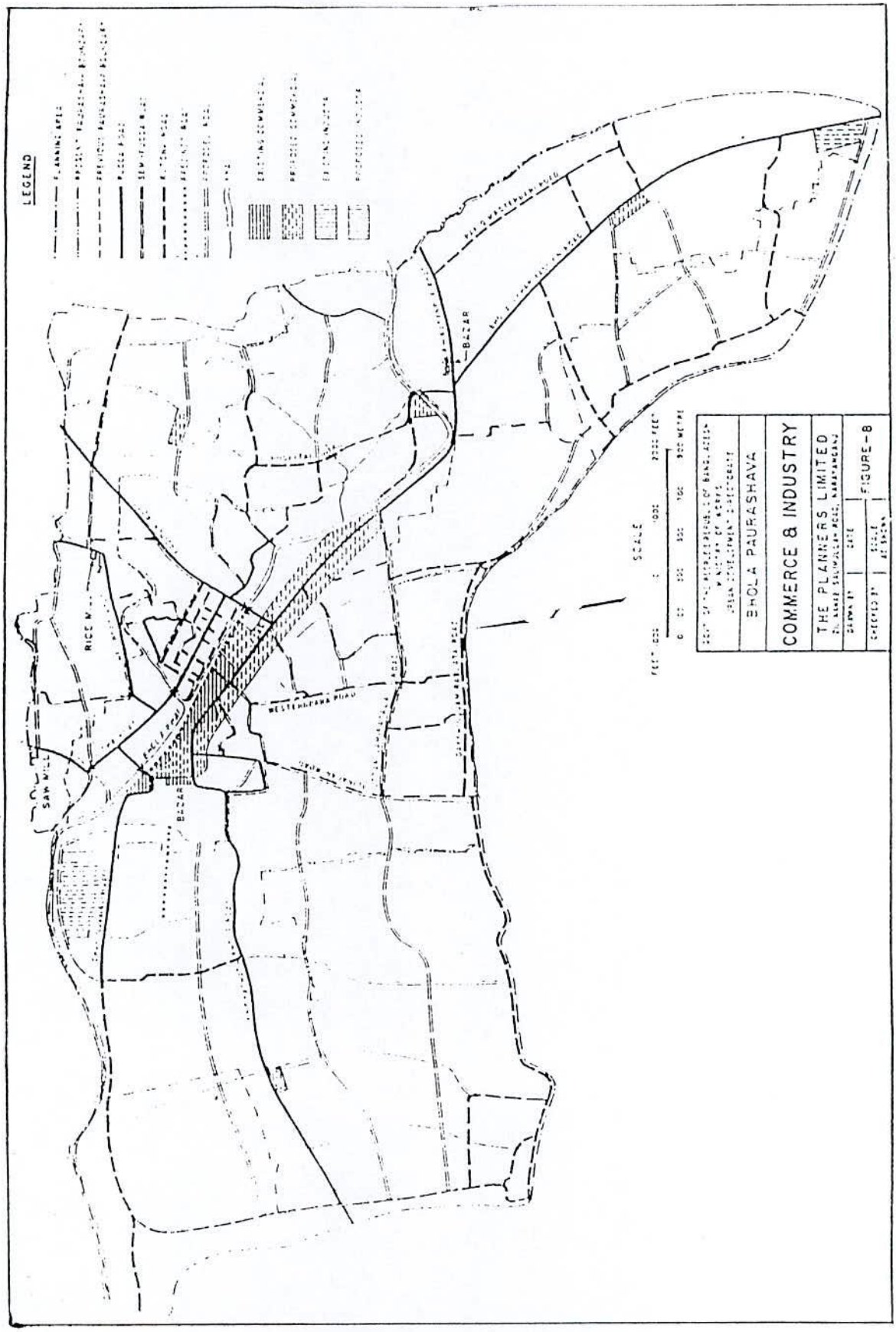


Figure 1.5 Base map of Bhola Pourashava.

CHAPTER II

LITERATURE REVIEW

2.1 General

As regards water supply, sanitation and solid waste management (SWM) sub-sectors in Bangladesh, Local Government Division (LGD) under the ministry of Local Government, Rural Development and Cooperatives at the national level is responsible for overall planning and implementation of investment projects, monitoring and observance of rules governing Urban Local Bodies namely City Corporations and Municipality/ Pourashava and the agencies under it namely DPHE, LGED, WASA, private sectors and NGOs. However, each organization is responsible for its own activities. The roles of the key actors for water, sanitation and SWM sub-sectors in Bangladesh are described as follows.

Department of public Health Engineering (DPHE)

It is the oldest department under the LGD. It gives municipalities technical assistance for water supply, sanitation and drainage services except in Dhaka and Chittagong in accordance in accordance with the National policy for Safe Water Supply and sanitation 1998 DPHE constructs water systems for municipalities and transfers ownership of infrastructure to the municipality concerned after three years of joint operation without any charge for the capital cost recovery. Non-recovery of capital leads to sow tariff charge by the municipalities for the service.

Local Government Engineering Department (LGED)

It is currently responsible for a number of Development project throughout the country covering besides physical interventions, in water supply, sanitation and solid waste management, socio-economic development of slum dwellers and other development activities in the city corporations and municipalities. Its prime responsibility is of a nodal agency for rural development and has also been associated with urban sector development. According to the National policy for safe water supply and supply and sanitation 1998, in particular foreign aided projects where it is specifically required as a component of overall infrastructure development package, LGED may also undertake water supply and sanitation related activities. In such project is similar to DPHE, i.e. technical assistance to Pourashavas.

Water and Sewerage Authority (WASA)

There are three WASAs, Dhaka Water and Sewerage Authority (DWASA), Chittagong Water and Sewerage Authority (CWASA) and Khulna Water and Sewerage Authority (KWASA). Under recent Water Supply and Sewerage Authority Act 1998, the WASAs are responsible for water supply and sanitation in Dhaka and Chittagong City areas only. KWASA is declared by the Government in recent during the year 2008.

Urban Local Body (City Corporation and Pourashava / Municipality)

At present there are 6 City Corporations in Dhaka. Chittagong, Khulna, Rajshahi, Barisal, Sylhet and about 300 municipalities called Pourashava. The city corporations are governed by respective City

Corporation Ordinances, while the municipalities are governed by Pourashava are responsible for such functions as sanitation and environmental pollution control solid waste management, water supply, street lighting, traffic control etc. In addition, they also carry out optional functions regulation of markets, planning and building control, preparation of development plants etc. The City Corporations also carry out same function but without compulsory or optional functions. In fact, urban local government bodies are very much restricted in what they can do through their merger resources and their actual activities depend heavily upon what is required by the central government.

NGOs /CBOs / Private sector: According to ADAB, it is estimated that there are 13,000 welfare NGOs and over 600 development NGOs in Bangladesh. Majority of NGOs are working on rural sectors. Only few NGOs (approximately 40-50) are working in the urban sector. According to different researches the growth of NGOs in terms of both number and amount of funding is explained by the fact that NGO are more responsive to their communities than the government agencies for delivering services in respective areas. In general, NGO roles are seen as complementary to those of government organizations.

Although NGOs and the private sector are currently not fully engaged in provision of municipal services, there are opportunities for their increased involved in doing so and in helping to improve efficiency of municipalities through technical support, training and other services. Already there are good examples of active involvement of NGOs in water, sanitation, and solid waste management projects with government agencies. National Policy for safe water Supply and Sanitation 1998 has also put emphasis on participation of private sector and in water supply and sanitation projects in urban areas. Most important feature on NGOs operating in the urban sector is that they are mainly concerned with organizing and mobilizing the poor so that they are empowered to meet the challenges they have to face. Part of this provided small credit for income generating activities and to provide programs aimed at delivering better facility in health, nutrition, education, literacy, sanitation and so on.

2. 2 Function of Pourashava

Pourashava is empowered to perform a wide range of functions, which provide services to its inhabitants. Pourashava has to cooperate with other GOs or NGOs for some services such as sanitation, sensitization awareness, micro –credit, electricity etc to the citizens. The functions categorized in two types like Compulsory Function and Optional Function is stated below.

Compulsory Functions :

1) Construction and maintenance of roads, bridges and culverts.
2) Removal, collection and dispose of refuse, wastage and rubbish.
3) Provision and maintenance of streetlights.
4) Maintenance of public streets and provision of watering them.
5) Provision and regulation of water supply.

6) Construction and maintenance of public markets and shopping centre.
7) Provision and maintenance of drainage.
8) Provision and maintenance of slaughterhouses.
9) Provision and maintenance of graveyards and cremation grounds.
10) Control erection and re-erection of buildings.
11) Regulation in sanitary buildings.
12) Prevention of infectious diseases and epidemics.
13) Plantation of trees on the roadsides.
14) Registration of births, deaths and marriages.
15) Control over traffic and public vehicles.

Optional Functions :

1) Checking adulteration of food products.
2) Control of private markets and shopping centers.
3) Maintenance of educational institutions and provision of stipends to poor and meritorious students.
4) Provision of flood and epidemic relief
5) Provision and maintenance of parks, gardens and playground.
6) Establish of welfare homes, orphanage and prevention of beggary and organization of social and voluntary services.
7) Establishment of public dispensaries, veterinary hospitals etc.
8) Provision of public toilets.
9) Established public libraries and reading rooms.
10) Registration of cattle sales and improvement of livestock.
11) Celebrations of national holidays.
12) Reception to distinguished guests.
13) Promotion of community development schemes.

In practical, Pourashavas can not be able to perform all functions, mainly due to acute shortage of funds caused by poor collection of taxes, non-realization of taxes from Government and Semi-government establishment for years together and insufficient grants from central Government. In this study, two major services namely, " Water supply " and " Sanitation " were included.

2. 3 National Policy and Strategy

Some important government polices and plans with regard of water supply and sanitation as well as sentimental issues are quoted below.

National policy for water supply and sanitation 1998

The Local Government Division of the Ministry of Local Government Rural Development & Cooperatives has prepared the policy. According to this, government shall follow the following strategies :

- Development of water supply and sanitation sector through local bodies, public private sector, NGOs, CBOs and women groups;
- Gradual cost sharing and introduction of economic pricing for services;
- Promotion of private sector participation through BOO /BOT and other arrangements for urban water supply. For this purpose opportunities will be created for involving the private sector in billing and collection;
- Local Government Bodies (City Corporation and Pourashava) may transfer, where feasible collection, removal and management of solid waste to private sector;
- Materials for compost and biogas production;
- Private sector including NGO participation in sanitation to be encouraged;
- Setting up of community latrines by urban local bodies and leasing out private sector for operation and maintenance. WASAs and relevant agencies shall support any collective initiative by the poor living in slums and squatter settlements having access to water services on payment.

Urban Management policy Statement 1998

The policy prepared by the Government of Bangladesh has clearly recommended the Pourashavas (Municipalities) for privatization of services as well as giving priority development of slums including provision of water supply, sanitation and solid waste disposal. Some of the key features of this policy are :

- In the interest of providing economic, efficient and reliable services, Pourashavas shall endeavor to contract out solid waste disposal, public sanitation, drain cleaning and road maintenance;
- In development of works, Pourashava shall give adequate priority to improvements of sums including provision of water, sanitation water, solid waste management, footpaths, and street lighting. self-help shall be the basis of such development but the Pourashava will provide, necessary facilitation;
- The government support to Pourashavas activities shall be closely linked with the Pourashava effort towards implementing the government policy. Local Government Division shall monitor the performance and implementation of this policy.

Draft National Sanitation strategy 2005

The goal of the National Sanitation Strategy is to achieve 100 % sanitation coverage by 2010. In this strategy sanitation means total sanitation condition for healthy living. The term 100% sanitation means to include the followings :

- No open defecation,
- Hygienic latrines available to all,
- Use of hygienic latrines by all,
- Proper maintenance of latrines for continual usage and
- Improved hygienic practice.

2.4 Pourashava Water Supply Service

Water supply is one of the most important services in Pourashava. This service is obviously an indicator of the standard of quality of life in an urban area namely City Corporation, Pourashava / Municipality. About 25 % population of Bangladesh live in urban areas and only 44 % of the urban people are served with tap water supplied by Pourashavas. Rest of them are to depend on different sources like - tube well (shallow or deep), ponds, canals and rivers to meet their daily demand of water which are sometimes hazardous to health and somewhere insufficient and expensive as well. The lower income people are the worst sufferers because they cannot avail safe drinking water. The Ordinance - 1997 of Pourashava, section 73 for Water supply are quoted below :

- A Pourashava shall within the limits of the funds at its disposal, provide or cause to be provided, to the municipality a supply of wholesome water sufficient for public and private purposes.
- A Pourashava may and if it is required by the Prescribed Authority shall in the prescribed manner, frame and execute of water supply scheme for the construction and maintenance of such works for the provision, storage and distribution of water may be necessary.
- Where a pipe water supply is provided, the Pourashava may supply water to private and public premises in such manner and on payment of such charges as the by-laws may provide.

2.4.1 History of Water Supply

The history of water supply is as ancient as the history of man. Waterworks structures are found in excavations of all prehistoric ruin. The remains of lake at Moeris in Egypt indicate its construction about 2000 BC. Especially notable are the structures of water supply, drainage, sewerage and swimming pools of Mohenjodaro, Roman and Greek civilization. The numerous conduits, which supplied water in ancient Jerusalem, are very old and these were probably constructed during the times of the Kings of Judah, 600 to 900 BC. The water supply of the city of Roam is one of the marvels of ancient times. The water was brought from the surrounding hills in aqueducts totaling about 616 km in length. The first aqueduct, the Apia, was about 16 km long and was built in 315 BC. The Greeks were very skillful in their methods of bringing water to their towns in conduits along contour lines or through tunnels. Ancient water supplies did not have proper treatment methods.

In the flat countries like Egypt, Babylonia and Assyria traversed by rivers subject to floods, water was supplied by means of open canals with large storage basins. Egyptian was known to be using wells in

2100 BC. Wells were also known to have been using in ancient Greece, Italy and artesian wells were sunk in China in early times. The deepest well was about 500m found in China.

John Gibb designed and constructed the first water filter at Paisley in Scotland in 1804. Among the lawyers, Sir Edwin Chadwick (England, 1842) and Lemuel Shattuck (USA, 1850) first warned the public not to drink polluted water. Famous among doctors were Sir (Dr.) Jhon Simon (London, 1942) and Dr. Stephen Smith (New York, 1950) who demanded the purity of public water supplies.

In context of Bangladesh, Nawab Sir Abdul Gani first started the water supply in Dhaka city with the establishment of Dhaka Water Works in 1874. Schemes for the collection of ground water through hand pump tube wells for community water supply in rural areas was taken in 1928.

In the study area, piped water supply system base on ground water was established in 1976 at Bagerhat Pourashava, in 1988 at Barguna Pourashava, in 1976 at Patuakhali Pourashava in 1985 at Bhola Pourashava.

2.4.2 Source of Supply Water

Water exists in solid, liquid and gaseous forms. Ocean and sea is the main sources of water on the earth. The fresh water sources are as liquid form on surfaces and in he ground constituted only about 1% of the total water on earth. The sources of water needed to be treated before supply in Bangladesh are (a) Surface water in rivers, reservoirs, lakes, canals and ponds, (b) Ground water in shallow and deep aquifers. In Bangladesh, ground water and surface water source are depended on each other. Water from surface streams are is the main source of recharge for ground water. The rainwater is an alternative source of water and has good potential for water supply in Bangladesh.

In the study area, ground water is the main source of supply water in all Pourashavas namely Bagerhat PS, Barguna PS, Patuakhali and Bhola Pourashava. In Barguna Pourashava, there is a water treatment plant having capacity 5 lakh liter based on surface water source named as Khardhan river established in 2000 by DPHE funded by Netherlands under 18 Districts Water Supply Project. But, the Pourashava authority seldom runs the plant owing to high operation cost mainly for heavy consumption of electricity for motor. In Bagerhat Pourashava, there is a water reservoir called Pacha Dighi that was used as surface water source before 2002. After then, the reservoir is not used due to scarcity and contamination of water.

2.4.3 Domestic Consumption of Water

The water consumption for domestic purposes can be brought under the broad categories like (a) Drinking, (b) Cooking and preparation of food, (c) Bathing, cleaning, washing and personal hygiene, (d)

Watering of vegetables and gardens, (e) Watering of livestock sanitation loss and wastage, (f) Loss and wastage.

The demand or requirement of water for any a city or a particular community depends on per capita consumption for various purposes. Again, the per capita water consumption is greatly influenced by various factors. Some major factors and the way they affect water consumption are briefly described below (Ahmed & Rahman, 2003) :

a) **Population distribution :**The distribution of the population of community in age groups, religious, sex, socio-economic conditions, profession etc. greatly influences average water consumption.

b) **Climatic conditions :** More water is used in warm and dry climates than in humid and cold climates. Water consumption on a summer day is 30 to 50% higher than the average daily demand.

c) Quality of water : The consumption of good quality water is higher because of good taste, feeling of safety and its suitability for all domestic purposes.

d) Pressure of water : In the case of piped water rate use increases with pressure in the distribution system mainly because of loss through leaks and wastage open through open faucets.

e) **Water rates and metering :** If the cost of water is high, people become more conservative in water use. Metered consumers are more likely to repair leaks close valves, and use water discretion.

f) **Nature of supply :** In piped water supply, the rate of water use with intermittent supply is much less than the use with continuous supply. The non availability of water around the clock restricts may use. Intermittent supplies result in a losses, and wasteful uses of water.

g) Water source : The distance the source of water and the point of consumption play the most important role in water consumption. Accessibility as well as privacy at the source also often influences water consumption.

h) Availability of an alternative source : Availability of alternative sources of water such a river, ponds, lakes, etc. greatly influences the use of a source of water supply for all domestic purposes.

i) **Sanitation :** The quantity of water needed for sanitary purposes depends on type of sanitation facilities. The water requirement is minimal for people using pit latrines and water requirements increase for flush latrines.

In Pourashava, water is not used only for domestic purposes and so additional quantity of water is required to be supplied. The water requirements for various purposes in a community are given in the Table 2.01 (Ahmed & Rahman, 2003).

Table 2. 01 Water requirements for different purposes :

Nature of Consumption	Range of Consumption	Average Consumption, lpcd
Commercial use	10 - 150	40
Industrial use	30 - 450	120
Public uses	10 - 100	25
Livestock	10 - 35	20
Loss and wastage	20 - 150	40

The consumption may widely from place to place and region to region. The water requirements in rural and urban areas of Bangladesh which are used for planning and design of water supply system are given in the Table 2.02 (Ahmed & Rahman, 2003).

Table 2. 02 Water requirements for different area in BD :

Nature of Area in Bangladesh	Water Consumption, lpcd
Rural areas	50
Upazila	100
Zilla town	120
City Corporation	180

The water requirement data mentioned here may be used for planning and preliminary design and may serve as a guide for final design. Studies of existing water supply system in a similar area and collection of primary data by field survey can provide accurate and useful water usage data for the final design.

2.4.4 Community Participation for Water

In Bangladesh, water supply and sanitation systems are mainly installed by Department of Public Health Engineering under different projects financed by the government or donors. The DPHE installed some deep tube wells in the Pourashavas under the study area. The tube wells have been installed in the community on cost sharing system from the beneficiaries. The peoples shared a part of the investment cost of HTW and thus the community participation is ensured. In the Pourashavas under the study area the list of community base HTW is shown in Chapter IV of this report. Also, there is a program under DPHE to install mini water supply system in rural areas with cost sharing system among the beneficiaries.

2.4.5 Water Quality Standards

Many countries in the world have developed drinking water criteria and standards. The World Health Organization (WHO) has been in the forefront in developing water quality standards. The WHO

International Standards for drinking water first published in 1958 were revised in 1963, 1968 and 1971. The WHO also published European Standards, the latest edition of which was published in 1970. The WHO International Standards 1971 and European Standards 1970 were superceded by WHO 1984 guideline values for drinking water quality.

Bangladesh developed the first water quality standards in 1976 based on the WHO 1971 International Drinking Water Standards. The revision of Bangladesh standards for drinking water was felt desirable after publication of the WHO drinking water quality guidelines. The Bangladesh Standard Specification for Drinking Water (BDS 1240: 1989) was prepared and published by the Bangladesh Standard and Testing Institution (BSTI) for the control of drinking water quality standard. The Ministry of Environment and Forests, Government of Bangladesh, adopted comprehensive water quality standards for drinking water by Gazette notification in 1997 as Environmental Conservation Rules (ECR) under the Environmental Conservation Act, 1995. The Bangladesh Drinking Water Quality Standards (BDWQS) with WHO guideline values of water quality parameters (Ahmed & Rahman, 2003) are presented in the Table 2.03.

Table 2. 03 Bangladesh Standards and WHO guideline values for drinking water :

Water quality parameters	Unit	BDWQS	WHO guideline values
1. Aluminum	mg/L	0.2	0.2
2. Alkalinity	mg/L	400	–
3. Ammonia (NH_3)	mg/L	0.5	1.5
4. Arsenic	mg/L	0.05	0.01
5. Barium	mg/L	0.01	0.7
6. Benzene	mg/L	0.01	0.01
7. BOD_5 at 20°C	mg/L	0.2	
8. Boron	mg/L	1	0.3
9. Cadmium	mg/L	0.005	0.003
Calcium	mg/L	75.0	
11. Chloride	mg/L	150 - 600 (1000 for CA)	250
12. Chlorinated alkenes			
Carbon tetrachloride	mg/L	0.01	0.002
1,1 Dichloroethylene	mg/L	0.001	
1,2 Dichloroethane	mg/L	0.03	0.03
Tetrachloroehylene	mg/L	0.03	
Trichloroethylene	mg/L	0.09	
13. Chlorinated phenols			
Pentachlorophenol	mg/L	0.03	
2, 4, 6 Trichlorophenol	mg/L	0.03	0.02
14. Chlorine (residual)	mg/L	0.2	0.6-1.0
15. Chloroform	mg/L	0.09	0.2
16. Chromium (hexavalent)	mg/L	0.05	

Table 2. 03 Bangladesh Standards and WHO guideline values for drinking water :

Water quality parameters	Unit	BDWQS	WHO guideline values
17. Chromium (total)	mg/L	0.05	0.05
18. COD	mg/L	4	
19. Coliform (Fecal)	No/100ml	0	0
20. Coliform (Total)	No/100ml	0	0
21. Color	Hazen	15	15
22. Copper	mg/L	1.0	1.0
23. Cyanide	mg/L	0.1	0.07
24. Detergents	mg/L	0.2	
25. Dissolved oxygen	mg/L	6	
26. Fluoride	mg/L	1	1.5
27. Hardness (as $CaCO_3$)	mg/L	200-500	
28. Iron	mg/L	0.3-1.0	0.3
29. Kjehldal Nitrogen (total)	mg/L	1.0	
30. Lead	mg/L	0.05	0.01
31. Magnesium	mg/L	30-35	
32. Manganese	mg/L	0.1	0.1
33. Mercury	mg/L	0.001	0.001
34 Nickel	mg/L	0.1	0.02
35. Nitrate	mg/L	10.0	50.0
36. Nitrite	mg/L	<1.0	3.0
37. Odor	mg/L	Odorless	
38. Oil and grease	mg/L	0.01	
39. pH	-	6.5-8.5	
40. Phenolic compounds	mg/L	0.002	
41. Phosphate	mg/L	6.0	
42. Phosphorus	mg/L	0	
43. Potassium	mg/L	12.0	
44. Radioactive substances			
Total alfa radiation	Bq/L	0.01	
Total beta radiation	Bq/L	0.1	
45. Selenium	mg/L	0.01	0.01
46. Silver	mg/L	0.02	
47. Sodium	mg/L	200	200
48. Suspended solids	mg/L	10	
49. Sulphide	mg/L	0	
50. Sulphate	mg/L	400	250
51. Total dissolved solids	mg/L	1000	1000
52. Temperature	°C	20-30	
53. Tin	mg/L	2	
54. Turbidity	NTU	10	5
55. Zinc	mg/L	5	3

2.4.6 Water Supply Information in Study Area

The study on water supply was conducted on all relevant parameters. The summery of data and information regarding water supply system in the four Pourashavas under the study area is reflected at a glance in the Table 2.04 (Source : Pourashava Office).

Table 2.04 Basic information of WS Parameters in four Pourashavas :

Information Parameter		Unit	Status in the 4 Pourashavas			
			Bagerhat	Barguna	Patuakhali	Bhola
01	Source of Supply Water	--	GW	GW, SW	GW	GW
02	Start of WS System	Yr.	1976	1988	1976	1985
03	Overhead Tank	No.	1	0	2	0
04	Production Well for WSS	No.	6	7	5	7
05	Diameter of Production Well	cm	150	150	150	150
06	Depth of Aquifer (avg.)	m	300	300	300	300
07	Total household (HH) connection	No.	4110	2110	2230	2545
08	Free service connection	No.	130	10	Nil.	70
09	Total length of distribution pipeline	Km	77	43.40	47.93	48.50
10	Length of distribution pipeline	M /HH	18.78	20.56	21.49	19.05
11	Daily Total supply of water (avg.)	M^3	4400	2550	5800	4550
12	Daily Supply of water (avg.)	M^3 /HH	0.97	1.20	2.37	1.78
13	Daily Duration of supply (avg.)	Hour	20	11	20	10
14	WB collection status	%	90	98	86	80

2.4.7 Data and Information on Water Supply

The research study on water supply has been conducted in a few urban local bodies i.e. Pourashava or City Corporation by the students / teachers from educational institutions and some NGOs with help of foreign supported projects. They can not conduct the same for all such bodies in Bangladesh. Also, the local urban bodies that possess the water supply system have no initiative or action regarding this to monitor and improve the status of the service. In this study report, some data and information regarding water supply status are reviewed and quoted as a part of the study.

2.4.7.1 Water Supply in Khulna City Corporation

There are a few research studies on water supply system of Khulna City Corporation (KCC) under DCE, KUET conducted in recent. Some data and information on water supply from a study report (Mohsin, 2007) is quoted in the Table 2.05.

Table 2.05 Basic information of WS in Khulna City Corporation :

Information Parameter		Unit	Status
01	Source of Supply Water	--	Ground water (97 %) mainly and Surface water 3 % only.
02	Water supply coverage	--	25 % population and administratively 23 wards out of 31.
03	Demand of water	Cum /day	71,000.
04	Supply against demand	%	37.60.
05	Production well	Nos.	50
06	Total household connection	Nos.	11000.
07	Total length of distribution pipeline	Km	226.43
08	Length of distribution pipeline	M /HH	20.05
09	Street hydrant	Nos.	503.
10	Public HTW (deep)	Nos.	956.
11	Public HTW (shallow)	Nos.	4753.
12	Private HTW (deep)	Nos.	1500
13	Overhead tanks	Nos.	5. (Total capacity 8 lakh gallons)
14	Mini surface treatment plan	Nos.	1. (Capacity 1 lakh gallon)
15	Area of KCC	Km^2	45.65
16	Population of KCC	Million	0.9 (NRPL, 2004).

2.4.7.2 Water Supply in Kathmandu Valley, Nepal

The summery information on water supply for Kathmandu Valley, Nepal presented in by Laxmam. Kharal (WEDC, Conference - 2000) is quoted in the Table 2.06.

Table 2.06 Summery information of WS for Kathmandu Valley, Nepal :

Information Parameter		Unit	Status
01	Area of Kathmandu Valley floor	Km^2	400.
02	Valley altitude above MSL	m	Range from 1300 m to 1400 m.
03	Population in the Valley	Million	1.10.
04	Surface water sources	Nos.	24.
05	Water sources developed during	Year	1896 – 1994.
06	Deep tube wells drilled after 1983	--	37 Nos. having total production 30 mld and coverage service area of 70 Km^2
07	Total WS capacity in Kathmandu Valley	mld	80 in dry season, 120 in wet season.
08	Total demand of warer in Kathmandu.	mld	160.
09	Total WS connection in Kathmandu.	Nos.	100,000 including 1278 public tap stands.
10	Distribution system consists of	--	Pipes of ductile irons, cast iron, galvanized iron and HDPE of sizes 25 mm to 800 mm.
11	Limitation of supply system.	-. ..-	# Not possible to supply water for 24 hrs. in some low-lying area. # No arrangement of water supply in some areas near transmission mains.

2.4.7.3 Water Supply in Hong Kong City

The summery information on water supply for Hong Kong presented by Tang (WEDC, Conference, 2000) is quoted in the Table 2.07.

Table 2.07 Summery information of WS for Hong Kong City :

Information Parameter		Unit	Status
01	Area of Hong Kong City	Km^2	1,000.
02	Population	Million	7.
03	Establishment of duel WS System	Year	1950.
04	Duel water supply system (Viability)	--	With two separate distribution networks for potable (fresh water) and non-potable (sea water). The system is viable large urban areas in coastal zones.
05	Avg. annual demand of fresh water	--	1 billion cubic meters.
06	Need to purchase 70 % of fresh water quantity for Hong Kong city from China (WSD, 1996).	--	Extracted from Dongjiang river at Guangdong Province of China 83 Km from northern boundary of Hong Kong.
07	Information on - Fresh water supply system	:	--
A	# Distribution network - Length	--	Total 4800 Km water mains.
B	# Service reservoir- Nos. with total capacity.	--	Total 166 nos. with capacity of 3.42 Mm^3.
C	# Pumping station - Nos. with total capacity.	--	Total 141 nos. with capacity of 28.57 Mm^3 / day.
D	# Treatment plant - Nos. with total capacity.	--	Total 19 nos. and capacity of 4 Mm^3 / day.
E	# Treatment processes adopted	--	Mixing and coagulation (with alum) – Flocculation – Sedimentation– Rapid gravity filtration– Disinfection.
08	Information on - Sea water supply system	:	--
A	# Distribution network - Length	--	Total 1100 Km water mains.
B	# Service reservoir- Nos. with total capacity.	--	Total 49 nos. with capacity of 0.2 Mm^3.
C	# Pumping station - Nos. with total capacity.	--	Total 38 nos. with capacity of 1.43 Mm^3 / day.
D	# Treatment processes adopted	--	Screening and disinfection.
09	Annual Expenditure (1999) for duel WSS	HK $	Total (A + B + C)
A	# Operation and administration	HK $	1,165 million. (47 % for light & power, 26 % contact maintenance).
B	# Water purchase from China	HK $	2,300 million.
C	# Staff	HK $	1,280 million.
10	Annual Expenditure in total (A + B + C).	HK $	4,745 million (Excluding capital investment).

2.4.8 Data and Information on Water Quality

There are a few research studies on water quality status for urban local bodies i.e. Pourashava or City Corporation conducted by the students / teachers from educational institutions and some NGOs with help of foreign supported projects. They can not conduct the same for all such bodies in Bangladesh. Also, the local urban bodies that possess the water supply system have no initiative or action to monitor

the status of water supplied them. In this study report, some data and information on water quality status are quoted as a part of the study.

2.4.8.1 Water Quality of Selected Slums in KCC

In Khulna City Corporation (KCC), water quality parameters were tested from some deep tube wells during the year 2006 under DCE, KUET (Rahman & Hasan, 2007). Total twelve parameters were tested from tube wells water of ten specified slums in KCC. The test result comparing with BDWQS is shown in the Table 2.08 (a) and 2.08 (b).

Table 2.08 (a) Result (avg.) of WQP for selected slum in KCC during the year 2006 :

Name of Slum, KCC Ward No.		pH	SC (µS/cm)	Color (Pt -Co)	TDS (mg/L)	Turbidity (NTU)	TH as $CaCO_3$ (mg /L)
WQP Sl. No. =		1	2	3	4	5	6
BDWQS =		***6.5 – 6.8***	--	**15**	**1000**	**10**	***200 – 500***
01	Kuli Bagan, Ward No. 03	7.6	526.5	1.5	861	1.8	240.8
02	Khalispur Bhasti Ward No. 07	7.5	134.3	2	780	1.4	187.5
03	Crecent Kacha Lane Ward No. 08	7.9	418.1	0	743.7	1.6	212.4
04	Syed Munshir Ward No. 09	7.7	654.1	1	657.8	2.35	128.5
05	Nayabati Ward No. 10	7.3	382.2	5	704.3	2.4	170.8
06	No. 1 Khema Ward No. 12	7.8	206.2	5	726	1.8	187.1
07	Alam Nagar Rail side Ward No. 13	8	500	3	748	1.2	167.1
08	Sonadanga Poura Colony, Ward No. 17	7.8	340.6	0	797.7	1.3	195.1
09	Rupsha Char Ward No. 22	8.1	420.3	1	767.5	2.5	159.4
10	GNB Khal Road Side Ward No. 25	7.5	397.1	0	763	2.2	168.5

Table 2.08 (b) Result (avg.) of WQP for selected slum in KCC during the year 2006 :

Name of Slum, KCC Ward No.		Chloride (mg/L)	TC (N/100ml)	FC (N/100ml)	Fluoride (mg/L)	Iron (mg/L)	Mg (mg/L)
WQP Sl. No. =		7	8	9	10	11	12
BDWQS =		***150 -- 600***	**0**	**0**	**1.0**	**0.3 – 1**	***0.1***
01	Kuli Bagan, Ward No. 03	96.2	1	0	1.4	0.2	0.1
02	Khalispur Bhasti Ward No. 07	126.3	1	0	1.2	0.4	0.2
03	Crecent Kacha Lane Ward No. 08	162.5	0	0	1	0.5	0.1
04	Syed Munshir Ward No. 09	175.5	1	0	1	1.3	0.1
05	Nayabati Ward No. 10	144.1	0	0	3.3	0.3	0.1
06	No. 1 Khema Ward No. 12	97.9	0	0	1.1	0.6	0.1
07	Alam Nagar Rail side, Ward No. 13	160	0	0	1.3	0.4	0.1
08	Sonadanga Poura Colony, Ward No.17	123.9	0	0	0.8	0.5	0.2
09	Rupsha Char Ward No. 22	149.7	0	0	0.9	0.5	0.1
10	GNB Khal Road Side, Ward No. 25	99.1	0	0	0.8	0.9	0.2

It is found from the results that all the water quality parameter (WQP) except Chloride (mg /L) are acceptable and satisfied BDWQS. The content of Chloride is less than the lower limit of BDWQS The results of TDS for some water samples exceeds the BDS limit. The bacteriological parameter such as TC and FC were hardly found in the water samples.

2.4.8.2 Water Quality of Hotels and Restaurants in KCC

A study was conducted for 167 nos of different hotels and restaurant in Khulna City conducted under DCE, KUET during the year 2006 (Mahmud & Rana, 2007). Most of those used tube well water for drinking purpose. The summery results of eight water quality parameters (WQP) comparing with BDWQS is shown in the Table 2.09.

Table 2.09 Summery results of WQP for hotel and restaurant in KCC during the year 2006 :

Water quality parameter		Unit	Test result		BDWQS value
			Maximum	Minimum	
01	pH	--	9..2	6.21	6.5 – 6.8
02	Specific Conductance	(µS/cm)	3502	471	--
03	Color	Hazen	20	0	15
04	Turbidity	NTU	14.3	0.42	10
05	Total Hardness as $CaCO_3$	Mg /L	452	63.8	200 - 500
06	Fe Concentration	Mg /L	2.1	0	0.3 – 1
07	TC	N/ 100ml	30	0	0
08	FC	N/ 100ml	27	0	0

It is found from the results that maximum value of pH exceeded the BD guild line value and the minimum value is also below of lower limit. Some samples contain greater value of Iron (Fe) as compared to BDS. The bacteriological parameters, TC and FC were also found in some samples.

2.4.8.3 Water Quality of Selected Water Taps in KCC

A study was conducted for 23 nos. of tap water source from 23 different wards in Khulna City conducted under DCE, KUET (Mohsin, 2007). The samplings were performed in three seasons namely rainy, winter and summer of 2006. They are all from taps of deep tube wells in 23 wards of KCC. The summery result of 15 water quality parameters comparing with BDWQS is shown in the Table 2.10.

Table 2. 10 Summery results of WQP for three seasons in KCC during the year 2006 :

Water Quality Parameter		Unit	Results in three seasons			BDWQS
			Rainy	Winter	Summer	
01	Turbidity	(NTU)	3.44	3.73	3.5	10
02	Color	Pt.– Co.	13.39	14.1	14.78	15
03	Temperature	^0C	26.9	19.5	26.3	20 -- 30
04	pH	-	7.7	7.9	7.4	6.5 – 6.8
05	Alkalinity as $CaCO_3$	mg / L	214.78	192.8	201.5	400
06	Conductivity	µS /cm	1251	1190	1542	600 –1000
07	TDS	mg / L	810	852.6	903	1000
08	Fluoride	mg / L	0.26	0.22	0.26	1
09	Sulphate	mg / L	1.62	1.51	1.7	400
10	Nitrate	mg / L	0.8	0.82	1.1	10
11	Chloride	mg / L	187	291	212.8	250
12	TC	N/ 100 mg/L	46	43.35	42.48	0
13	FC	N/ 100 mg/L	19.61	15.13	16.91	0
14	Escherichia Coli	N/ 100 mg/L	5.52	5.13	6.48	0

It is found from the results that the value of Sulphate is very low as compared to BD guild line value. The bacteriological parameter such as TC, FC and E- Coli are found in all the water samples.

2.4.8.4 Water Quality of Comilla Pourashava

In Comilla, water quality parameters were tested from different locations during the year 2001 under STIDP, LGED (PAR, 2001). Several tests were conducted against 17 selected locations in the Pourashava. The test result comparing with BDWQS is shown in the Table 2.11 (a) and 2.11 (b).

Table 2.11 (a) Result of WQP of selected locations in Comilla Pourashava during the year 2001 :

Location of Water Samples in Comilla Pourashava		pH	EC (mg/L)	TDS (mg/L)	Turbidity (JTU)	DO (mg/L)	BOD (mg/L)
WQP Sl. No. =		1	2	3	4	5	6
BDWQS =		***6.5 -- 6.8***	**800-1000**	**1000**	**10**	***4 -- 6***	***SW = 50 GW = 0.2***
Out falls :							
01	In front of Zilla school	6.8	220	132	4	0.5	0.5
02	Tomson bridge	7	900	540	4	1.9	0.4
03	Kaliajuri	7.3	450	270	24	1	0.5
Ponds :							
04	Fire service, Bagichagaon	6.5	275	165	8	5.5	3.5
05	Ujir Dighee	6.5	265	159	8	4	2.5
06	Sadar Hospital	7	300	180	3.5	1.7	0.7
07	Ranir Dighee	6.8	90	54	38	5.6	5.6
Production tube wells :							
08	Gobindapur	6.5	Not done	Not done	Not done	Not done	0.6
09	Bisnapur	7.1	Not done	Not done	Not done	Not done	0.7
Hand tube wells :							
10	Pourashava Office	7	Not done	Not done	Not done	Not done	Not done
11	Zilla School road, Kandirpur	6.9	Not done	Not done	Not done	Not done	Not done
12	BNCC office, Ranir Dighi	7.1	Not done	Not done	Not done	Not done	Not done
13	Jail Primary school	6.9	Not done	Not done	Not done	Not done	Not done
Street taps :							
14	Zilla school gate	6.7	Not done	Not done	Not done	Not done	Not done
15	Near Juba Unnayan Office	6.9	Not done	Not done	Not done	Not done	Not done
16	Shapla bus, Baganbari	7.2	Not done	Not done	Not done	Not done	Not done
17	Near DIG Banglo, DC road	6.7	Not done	Not done	Not done	Not done	Not done

Table 2.11 (b) Result of WQP of selected locations in Comilla Pourashava during the year 2001 :

Location of Water Samples in Comilla Pourashava		Mg	Total Hardness (mg/L)	Iron (mg/L)	Chloride (mg/L)	TC (N /100 ml)	FC (N /100 ml)
WQP Sl. No. =		7	8	9	10	11	12
BDWQS =		*0.1*	**200 - 500**	**0.3 -- 1**	**150 -- 600**	*0*	*0*
Out falls :							
01	In front of Zilla school	0.09	Not done	Not done	16	32	10
02	Tomson bridge	0.09	Not done	Not done	112	105	55
03	Kaliajuri	0.18	Not done	Not done	48	45	25
Ponds :							
04	Fire service, Bagichagaon	ND	Not done	Not done	40	106	64
05	Ujir Dighee	0.045	Not done	Not done	30	210	140
06	Sadar Hospital	0.045	Not done	Not done	56	0	0
07	Ranir Dighee	ND	Not done	Not done	4	0	0
Production tube wells :							
08	Gobindapur	0.045	100	2.43	32	0	0
09	Bisnapur	0.045	86	3.11	64	0	0
Hand tube wells :							
10	Pourashava Office	0.045	70	0.62	14	0	0
11	Zilla School road, Kandirpur	ND	80	0.31	48	0	0
12	BNCC office, Ranir Dighi	0.045	68	2.27	62	0	0
13	Jail Primary school	0.045	82	2.38	54	0	0
Street taps :							
14	Zilla school gate	ND	70	1.97	8	24	0
15	Near Juba Unnayan Office	0.045	144	1.97	56	17	0
16	Shapla bus, Baganbari	0.045	114	2.49	58	32	7
17	Near DIG Banglo, DC road	0.045	80	1.35	32	160	48

It is found from the results that high degree of iron content in drinking water in Comilla Pourashava remains a matter of concern. The presence of Total Coliform and Fecal Coliform in some of the drinking water sources is also highly undesirable. The presence of chloride in all the samples is less than the lower limit of Bangladesh Drinking Water Quality Standards (BDWQS). The other water quality parameters (WQP) are found almost satisfactory.

2.4.9 Effect of Impurities Present in Water

Pure water is not available in nature and not desirable for water supply. The impurities present in natural water may be grouped into the four categories like (a) impurities of mineral origin, (b) impurities of organic organ, (c) living impurities and (d) radioactive. These impurities are present in a form of

suspension, solution or pseudo solution. The effects of some of the impurities on water and human health are presented in the Table 2.12.

Table 2.12 Effect of impurities present in water on human health :

Impurities	Effect on water	Effect on health
Living impurities :		
◘ Bacteria	◘ Turbidity at high concentration	◘ Diseases
◘ Viruses	---	◘ Diseases
◘ Algae, protozoa, fungi	◘ Turbidity, odor, color	◘ Diseases, toxicity
Impurities of mineral and organic origin :		
◘ Silt and clay	◘ Turbidity	--
◘ Salt of calcium and magnesium	◘ Hardness, alkalinity, taste, corrosiveness and scale formation	--
◘ Salt of Sodium	◘ Alkalinity, salinity, foaming, taste, scaling	--
◘ Fluorides	---	◘ Tooth decay
◘ Nitrate	◘ Algal growth	◘ Child disease
◘ Iron and manganese	◘ Taste, hardness, scaling	--
◘ Arsenic, lead, heavy metals	---	◘ Toxicity
◘ Vegetable dyes	◘ Color, acidity	◘ Diseases
Gases		
◘ Oxygen	◘ Corrosiveness, taste	--
◘ Carbon dioxide	◘ Acidity, corrosiveness	--
◘ Hydrogen sulphide	◘ Odor, corrosiveness, acidity	◘ Toxicity
Radioactive impurities	--	◘ Diseases

2.4.10 Water Borne Disease

The most important parameter of dirking water quality is the bacteriological quality, i.e. presence of pathogenic organisms. The water borne diseases are caused by the ingestion of pathogens with drinking water. The impurities present in water may be grouped into four categories such as impurities of mineral origin, impurities of organic origin, living impurities and radioactive impurities (Ahmed & Rahman, 2003). The common water borne diseases is shown in the Table 2.13.

Table 2.13 Common water borne pathogenic microorganisms in water and diseases :

Organisms	Diseases
Viruses	
◘ Enteric cytopathogenic human orphan (ECHO)	◘ Aseptic meningitis, infantile diarrhea
◘ Poliomyelitis	◘ Acute anterior poliomyelitis, infantile paralysis
◘ Unknown viruses	◘ Infectious hepatitis
Bacteria	

Table 2.13 Common water borne pathogenic microorganisms in water and diseases :

Organisms	Diseases
▫ Francisella tularensis	▫ Tularemia
▫ Leptospirae	▫ Leptospirosis
▫ Salmonella paratyphi	▫ Paratyphoid fever
▫ Salmonella typhi	▫ Typhoid fever
▫ Shigella	▫ Shigellosis (bacillary dysentery)
▫ Vibrio comma (Vibrio cholerae)	▫ Cholera
Protozoa	
▫ Entamoeba histolytica	▫ Amebiasis
▫ Giardia lamblia	▫ Giardiasis
Helminths (parasitic worms)	
▫ Dracunculus medinensis	▫ Dracontiasis
▫ Echinococcus	E▫ chinococcosis
▫ Schistosoma	▫ Schistosomiasis

2.5 Pourashava Sanitation Service

The word sanitation actually refers to all conditions that affect health. The aim of sanitation program in Pourashava is to improve health condition in the Pourashava area. Sanitation may be defined as the science and practice of effecting healthful and hygienic condition and involves the study and use of hygienic measures such as (a) safe, reliable water supply, (b) proper drainage of wastewater and (c) proper disposal of all human waste, prompt removal of all refuse.

Sanitation is necessary to overcome the effects of man's activities on his environment. The increase in population and the movement of population into urban areas (Pourashava and City Corporation) have intensified environmental-control difficulties in those areas. The provision of safe water; the collection and disposal of human, domestic, and industrial wastes; the prevention of atmospheric pollution and stream pollution and the control of ionizing radiation are becoming more difficult from year to year.

2.5.1 Sanitation and Health

It is important to understand that the improvement of health is not possible without sanitary disposal of human excreta. However, neither sanitation nor water supply alone is good enough for health improvement. It is now well established the health education or hygiene promotion must accompany sufficient quantities of safe water and sanitary disposal of excreta to ensure the control of water and sanitation related diseases. The people have poor understanding about the link between poor hygiene and disease. Only 26.7 % of people their hands with water, soap or ashes after defecation, and only 3% wash their hands with soap and water before taking a meal, feeding children and preparing food (ADB, LGED, 2005). Hygiene related diseases in Bangladesh cost 5 billion taka each year for treatment alone.

Unsafe and human excreta are the main elements of transmission of common disease like diarrhoea, dysentery, typhoid, pasitic, worm infestation, measles and polio.

The health situation in Bangladesh however, is gradually improving with the infant mortality rate declining to 77 per 1000 live births in 1996, with the gradual improvement of the sanitation coverage in Bangladesh. The performance of sanitation coverage is rapidly increasing due to effective action by local bodies as per National policy for 100 % sanitation by 2010.

2.5.2 Factors for Sanitation

The important factors for sanitation are described as follows :

a) **Housing density :** Simple single pit latrines are suitable for use in rural and low-density urban areas up to about 300 people per hectare. It is, however, difficult to be more precise in general terms, as local factors such as average household size, housing design, plot layout and area have such a large influence. At higher densities alternating double pit latrines may be feasible, but other options, such as small bore sewers community latrine cum biogas plant etc. many even be more appropriate solutions.

b) **Water supply service level :** In areas where water usage is low (say less than 30 l/c/d) and where water has to be hand carried from public stand taps, communal tube wells.

c) **Difficulties associated with pit latrines :** Digging pits in loose and unconsolidated soils (e.g. san or fine grained alluvium) is difficult and the lining must not prevent the seepage of faucal liquids out of the pit into the surrounding soil. Pit latrines are vulnerable in areas subject to annual to annual flooding or where water tables rise during rise during the monsoon.

d) **Operation and maintenance :** In all latrines cleanliness is of utmost importance. Squatting slabs easily become fouled and pour flush bowls may block up. Fouled and unhygienic pit latrines are found all over the country, often because they have been constructed in communities previously accustomed to open defection. Fouled pit latrines become a focus of disease transmission and may create a health hazard. The water seal, the essential part of the pour flush pit latrine, often breaks down. Sometimes, garbage is thrown into the pan and blocks the latrine. Most of the Y junctions of the double pit latrines do not work properly. Often it is observed that individual households have not taken necessary action when the pot fills up.

e) **Soil permeability :** Soils with permeability below 2.5 mm per hour for example, expansive clays are unsuitable for pit latrines, as the liquid fraction of the excreta is unable to infiltrate into the soil thereby leading to overflow of the pits. Infiltration capacity of pits is also greatly reduced where the water table is high, e.g. in the coastal region of the country.

f) **Groundwater pollution :** The deposition of excreta in pots may pollute water sources, particularly wells tube wells, pond etc. located nearby. The danger of pollution increases if the pot is dug down to the water table or to fissure of weathered rock. Bacteria will not penetrate more than 1- 2m in most unsaturated soils, but they have been known to travel over 100 m in gravel below the water table and rock fissures. In general, the bacterial contamination may spread as far as the distance traveled by the ground water itself in ten days. Where it is necessary to avoid any risk of fecal contamination of groundwater, there should be at least 2 m of soil depth between the bottom of the pit and the water tables surface. As a general guide, users are required to install their latrines at least 10 m from tube wells or other water sources to avoid potential pollution.

2.5.3 Sanitation Practices in Bangladesh

In Bangladesh, about 16% of the 90 million rural population use sanitary latrines. In addition, 22% use the so –called home pit latrine constructed by a squatting slab made of bamboo over a manually dug pit (Ahmed & Rahman, 2003). People in general have a very poor understanding of the relationship between health and sanitation. In most cases, latrines are used for reasons of convenience and privacy rather than health reason. In urban areas, a range of non –site options such as septic tanks, single and double pit pour – flush latrines are used. In urban areas of Bangladesh, 60% households used sanitary latrines (ADB, LGED, 2005). People are now conscious of using sanitary latrines. Government has taken initiatives through National Sanitation strategy 2005 for the goal to achieve 100 % sanitation coverage by 2010. Government and non–government agencies are now working in full sewing both in rural and urban areas to achieve this goal of sanitation. The overall achievement in context of sanitary latrine is satisfactory at present. From this study in four Pourashavas and news from many reliable sources, the present coverage of sanitary latrine is more than 90% in urban areas of Bangladesh.

Data and information on sanitation of different Pourashavas

In order to assess sanitation condition in Mymensingh Pourashava, a sample survey among 195 households was conducted under LGED in January of 2005 (APS /LGED, 2005). The obtained status on sanitation is reflected in the Table 2.14

Table 2.14 Sanitation condition in Mymensingh Pourashava during the year 2005 :

Sanitation Parameter		Sanitation Status (Nos.)	Sanitation Status (%)
01	Toilet – not available	15	7.69
02	Unhygienic toilet – connected drain.	66	33.84
03	Hygienic toilet	114	58.47
	Total =	**195**	**100**

Also, in order to assess the diseases occurrence condition in Mymensingh Pourashava, a sample survey among 191 households was conducted under LGED in January of 2005 (APS /LGED, 2005),. The obtained status on diseases occurrence is reflected in the Table 2.15

Table 2.15 Diseases occurrence rate in Mymensingh Pourashava during the year 2005 :

Sanitation Parameter		Occurrence Status (Nos.)	Occurrence Status (%)
01	Diarrhoea / Dysentery	41	21.46
02	Typhoid / Fever	30	15.71
03	Eye and Skin Infection	29	15.19
04	Jaundice	8	4.18
05	No disease	83	43.45
	Total =	**191**	**100**

The sanitation condition in Patuakhali Pourashava was assessed by MSP, LGED. The private sanitation facilities in Patuakhali Pourashava during the year 1995 (MSP, FFR, 1997) quoted from the report is presented in the Table 2.16.

Table 2.16 Private sanitation facilities in Patuakhali Pourashava during the year 1995:

Sanitary Facilities				Unsanitary Facilities			
Type of latrine	Households (Nos.)	Users (Nos.)	Coverage (%)	Type of latrine	Households (Nos.)	Users (Nos.)	Coverage (%)
Single pit	2,138	12,831	28.3	Pit -ordinary	763	4,579	10.1
Twin pit	212	1,269	2.8	Surface	1,270	7,617	16.8
Septic tank	1,262	7,572	16.7	No facility	1,912	11,472	25.3
Total =	3,612	21,672	**47.8 %**	**Total =**	3,945	23,668	**52.2 %**

2.5.4 Pourashava Solid Waste Management

In Pourashava, the solid waste management involves managing activities associated with waste generation, storage, collection, transfer and transportation, processing and recovery, and finally disposal in a safe environmental manner, with due attention towards economy, aesthetics, energy and conservation. It is practical that municipal SWM is a complex task, which depends on both public and private sectors and their partners (households, communities, municipalities, private operators, service users, NGOs) many of which are directly or indirectly involved, affected and influenced, and also on the technology adopted. In the case of garbage, nobody seems to be interested to know where eventually his or her refuse goes. From the management point of view, the first priority for solid waste management environmentally is getting the refuse out from underfoot and the second is the provision of

an affordable (least cost and viable techniques) level of services. It is important that the service reaches all corners of the urban area.

Pourashava solid waste includes mainly domestic waste resulting from household activities (e.g. kitchen wastes, food preparation, cleaning, gardening etc.), from commercial establishment (like stores, offices, fuel service, restaurants, warehouses, hotels etc.), from industry, institution, road sweeping, construction debris, sanitation resides (drain dirt cleaning materials mostly semisolid sludge) on the whole. Domestic solid waste is a composition of organic food waste, papers, wood, plastic, leather and rubber materials, rags and textile products, glass, metals, inert stones, and other bulky wastes. In developing countries domestic waste is generally account for 60 to 80% of total waste as well as commercial waste (from stores, offices, fuel service stations restaurants, warehouses, hotels etc.) industrial, institutional, road sweeping (dirt litter etc) construction debris, sanitation resides (drain dirt cleaning materials mostly semisolid sludge)

2.5.4.1 Classification of Municipal Waste

Municipal or Pourashava solid waste can be broadly divided into organic or biodegradable waste, and non-organic or non-biodegradable waste.

a) **Organic waste :** Kitchen waste, food leftover, rotten fruit and vegetables and peelings, straw and hay, leaves and garden trimmings, crop residues, animal excreta, bone, leather etc. The amount of organic waste is 70 –80% of the total municipal waste in Bangladesh.
b) **Non -organic :** Earth ash, stone, bricks, cinders glass, plastic, rubber and ferrous/ non-ferrous metal.

In Bangladesh, the major components of urban waste are organic in nature and constitute 80% of the total both in residential and commercial areas. A thorough understanding of the different types of wastes and their composition is essential for determining the most suitable option or options for their efficient management and disposal, The could be many different ways, and again such classification may vary from country to country. In general, wastes can be classified as follows.

a) **Human waste or human excreta :** This refers to only human faces and urine and usually is not combined with other liquid or solid wastes. They are also widely known as night solid when cosseted collected without dilution in large volumes of water
b) **Municipal sewage/ Wastewater :** This is the liquid waste conveyed by a sewer which include domestic and industrial discharges as well as storm water, groundwater infiltration and inflow.
c) **Domestic sewage :** This is the liquid waste which originates in the sanitary conveniences, e.g., water closets, urinals baths, sinks etc. of dwelling, commercial facilities and institutions in a community. Sometimes it is also referred to as sanitary sewage.

d) **Sullage :** It is the liquid discharges from kitchens, wash basins etc. and excludes human excreta. Sludge is less foul than domestic sewage and can be discharged through open surface drains in answered areas.

e) **Industrial wastes : It** include the liquid discharges from spent water in different industrial processes such as manufacturing and food processing.

f) **Storm water :** It is the surface fun off during and immediately after the rainfall, which enters sewers through inlets. Storm water is not as foul as sanitary or industrial sewage and hence can be carried through open drains and disposed of in natural rivers without any treatment.

2.5.4.2 Privatization of Solid Waste Management

NGOs can also take part as supporting role in waste collection, treatment and disposal. They can help in making policy for improvement of recycling and collection of waste. In taking a decision to privatize a public service and choice of the appropriate formation, the costs and benefits of alternative organizational arrangements need to be considered very carefully. In the SWM system, being a public good, open competition is desirable to get a low cost, good quality service from private sector operator. For example, in Keying, Korea, a cost reduction of up to 50% was gained through partial privatizing of waste collection (Amzad, 1999). In Kuala Lumpur, Malaysia, the private sector operator made more collection and disposal per day in public sector. In Bangladesh, some NGOs work on solid waste management in a few Pourashava or City Corporation partially with view to develop systematic manner to operate solid waste management activities. They also involve participation of the community people in solid waste activities. They have also tasks on solid waste composing somewhere. The NGOs work in Pourashavas actually on foreign aid for a specific period of time. After end of their duration, the activities again go to the previous stage in most cases.

2.5.4.3 Data on Solid Waste Composition

The characteristics of the composition of solid waste vary considerably from country to country and even place to place within a country depending upon standard of living, urbanization, industrialization and many other factors. Here, some data and information is presented on composition of solid waste in different cities in home and abroad.

Dhaka, India and Europe

A typical composition of solid waste from some developing and industrialized countries is presented in the Table 2.17 (Ahmed & Rahman, 2003).

Table 2.17 Composition of solid waste in Dhaka, India and Europe :

Composition of Waste		Dhaka (% by weight)	India (% by weight)	Europe (% by weight)
01	Food and vegetable waste	70	75	30
02	Paper products	4	2	27
03	Plastic	5	1	3
04	Rags	--	3	3
05	Metals	0.13	0.1	7
06	Glass and ceramic	0.25	0.2	11
07	Wood	0.16	--	--
08	Garden wastes	11	--	4 -- 6
09	Others (stone, dirt etc.)	5	7	3
10	Moisture content	65	22 -- 32	15 -- 35

Major Cities in Bangladesh

There are six major cities called City corporations in Bangladesh. The average physical composition of MSW in major six cities of Bangladesh is given in the Table 2.18 (Waste Safe, KUET, 2005).

Table 2.18 Avg. physical composition of MSW in the major six cities of Bangladesh :

MSW Composition	(In Wet Weight %)						
	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet	Avg.
Food and vegetables	70	62	68	69	76	72	**69.4**
Paper and paper products	7	6	7	7	4	6	**6.2**
Pplythene plastic	3	5	6	5	3	8	**5.0**
Textile and wood	5	9	7	6	6	5	**6.3**
Rubber and leather	2	3	3	2	1	2	**2.2**
Metal and tins	1	2	1	1	1	1	**1.2**
Glass and ceramics	2	2	1	1	2	1	**1.5**
Brick, concrete and stone	2	2	3	2	2	1	**2.2**
Dust, ash and mud products	2	4	2	3	1	1	**2.0**
Others (bone, rope etc)	6	5	2	4	4	3	**4.0**
Total =	100	100	100	100	100	100	**100**

2.5.4.4 Data on Solid Waste Generation

It is difficult to obtain reliable data for quantity of solid wastes generated at different places. In most cases, only a fraction of wastes generated are collected , and therefore data based on measurements of collected wastes only is not representative of the total quantity. Generally, measurement of solid waste is done at the disposal site. The quantity of solid waste generation varies widely and is influenced by the factors like (a) Geographic location, (b) Season of the year, (c) Population characteristics, (d)

Legislation, (e) People's attitude. Here, some data and information is presented on quantity of solid waste generation in different cities.

Khulna City Corporation, Bangladesh

In Khulna City Corporation, the approximate quantity of solid waste generation is 455 tons per day and the estimated (considering specific weight 0.5 ton / m^3) approximate volume is 940 m^3 per day. The major sources of solid waste are given in the Table 2.19 (Rahman & Hasan, 2007).

Table 2.19 Quantity of SW generated in Khulna City :

Sources of SW generation		SW generation (Ton / Day)
01	Households	418
02	Commercial	25
03	Hospital /clinic	2.9
04	Institution	2.2
05	Street sweeping	2.6
06	Drect sweeping	2.43
	Total =	**453.13**

Divisions in Bangladesh

There are six administrative divisions in Bangladesh. The approximate quantity of solid waste generation (estimated) in rural and urban areas in each division is shown in the Table 2.20 (Ahmed & Rahman, 2003).

Table 2.20 Estimated quantity of solid waste in Bangladesh in 1991 :

Administrative Division		Urban area (Ton / day)	Rural area (Ton / day)	Total quantity (Ton / day)
01	Rajshahi	1107	3793	4900
02	Barisal	186	1094	1280
03	Khulna	805	1745	2550
04	Dhaka	2983	4196	7179
05	Chittagong	1310	2888	4198
06	Sylhet	102	1034	1136
	Total =	**6,493**	**14,750**	**21,243**

Major Cities in Bangladesh

There are six major cities called City corporations in Bangladesh. The total generation of MSW in major six cities is shown in the Table 2.21 (Waste Safe, KUET, 2005).

Table 2.21 Total generation of MSW in the major six cities of Bangladesh :

Name of Source	Generation of MSW (Ton /day)					
	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
Residential	4048.00	1102.30	455.50	130.95	103.20	167.50
Commercial	1177.61	183.07	60.14	31.54	20.14	39.66
Institutional	62.45	14.91	5.26	2.06	1.89	2.76
Municipal services	28.30	6.67	2.86	2.11	1.49	1.72
Others	20.00	8.00	5.00	3.00	3.00	3.00
Total =	**5340**	**1315**	**521**	**170**	**130**	**215**

Some Important Cities in Asia

The estimated quantity of solid waste generation (on based on Kg per capita per day) of eight important cities in Asia is quoted in the Table 2.22 (Ahmed & Rahman, 2003).

Table 2.22 Quantity of SW generated and collected in some cities of Asia :

Name of City		SW generated (Kg / capita day)	SW generated (10^3 Ton / year)	SW collection (10^3 Ton / year)
01	Bombay	0.5 – 0.6	1150	1150
02	Manila	0.5	1380	1140
03	Bangkok	0.88	1800	1533
04	Kuala Lumpur	1.29	730	730
05	Singapore	0.98	1873	943
06	Beijing	1.59	3580	2983
07	Shanghai	0.87	2256	2256
08	Tokyo	0.54	4491	3417

2.5.4.5 Data on Solid Waste Management

There is no specific and systematic preservation of data and information on different issues like solid waste management in Pourashavas like other agencies in Bangladesh. Only the research report contains data and information in depth and specifically on different issues. But, these are not enough in practical to serve the purposes of all concern. Some data and information on solid waste management is quoted in this section.

Mymensingh Pourashava :

Mymensingh Pourashava is a very old one established in 1869. It is situated beside Brahmaputra River which covers an area of 21.73 Km^2 and consists of 21 wards. The overall solid waste condition is reviewed under LGED in 2005 (APSWM /LGED, 2005). The summery of findings is stated in the Table 2.23.

Table 2.23 Summery information of solid waste in Mymensingh Pourashava during 2004 :

Information Parameter		Unit	Status in Mymensingh Pourashava
01	Population	Nos.	2, 31, 166.
02	Solid waste generated	Ton /day	48.
03	Solid waste collection and disposal	Ton /day	31.5 (which is 65.6% of generation)
04	Rate of domestic waste generation	Kg /cap /day	0.21
05	Domestic waste is	--	60% of total solid waste. (Rest 40% is from street sweeping, commercial and clinical sources).
06	Organic waste	%	84.21%
07	Inorganic waste	%	16.79%
08	Nos of dustbin	Nos.	370.
09	Total cleaner in SWM	Nos.	395.
10	a) Density of SW in household level	Kg /m^3	211.35.
	b) Density of SW in lower income group	Kg /m^3	246 (highest)
	c) Density of SW in market area	Kg /m^3	198 (lowest)
11	NGO involvement in SWM	--	Door to door collection system.
12	SW disposal site	--	# Near Shambhugang bridge 4 Km from city center. # Area 3 acres with a depth of 6.7m. # 50% dumping in this site (rest 50% in the river).
13	Recycling of SW	--	# 2.6 ton /day (5.4% of total generation) by informal sector (Tokai) in Mymensingh Pourashava. # Estimated saving is Tk 2, 31,109 annually.
14	Expenditure for SWM in 2003 --04	--	# 2.8 million.
15	Respondents' perception on SW	--	87% unsatisfactory and 13% satisfactory.

Dhaka :

Some data on solid waste are reported by Concern /CESD (NGOs) for Dhaka and Bangladesh which is published in the daily newspaper "Amar Desh" of June 07, 2005. The data is given in the Table 2.24.

Table 2.24 Basic data on solid waste of Dhaka and Bangladesh :

Information Parameter		Unit	Status
Dhaka :			
01	Daily generation of SW	Ton	3,500.
02	Daily collection of SW	%	42 % of total generation (Remaining 58 % remains on road or anywhere).
03	SW applicable for composting	%	70 % of total generation .
04	Rate of SW generation	--	0.55 Kg /capita /day.
05	Estimated SW generation in 2025	Ton	47,064.
Bangladesh :			
04	Daily generation of SW	Ton	13,300.
05	Daily collection of SW	%	55 % of total generation (Reaming 45 % remains on road or anywhere).
06	SW applicable for composting	%	70.

2.6 Conclusion

There are 4 City Corporations and about 300 Pourashavas in Bangladesh called urban local bodies. Water supply and sanitation are the two very important services in Pourashavas. Due to rapid urbanization, population is increasing day by day and makes stress on limited services of Pourashava. Pourashava is not capable to serve the additional people with its existing facilities and infrastructures. The main source of income of Pourashava is tax collection which is very poor condition. The overall social and political issues are the main hindrance factors for improvement of Pourashava. Therefore, Pourashava can not maintain the basic services like water supply and sanitation to a desirable condition. Also, there are some issues regarding problems and limitations in Pourashava which are (a) Organizational problem, (b) Human resource and capabilities (c) Technological capabilities, (d) Public awareness and motivation, (e) Commitment of stakeholders and (f) Ineffective legislation and enforcement.

CHAPTER III

RESEARCH METHODOLOGY

3.1 General

In this chapter, the overall methodology to conduct the research study has been described covering the location and basic information of the study area with Pourashava base maps. The methodology also includes review of literature, extensive data collection, water sample collection and examination in laboratory, data analysis and presentation, questionnaire survey and people's perception.

3.2 Selection of Study Area

The research study was conducted in district level four Pourashavas selected from the coastal region of Bangladesh. The coastal region is to the southern part of Bangladesh which includes 19 districts from Satkhira to Cox's Bazar district as geographical map of Bangladesh shown in Figure 1.1 at page 5 this report. This study included (1) Bagerhat Pourashava situated in Khulna division, (2) Barguna Pourashava, (3) Patuakhali Pourashava and (4) Bhola Pourashava in Barisal division.

3.2.1 Location of Selected Pourashavas

Bagerhat Pourashava is 40 Km distance from KUET, Khulna and is situated beside the Bhairab River with location of latitude 22° 40' N and longitude 89° 45' E. This is an 'A' category Pourashava which stated its official journey in 01 April, 1958.

Barguna Pourashava is is 200 Km distance from KUET, Khulna via Bagerhat, Pirojpur, Jhalakathi, Barisal and Patuakhali districts passing across 4 nos. of ferry namely, Bekutia in Pirojpur, Dhapdapia and Lebukhali in Barisal and Amtali in Barguna districts. It is situated beside the Khardhan River with location of latitude 22° 10' N and longitude 90° 07' E. This is an 'A' category Pourashava which stated its official journey in 23 July, 1973.

Patuakhali Pourashava is 155 Km distance from KUET, Khulna via Bagerhat, Pirojpur, Jhalakathi and Barisal districts passing across 3 nos. of ferry namely, Bekutia in Pirojpur, Dhapdapia and Lebukhali in Barisal districts. It is situated beside the Lohalia River with location of latitude 22° 22' N and longitude 90° 20' E. This is an ' A ' category Pourashava which stated its official journey in 01 April, 1892.

Bhola Pourashava is 160 Km road distance from KUET, Khulna via Bagerhat, Pirojpur, Jhalakathi and Barisal districts passing across 3 nos. of ferry namely, Bekutia in Pirojpur, Kawarchar in Barisal city and Laharhat--Veduria (need one hour by ferry) on the way to Barisal and Bhola. It is situated beside both the Meghna and the Tetulia Rivers with location of latitude 22° 40' N and longitude 90° 45' E. This is an 'A'category Pourashava which stated its official journey in 10 October, 1920.

3.3 Methodology of the Study

Methodology that was adopted for the research study consists of literature review, extensive data collection, water sample collection and examination in laboratory, data analysis and presentation, questionnaire survey. The following procedures will be followed to fulfill the objectives of the study. Several times field visits had to be conducted for the research study.

3.3.1 Literature Review

An intensive literature review was undertaken to acquire the knowledge on water supply and sanitation condition in Bangladesh and abroad. The relevant data and information reviewed from various reports and research studies have been included in Chapter II of this thesis report. Also, the initiatives and program taken by both the GOB and the NGO's for water supply and sanitation facility in Bangladesh was quoted in the same Chapter captioned as " Literature Review ".

3.3.2 Visual Inspection

Visual inspection was carried out to assess the practical condition of the study area regarding water supply and sanitation issues. It also helps to identify the impacts of various interventions to the existing situations. Several times visit were required for visual inspection and to perfume other related tasks under the research study.

3.3.3 Data collection

Data collection had been performed to identify the existing condition of water supply and sanitation of the four selected Pourashavas namely, Bagerhat, Barguna, Patuakhali and Bhola under the study area. Data were collected from respective personnel in the four Pourashavas under the study area as well as other relevant agencies and individuals. The data and information includes all probable issues available and practiced in the selected Pourashavas such as source, production, supply, coverage, demand, cost, alternative facilities for water, quality in context of Pourashava water supply system as well as drainage and sanitation issues.

3.3.4 Water Sampling

Water samples were collected from the four Pourashavas during the year 2004. Three water samples were collected from each Pourashava water supply network. Samples were collected from 3 locations from each Pourashava in 3 different seasons such as January for winter, April for summer and September for rainy during the year 2004. Thus, the water samples were collected (3 x 3 x 4=) 36 in total. The detailed information regarding water sampling and laboratory test are stated in Chapter V.

3.3.5 Laboratory Experiment

Total 12 water quality parameters were tested in the laboratory for all the water samples collected from the four Pourashavas. The experiments were preformed at Environmental Laboratory in the Department of Civil Engineering, KUET, Khulna. Thus, the nos. of tests preformed in the laboratory is (36 samples x 12) 432 in total. The list of test parameters is mentioned in the Table 5.02.

3.3.6 Questionnaire for People's Perception

The questionnaire of survey includes 41 questions covering all possible issues consisting (a) water supply -13 questions, (b) SW management -10 questions and (c) sanitary and drainage -18 questions. One person from each household participated in the questionnaire survey and there were 750 respondents in total from the four Pourashavas such as Bagerhat – 200 Nos., Barguna – 182 Nos., Patuakhali - 176 Nos. and Bhola - 192 Nos.

The questionnaire was in the Bengali language with all probable answers with option for comments where necessary attached as *Appendix A*. The survey was conducted in random manner and the people's perception was explored the actual picture on water supply and sanitation conditions in the study area. The English version of all questions (without option of answers) is attached as *Appendix B*.

3.3.7 Data Analysis and Presentation

Computer statistical package has been used to analyze and present the collected data. All data have been arranged systematically in tabular formats. The results of test parameters were analyzed with graphical presentation to observe the seasonal variation. The numerical information from respondents' perception are summarized and presented in the tabular formats on Pourashava wise and overall status on water supply and sanitation condition has been presented through bar chart / pie chart to understand at a glance.

CHAPTER IV
WATER SUPPLY CONDITION

4. 1 General

Water supply is one of the most important services in Pourashava. The Pourashava inhabitants always expect adequate and quality supply water from the Pourashava. The water supply service is the indication of the level of standard of a Pourashava. Water supply section is a complete section of Pourashava that manage and operate the whole water supply system. The supply system is intermittent one. The Pourashava generally explore ground water through production well with the help of motor pump and supply the explored water through pipe network to the households in Pourashava.

In this chapter, the overall condition of the existing water supply system in the selected Pourashava has been described. It includes production, supply and demand of water, non–supply water source in Pourashava and other relevant issues on water supply system in the four Pourashavas namely Bagerhat PS, Barguna PS, Patuakhali PS and Bhola PS.

4.2 Water Supply in Study Area

The four Pourashavas under the study area mainly depend on the source of ground water for their supply system. The water supply system based on ground water was established in 1976, 1968, 1976 and 1985 respectively in the four Pourashavas namely, Bagerhat PS, Barguna PS, Patuakhali PS and Bhola PS. The status of water supply system in the study is described below and the basic information on related parameters is presented already in the Table 2.04 of this report.

4.2.1 Source of Supply Water

Ground water is the main source of supply water in almost all Pourashavas in Bangladesh. It is found that the four Pourashavas under the study area namely Bagerhat PS, Barguna PS, Patuakhali PS and Bhola PS explore ground water for their supply system.

In Barguna PS, there is a water treatment plant having capacity 5 lakh liter /day based on surface water source named as Khardhan river established in 2000 by DPHE funded by Netherlands under 18 Districts Water Supply Project. But, the Pourashava authority seldom runs the plant owing to high operation cost mainly for heavy consumption of electricity for motor. In Bagerhat Pourashava, there is a water reservoir called *Pacha Dighi* that was used as surface water source before 2002. After then, the reservoir is not used due to scarcity and contamination of water.

4.2.2 Production Well

The tube well used for exploration of ground water for supply system with the help of electric motor is known as production wells. The production wells are located generally in different spots within the Pourashava for providing highest coverage of water supply through the supply pipe network. In this well, water is withdrawn from the deep aquifer by pumping with the help of high power electric motor. The water is drawn up to a suitable position on the ground and then the water is allowed to flow gravitationally to the distribution piped network placed beneath the ground surface along the roadside and thus overhead tank is not necessary in this type of water supply system. The head difference is generally 1 to 2m and the depth of the wells varies from 275m to 325m in the study area.

In Patuakhali Pourashava, DANIDA -DPHE project has installed new water supply distribution piped network in the year 2005 with two overhead tanks having capacity 7 lakh liter each. The old water supply connections are being replaced with this new network and the water consumption is measured in metering system. Now the supply water is available for 24 hours.

In Bagerhat Pourashava, there exists also an overhead tank with some treatment facility. The location of the new production well is in Dashani 12 km apart from the treatment plant because no aquifer is available within Pourashava area.

The basic information regarding production well in the study area is shown the Table 4. 01.

Table 4. 01 Basic Information of Production Well for Pourashava WSS :

Name of Pourashava	Nos. of PW	Range of Depth (m)	Pipe Dia. (mm)	Daily OH	Production (m^3 / day)
Bagerhat PS *	6	275 -- 300	150	20	4400
Barguna PS	7	275 -- 300	150	11	2550
Patuakhali PS	5	275 -- 300	150	20	5800
Bhola PS	7	275 -- 300	150	10	5300

* One PW is not used due to disorder for more than one year.

4.2.3 Production, Supply and Demand of Water

In all Pourashavas under the study area, the concerned Officers delivered their common idea that the withdrawal and supply water quantity is same. Demand of water may be classified into two groups; one is from existing consumers and other is from new households in Pourashava who have no pipe connection. It is noticed that existing connection holders somewhere complain for inadequate supply of water. This is due to the reasons actually created by the water consumers. Many households in Pourashava are habituated to waste water carelessness. It is also observed that a single house water connection is somewhere used by a group of families as well as water tap remains open unnecessary

during the period of supply. Further, population increase day by day due to rapid urbanization. As a result, demand for new connection by the Pourashava inhabitants are being increased every year.

The quantity of water requirement can be estimated from the data of total population and the average per capita water consumption. The average per capita water consumption for design consideration is 120 lpcd for Zila town in Bangladesh (Ahamed & Rahman, 2003) and is 100 lpcd for South –East Asia (BRGM /LGED, 2005). The theoretical quantity of water requirement in total for the Pourashavas under the study area is shown with present production of supply water in the Table 4.02.

Table 4. 02 Estimated total quantity of water requirement in Pourashavas :

Name of Pourashava	Population (Nos.)	Avg. water consumption (lpcd)	Daily total requirement (m^3)	Present production (m^3)
Bagerhat Pourashava	70,000	100	7,000	4400
Barguna Pourashava	37,000	100	3,700	2550
Patuakhali Pourashava	80,000	100	8,000	5800
Bhola Pourashava	60,000	100	6,000	5300

4.2.4 WS Connection and Area Coverage

The distribution piped network is not available in whole area of the Pourashava. Every Pourashava contains 9 different wards and water supply pipe network is not available in all wards. The water supply network was established in densely populated areas in the Pourashava and the rest area was planned to be brought under water supply in future. Pourashava is not capable to install additional water supply network. As a result, the other inhabitants meet up their demand of water from hand deep tube well and some people depend on ponds, canal or river. Some Hand tube wells (HTW) installed by DPHE / Pourashava as community based service in Pourashavas with sharing contribution from the beneficiaries as a system of participatory approach.

The record of water supply connection for last few years in four Pourashavas under the study area is plotted in the Figure 4.01. It is revealed from the figure that the household water supply (WS) connections are increased every year.

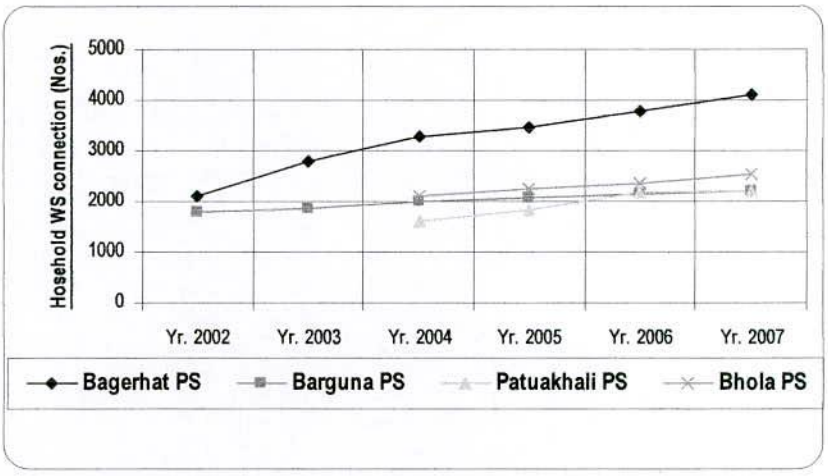


Figure 4.01 Yearly household WS connections in Pourashavas.

The percentage of increase of household WS connection for the last few years in four Pourashavas under the study area is shown in the Table 4.03. it is revealed that the demand for new household WS connection is 9.23% where WS network is available.

Table 4.03 Increase (%) of household WS connection in Pourashavas :

Name of Pourashava	Increase status in percentage (%)					
	2003	2004	2005	2006	2007	Average
Bagerhat PS	33	17	4	9.6	8.5	14.42
Barguna PS	5.6	7.6	3.5	3.1	2.8	4.52
Patuakhali PS	--	--	12	21.5	1.6	11.7
Bhola PS	--	--	6.3	4.5	8.1	6.3
				Yearly avg. increase of demand) =		9.23

The WS coverage based on household is calculated for the four Pourashavas under the study area and the status is presented in the Table 4.04. From this table, it is revealed that the average WS coverage based on household is 29% only with respect to the entire study area. The highest value is 73% in Bagerhat Pourashava and lowest is 13% (due to metering system) in Patuakhali Pourashava.

Table 4.04 WS coverage on the basis of total households of Pourashava :

Pourashava	WS connection Nos.	Household Nos.	WS Coverage (%)	Average coverage (%)
Bagerhat Pourashava	4,100	5,579	73	29 %
Barguna Pourashava	2,210	4,706	47	
Patuakhali Pourashava	2,230	17,792	13	
Bhola Pourashava	2,545	10,089	25	

The WS coverage based on service area (distribution network of pipe line) of Pourashava is reported from respective Pourashava under the study area is presented the Table 4.05. From this table, it is revealed that the average WS coverage based on service area is 66.5% with respect to the entire study area. The highest value is 75% in Bagerhat Pourashava and lowest is 60% in Patuakhali Pourashava. It is also known that a few wards in every Pourashava possess WS network of inadequate quantity due to less population during the time of installation. Only ward no. 3 of Barguna Pourashava possesses no WS distribution network.

Table 4.05 WS coverage on the basis service area of Pourashava :

Bagerhat PS	Barguna PS	Patuakhali PS	Bhola PS	Average coverage
75%	65%	60%	66%	66.5%

Pourashava with the support of DPHE installs community base hand tube well (CHTW) on cost sharing as participatory approach. The list of CHTW is given in the Table 4.06 below. In Pourashavas under the study area, there is no record of private tube wells owned by Pourashava households.

Table 4.06 Community based hand tube well (CHTW) in Pourashava :

Bagerhat PS	Barguna PS	Patuakhali PS	Bhola PS
1200 nos.	309 nos.	350 nos.	350 nos.

4.2.5 Cost for Water Consumption

In the study area, only Patuakhali Pourashava started metering system to measure the consumption of supply water for each household WS connection since 2006. The previous (old) connection is being made replacement with this new connection of non–stop water supply that is water to all consumers for 24 hours. The payment system is monthly basis with actual water consumption deepening upon the category of consumer. The cost for water supply connection and water consumption in Patuakhali Pourashava is mention in the Table 4.07 and the Table 4.08 respectively.

Table 4.07 Connection Fee (in Taka) in Patuakhali Pourashava :

Diameter of connected pipe (Inch.)	Residential		Commercial		Industry /Factory	
	New	Old	New	Old	New	Old
0.50	1500	500	4000	2000	N /A	N /A
0.75	3000	1500	4000	2000	N /A	N /A
1.00	N /A	N /A	4000	2000	6000	5000
1.50	N /A	N /A	N /A	N /A	6000	5000
2.00	N /A	N /A	N /A	N /A	6000	N /A

Note : N /A = Not applicable.

Table 4.08 Cost (in Taka) for supply water in Patuakhali Pourashava :

Consumer Category		Monthly fixed cost	Rate per m^3 of water	Fine if applicable
01	Non– Flat Residence	80	6	10 % additional cost for delay payment.
02	Flat Residence –per flat	60	6	
03	Holding –per family	60	6	
04	Commercial holding	200	10	
05	Industry /Factory	400	10	
06	Educational and Religious holding	60	6	
07	Slum and poor group	50	6	

The other three Pourashavas namely Bagerhat, Barguna and Bhola adopt monthly payment system for supply water depending upon the diameter of the connected pipe to the consumers. In these three Pourashavas, there is no restriction for consumption or misused of supply water. The cost for supply water in Bagerhat, Barguna and Bhola Pourashavas is mention in the Table 4.09.

Table 4.09 Cost (in Taka) for SW in Bagerhat , Barguna and Bhola Pourashavas :

Name of Pourashava	Consumer Category	Cost (Taka) against listed pipe diameter (Inch.)				
		0.50	0.75	1.00	1.50	2.00
Bagerhat Pourashava	Residential	70	110	250	400	N /A
	Commercial	140	220	500	800	1000
Barguna Pourashava	Residential	100	200	N /A	N /A	N /A
	Commercial	200	400	N /A	N /A	N /A
Bhola Pourashava	Residential	125	200	N /A	N /A	N /A
	Commercial	200	400	800	1000	N /A

Cost for water consumption in metering system :

The monthly expenditure for supply water becomes high in Patuakhali PS duo to metering system as compared to other three Pourashavas namely Bagerhat PS, Barguna PS and Bhola PS. Further, cost for water consumption is not same in these three Pourashavas. Monthly tentative cost for supply water (or water consumption) in Patuakhali Pourashava can be calculated from average water consumption (0.90 M^3 /HH) stated in the Table 2.04 (Sl. No. 12).

Thus, the monthly cost for a single household becomes Tk 222 (= Tk 60 +*0.9 M^3* x 30 days x Tk 6) in average of all supply water connections in Patuakhali Pourashava. Again, considering the average supply water consumption for Patuakhali Pourashava with respect to other three Pourashava stated in the Table 2.04 (Sl. No. 12), the monthly cost for a single household stands Tk 303 (= Tk 60 +*1.35 M^3* x 30 days x Tk 6). Therefore, it is revealed from this analysis that monthly expenditure for water consumption in Patuakhali PS is about 1.5 to 4 times for the same of Bagerhat PS, Barguna PS and Bhola PS. Pourashava authority should think to introduce metering system for sustainable WSS.

4.2.6 Water Bill Recovery Status

In all Pourashavas under the study area, bill is prepared on monthly based system and is delivered to the respective consumer to pay the bill by a certain date. Bill Clerk prepares the monthly bill sheets with relevant information and is delivered to the consumers' house before the date of payment. The date of payment is before the end of the current month in Bagerhat, Barguna and Bhola Pourashavas because their monthly bill amount is fixed and known. In Patuakhali Pourashava the monthly water bill is prepared on metering system and payment is to be paid by a certain date of the next month.

Before 2006, all Pourashavas prepared monthly water bill manually. The bill clerk had to need help from other staff to write the bill sheet for a many days. After then, the computerized billing software has been installed by the support of MSP, LGED, in Bagerhat, Barguna and Bhola Pourashavas. Now these three Pourashavas can prepare water bill very fast. This is a tremendous positive change in Pourashava water supply section which has brought a better performance in bill preparation, delivery and recovery system. The water consumers become satisfied with computerized water bill and they pay the water bill timely through assigned bank. Separate billing software is needed for Patuakhali Pourashava due to metering system that will be developed later. The recovery status of water bill is almost satisfactory and the status for the FY 2006 -07 is presented in the Table 4.10. The depreciation cost is not considered in expenditure and the due of previous years is added with income stated in this table. The total income can be increased by intruding metering system in Bagerhat, Barguna and Bhola Pourashavas.

Table 4.10 Recovery and related status on WSS in four Pourashavas in FY 2006 - 07 :

Information Parameter		Unit	Status in the 4 Pourashavas as :			
			Bagerhat	Barguna	Patuakhali	Bhola
01	Recovery of WB	%	90	98	86	80
02	Monthly income - target	Taka	4,50,000	3,17,600	7,93,200	2, 91,500
03	Income in FY 2006 -07	Taka	54,00,000	38,11,386	82,31,160	27,93,600
04	Expenditure in FY 2006 -07	Taka	52,00,000	26,13,187	RNA	RNA

Note : RNA = record not available.

4.2.7 Staff in Water Supply Section

In all the Pourashavas under study area has shortage of staff in water supply section. The main reason is that the recruitment system is time being and complicated. Pourashava has to take the permission from the Ministry and sometimes approval takes lengthy time or is not approved sometimes. After approval advertisement is to be published in the Newspaper and others procedures are to be performed accordingly. So, the total recruitment period is lengthy. The present staff position in water supply section of four Pourashavas is shown in the Table 4.11.

Table 4.11 Staff position in Pourashava water supply section in Jan - 2008 :

Name of Post		Staff position (No.) in four Pourashavas :			
		Bagerhat	Barguna	Patuakhali	Bhola
01	Superintendent	1	1	1	1
02	Accountant	1	1	0	1
03	Account Assistant	0	0	0	1
04	Bill Clerk	4	1	2	2
05	Plumber	0	2	0	0
06	Pump Operator	8	8	3	8
07	Valve Operator	3	0	8	3
08	HTW Mechanic	1	1	0	0
09	MLSS	1	1	2	4
10	Guard	4	1	2	1
	Total =	**23**	**16**	**18**	**21**

4.3 Summery of Findings

The findings on various issues regarding water supply system in the four Pourashavas namely, Bagerhat, Barguna, Patuakhali and Bhola under the study area are summarized as follows :

01. Water supply in Pourashavas (PSs) :

Ground water is the only source of water supply system in the study area. The treatment plant based on surface water in Barguna Pourashava is operated seldom. Patuakhali Pourashava possesses one stop water supply system with metering system.

The inhabitants with out water supply (WS) connection, depend on river, pond, own tube well or community tube well for their daily usage of water.

The daily supply water or water consumption in four PSs ranges 0.90 to 1.77 M^3/HH/day where the highest value is in Bhola PS.(*Sl. No. 12 of Table 2.04*).

The average length of supply pipe ranges 18.78 to 21.49 M/HH in the study area (*Sl. No. 10 of Table 2.04*).

02. WS coverage and demand :

The yearly increase (or demand) for WS connection ranges 6.3% to 14.42% in the area where water supply network is available under the study area and the highest value is in Bagerhat PS (*Table 4.03*).

The average supply water coverage in the four PSs based on household ranges 13% to 73% and the coverage based on service area ranges 60% to 75%. The highest coverage for both the cases is in Bagerhat Pourashava.

03. Cost and payment for supply water :

The estimated monthly cost of water consumption is 303 Tk /HH in Patuakhali PS which is 1.5 to 4 times with respect to other three Pourashava namely Bagerhat, Barguna and Bhola.

The payment status by the consumer for supply water in the four PSs ranges 80% to 98% where the highest value is in Barguna Pourashava (*Table 4.10*).

Total yearly net income status of supply water is not so high that it can be possible to improve and expand the water supply system.

04. Staff position :

The staff position is always shortage in Pourashava Water supply section with respect to the sanction posts due to complicated recruitment system.

CHAPTER V

WATER QUALITY CONDITION

5.1 General

The main responsibility of Pourashava water supply section is to ensure potable water of adequate quantity to the consumers. Potable water is one that must be safe to drink, pleasant to take and suitable for domestic usage. The drinking water needs some basic requirements that should be investigated by the Pourashava authority. The basic needs can be stated as follows i.e. water should

(a) be completely fee of pathogenic micro organisms that can cause disease.
(b) contain no matter in concentration that can acute or adverse effect on human health.
(c) be fairly clear and aesthetically attractive i.e. low turbidity and color.
(d) contain no compounds that can cause an offensive taste and odors,
(e) not cause corrosion, scale formation, discoloration or staining.
(f) not have a temperature unacceptable to the consumers.

In this chapter, the qualitative information of supply water is described in details including sampling of water, laboratory experiments of water, graphically presentation of test results and explanation with BDWQS in respect of the four Pourashavas under the study area namely, Bagerhat PS, Barguna PS, Patuakhali PS and Bhola PS.

5.2 Water Quality Assessment

To evaluate the suitability of water for drinking purpose, assessment of water quality should be performed. Water samples were collected from various location of water supply system of the Four Pourashava under the study area and tested of various physical, chemical and bacteriological parameters. The water quality parameters were assessed by technology type in relation to Bangladesh Drinking Water Quality Standards and WHO guild line value. The details on water sampling and test parameters are described in this section.

5.2.1 Water Sampling

The water samples were collected from some sources and supply points of the four Pourashavas (Bagerhat, Barguna, Patuakhali and Bhola) under the study area. All the samples were collected in plastic clean battles of 1.5 liter capacity. Before sampling of water, the bottles were washed thoroughly with the same water and all the bottles are marked properly mentioning date, time and location of sampled water. For bacteriological test, the samplings were performed in Sterilized Water Sampling Bags containing Sodium Thaiosulfate by HACH. The water samples were collected in the morning and most of the parameters were tested by 24 hours. Three point sources had been selected for water sampling from each Pourashava water supply system under the study area with a view to monitor the

water quality status. From each point, samples have been collected for three times such as January, April and September respectively three seasons namely winter, summer and rainy of the year 2004.

The data and information regarding water sampling and date of test are presented on Pourashava wise in the Table 5. 01.

Table 5. 01 Water sampling and test information in details :

Name of Pourashava	Location of water sample	Date of Collection	Date of test
Barguna Pourashava	(A) Tultala Pump No. 6	07 Jan - 04	08 Jan - 04
	(B) H/O Nurul Huda, Beside WAPDA Road.	28 Apr - 04	29 Apr - 04
	(C) H/O Harun –or– Rashid, Beside BRAC Office.	22 Sep - 04	23 Sep - 04
Patuakhali Pourashava	(A) Thana Para Pump No. 2	07 Jan - 04	08 Jan - 04
	(B) Street Tap, Sanibar Road, Charpara.	28 Apr - 04	29 Apr - 04
	(C) H/O. Ranjit Pal, Kumar Patty, Charpara	22 Sep - 04	23 Sep - 04
Bhola Pourashava	(A) Pourashava Pump No. 5	26 Jan - 04	26 Jan - 04
	(B) Street Tap, Beside Abahaoa Office.	24 Apr - 04	25 Apr - 04
	(C) Goldar Vila, Abahaoa Office Road.	14 Sep - 04	15 Sep - 04
Bagerhat Pourashava	(A) Dashani CWR of Pourashava.	12 Jan - 04	12 Jan - 04
	(B) Water Supply Office of Pourashava.	25 Apr - 04	25 Apr - 04
	(C) Pourashava Office Bhaban.	15 Sep - 04	15 Sep - 04

5.2.2 Test Parameter

There are a number of tests parameters for water quality standards mentioned in chapter II. In the study 12 nos. of common and important test parameters have been conducted in context of locality at the environmental laboratory of KUET. All the test parameters were determined as per standard method (APHA, 1998) and HACH recommended method. The parameters included all types of test like physical, chemical and bacteriological parameters. The arsenic test was not performed for the collected water samples as there is no arsenic problem in the supply water of four Pourashavas under the study area reported by the Pourashava authority.

The test parameters with respective test information are presented in the Table 5.02 as follows.

Table 5. 02 Water quality parameters tested in the laboratory :

Type of Test	Name (& Unit) of water quality parameter	Adopted Test method
Physical test	▫ Turbidity (NTU)	▫ Standard turbidity meter (HACH)
	▫ Color (Hazen)	▫ Spectrophotometer
	▫ Dissolved Solids (mg /l)	▫ Evaporation
	▫ Suspended Solids (mg /l)	▫ Evaporation
Chemical test	▫ pH	▫ pH meter (HACH)
	▫ Alkalinity (mg /l)	▫ Titration method.
	▫ Hardness (mg /l)	▫ Titration method (EDTA)
	▫ Chloride (mg /l)	▫ Titration method.
	▫ Iron (mg /l)	▫ Spectrophotometer
	▫ Manganese (mg /l)	▫ Spectrophotometer
Bacteriological	▫ Total Coliform (Nos./100 ml)	▫ Membrane filtration method.
	▫ Fecal Coliform (Nos./100 ml)	▫ Membrane filtration method

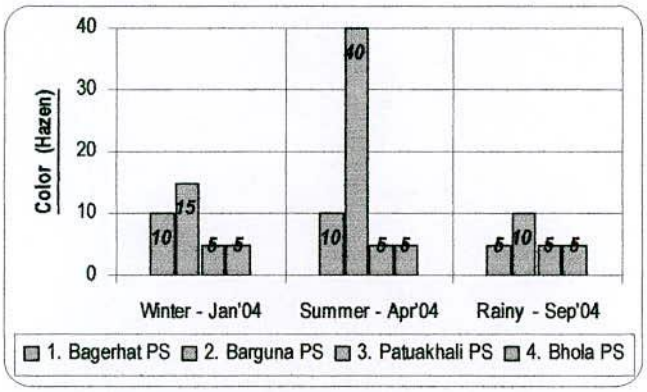
5.3 Presentation of Test Results

Twelve parameters were tested for 36 water samples in total from 3 locations of supply water of 4 Pourashavas during 3 seasons (i. e. 3 Location X 4 PS X 3 Season). The three seasons are winter, summer, and rainy respectively in January, April and September of 2004. In this section, the tests results are reflected in bar charts with necessary explanation. The results obtained from the laboratory experiment are presented in tabular format as *APPENDIX F or G*.

01. Color :

Color is formed in water due to presence of colored organic substances, weeds, colored industrial waste or metals such as iron, manganese and plankton. Color caused by suspended matter is defined as apparent color which can be removed by centrifugation or filtration. Color caused by dissolved and colloidal matters is defined as true color. Water should be colorless or transparent and according to Bangladesh Drinking Water Quality Standards (BDWQS), the drinking water should possess within 5 Hazen (unit). Drinking water possessed high color is not accepted by the consumer for aesthetic reason as well as suspecting contamination of water.

From the test results, it is noticed that the supply water samples of Barguna Pourashava have exceeded the limit of BDWQS. The supply water of other three Pourashavas namely Bagerhat, Patuakhali and Barguna possess the color within the limit of BDWQS.



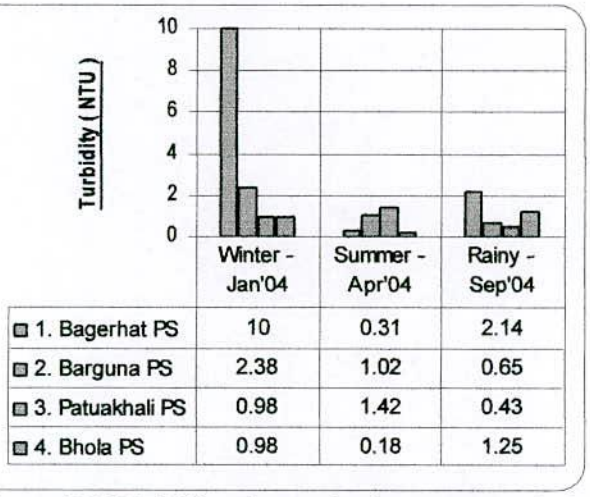
It is revealed from the Figure 5.01 that there is no notable seasonal effect of color on the supply water of the four Pourashavas under study the area.

Figure 5.01 Color of water for three seasons in four Pourashavas.

02. Turbidity :

Turbidity occurs in water due to presence of suspended clay, silt, fine organic or inorganic matters and microorganisms. The suspended particles that cause turbidity range in size from colloidal dimension (approximately 10 mm) to diameter in the order of 0.1 mm. Turbidity is an expression of certain light scattering and light absorbing properties of a water sample. According to BDWQS, the drinking water should possess within 5 NTU and excess of turbidity is objectionable to consumer.

From the test results, it is noticed that except one (sample of Bagerhat PS in Jan -04), all other supply water samples of four Pourashavas under study area possess the turbidity within the limit of BDWQS.



	Winter - Jan'04	Summer - Apr'04	Rainy - Sep'04
1. Bagerhat PS	10	0.31	2.14
2. Barguna PS	2.38	1.02	0.65
3. Patuakhali PS	0.98	1.42	0.43
4. Bhola PS	0.98	0.18	1.25

It is revealed from the Figure 5.02 that there is no notable seasonal effect of turbidity on the supply water of the four Pourashavas under the study area.

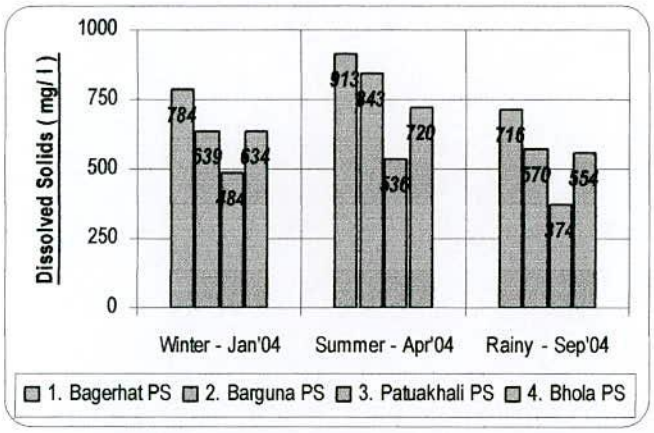
Figure 5.02 Turbidity of water for three seasons in four Pourashavas.

03. Dissolved Solids :

Dissolved solids (DS), also called total dissolved solids (TDS) in water comprise inorganic salts and small amount of organic matters. The water contained TDS more than 1000 mg /l is not suitable as per BDWQS for drinking purpose. Water with higher solids content often has a laxative and sometimes reverse effect upon people. Depending on the TDS (mg /l) in water is often classified as follows : (a)

Excellent for less than 600, (b) Good for 300 -- 600, (c) Fair for 600 -- 900, (d) Poor for 900 - 1200 and (e) Unacceptable for more than 1200 (Ahmed & Rahman, 2003).

From the test results, it is noticed that all supply water samples of four Pourashavas under study area possess the DS or TDS within the limit of BDWQS.

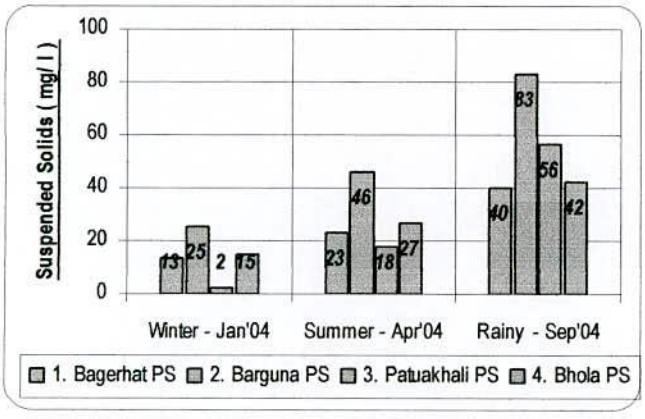


It is revealed from the Figure 5.03 that there is no notable seasonal effect of dissolved solids on the supply water of the four Pourashavas under the study area.

Figure 5.03 Dissolved Solids in water for three seasons in four Pourashavas.

04. Suspended Solids :

The water contained Suspended solids more than 10 mg /l is not suitable for the consumer as per BDWQS for drinking water. It is noticed from the test results that all supply water samples of four Pourashavas under study area possess Suspended solids higher than the BDWQS.



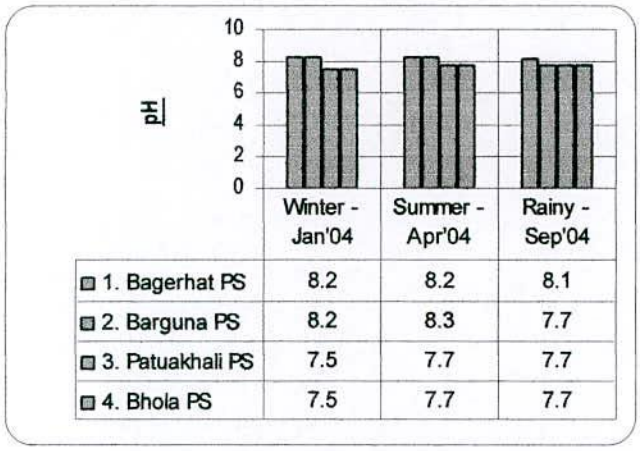
It is revealed from the Figure 5.04 that there is no notable seasonal effect of suspended solids on the supply water of the four Pourashavas under the study area.

Figure 5.04 Suspended Solids in water for three seasons in four Pourashavas.

05. pH :

The term pH is used universally to express the intensity of acid or alkaline of a solution or water. It is a measure of the concentration of free hydrogen ions (H+) in water and is expressed as pH = -log (H+) In water supply pH is important for coagulation, disinfection, water softening and corrosion control as well as biological treatment of water. According to BDWQS the drinking water should possess the range of

pH value 6.5 to 8.5. It is noticed from the test results that all supply water samples of four Pourashavas under study area possess the pH value within the limit of BDWQS.

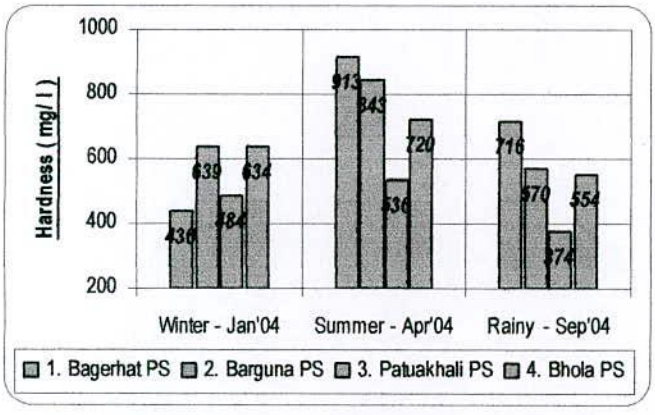


It is revealed from the Figure 5.05 that there is no notable seasonal effect of pH on the supply water of the four Pourashavas under the study area.

Figure 5.05 pH of water for three seasons in four Pourashavas.

06. Hardness as $CaCO_3$:

Hard water are generally considered to be those waters that require considerable amounts of soap to produce a foam or lather and that produce scale in hot water pipes, heaters and other units. The principal hardness causing cations are divalent calcium and magnesium, strontium, ferrous ions and manganese ions. Hard water consumes so much soap, and that is clog skin, discolor porcelain, stains shortens fabrics, and toughens and discolor vegetables and cooked foods. There is evidence that cardiovascular death rates are inversely correlated to hardness of water. The BDWQS recommends hardness range 200–500 mg /l based on taste and household use consideration. The test results express that except Barguna; all other supply water samples of three Pourashavas (Bagerhat, Patuakhali and Bhola) possess the hardness near to the limit of BDWQS. In Barguna Pourashava, the hardness of all water samples are less than the minimum value of BDWQS.

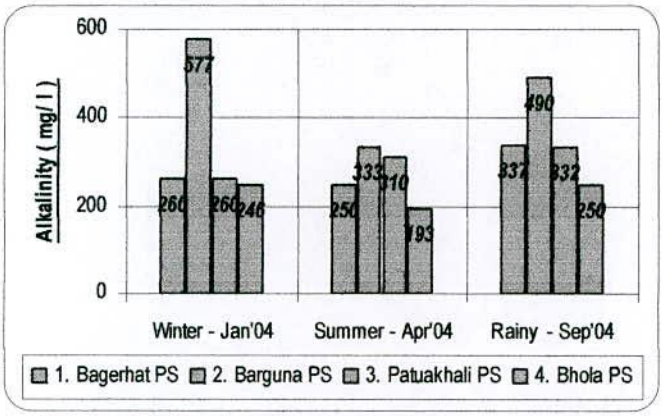


It is revealed from the Figure 5.06 that there is no notable seasonal effect of hardness as $CaCO_3$ on the supply water of the four Pourashavas under the study area.

Figure 5.06 Hardness of water for three seasons in four Pourashavas.

07. Alkalinity :

Alkalinity is caused in natural water from by bicarbonate, carbonate, hydroxide content and alkalinity is a measure of the concentrations of these constituents. Salts of weak acids, such a borate, silicates and phosphates, may be present in small amounts. Alkalinity is a measure of the buffer capacity. According to BDWQS, the drinking water should possess alkalinity less than 400 mg /l. The test results represent that except Barguna; all other supply water samples (from Bagerhat, Patuakhali and Bhola) possess the alkalinity within the limit of BDWQS.

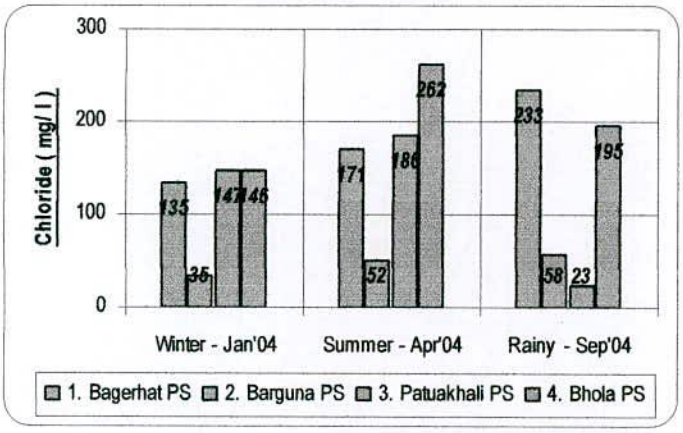


It is revealed from the Figure 5.07 that there is no notable seasonal effect of alkalinity on the supply water of the four Pourashavas under the study area.

Figure 5.07 Alkalinity of water for three seasons in four Pourashavas.

08. Chloride :

Chloride is distributed generally in the compound form with sodium, potassium and calcium. Chlorides occur in nature in widely varying concentrations. Rivers and ground water usually have a considerable amount of chloride. High chloride concentrations are corrosive to metals in the water distribution system. According to BDWQS, the drinking water should possess chloride in the range of 150 – 600 mg /l and 1000 mg /l for coastal area. The test results represented in the Table 5.04 express that except Barguna; all other supply water samples of three Pourashavas (Bagerhat, Patuakhali and Bhola) under the study area possess the chloride within the range of BDWQS. In Barguna Pourashava, the result of chloride is only 48 mg /l in average which is less than the minimum limit 150 mg /l.

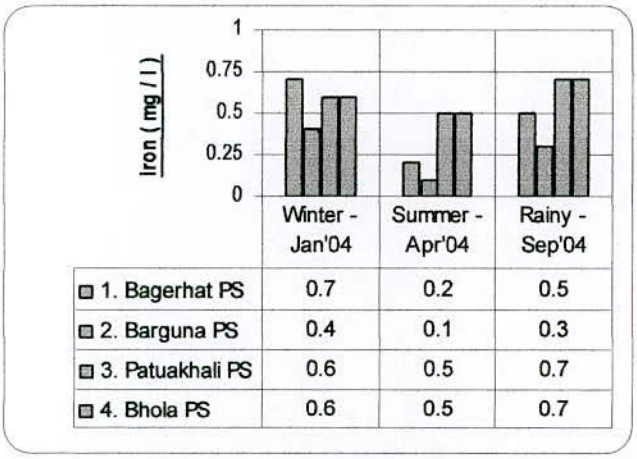


It is revealed from the Figure 5.08 that there is no notable seasonal effect of chloride on the supply water of the four Pourashavas under the study area.

Figure 5.08 Chloride of water for three seasons in four Pourashavas.

09. Iron :

The presence of iron in natural waters can be attributed to the dissolution of rocks and minerals, acid mine drainage, landfill leaches, sewage, or discharge from iron-related industries. Iron in water may cause hardness, undesirable taste in beverages, staining of clothes and plumbing fixtures, and may impart a reddish brown color to water. Iron in water is frequently accomplished by heavy growths of iron bacteria (Chrenothrix, Gallionella etc.) which exaggerate the staining and pipe clogging. According to BDWQS, the drinking water should possess in the range of 0.3 – 1.0 mg /l. The test results express that all supply water samples of four Pourashavas (Bagerhat, Barguna, Patuakhali and Bhola) under the study area possess the iron within the range of BDWQS.



	Winter - Jan'04	Summer - Apr'04	Rainy - Sep'04
1. Bagerhat PS	0.7	0.2	0.5
2. Barguna PS	0.4	0.1	0.3
3. Patuakhali PS	0.6	0.5	0.7
4. Bhola PS	0.6	0.5	0.7

It is revealed from the Figure 5.09 that there is no notable seasonal effect of iron on the supply water of the four Pourashavas under the study area.

Figure 5.09 Iron of water for three seasons in four Pourashavas.

10. Manganese :

According to BDWQS, manganese limit is 0.1 for dinking water. There is no trace of manganese in all supply water samples of four Pourashavas under the study area namely Bagerhat, Barguna, Patuakhali and Bhola Pourashavas.

11 Total Coliform :

The Coliform (TC) group is of great importance in the microbiological quality analysis of water. The Coliform group is made up of bacteria with biochemical and growth characteristics that reused to identify bacteria that are more or less fecal contamination. TC is characterized broadly by their ability to ferment lactose in culture at 35^0 C or 37^0 C.

According to BDWQS, the drinking water must be free from TC. From the results, it is noticed that almost all supply water samples collected from four Pourashavas possess TC with average range of 1 - 5 Nos. /100 ml. It is revealed from the Figure 5.10 that there is no seasonal effect of iron on the supply water of the four Pourashavas under the study area.

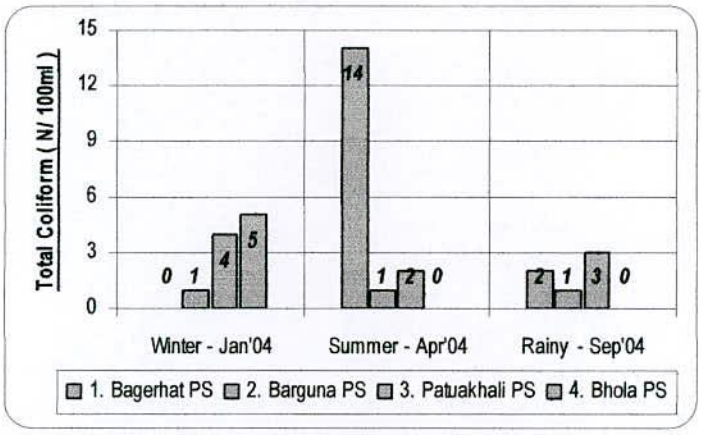


Figure 5.10 TC in water for three seasons in four Pourashavas.

12. Fecal Coliform :

Fecal Coliform (FC) organisms, which are exclusively of fecal organic, are characterized as coliform organisms that are able to ferment lactose at 44^0 C or 35^0 or 44.5^0C. Fecal pollution of water may introduce a variety of intestinal pathogens, e.g. bacterial, viral or parasitic. These include bacteria causing typhoid fever, bacillary dysentery and cholera.

According to BDWQS, the drinking water must be free from FC. From the test results, it is noticed that almost all supply water samples collected from four Pourashavas under study area possess FC with average range of 0 - 5 Nos./100 ml. It is revealed from the Figure 5.11 that there is no seasonal effect of iron on the supply water of the four Pourashavas under the study area.

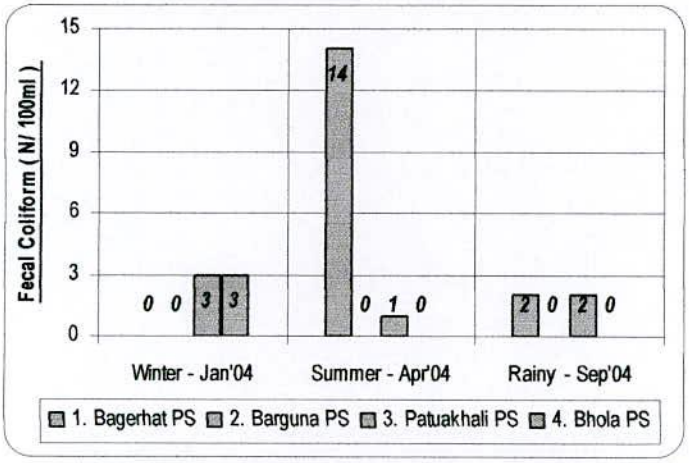


Figure 5.11 FC in water for three seasons in four Pourashavas.

5.4 Summery of Findings

The findings regarding supply water quality in the four Pourashavas namely, Bagerhat, Barguna, Patuakhali and Bhola under the study area are summarized as follows :

01. Water Quality Parameter (WQP) for Turbidity, Total Dissolved Solids, pH, Iron and Manganese :
Result is satisfactory in all Pourashavas.

02. WQP for Color and Hardness :
Satisfactory in three (3) Pourashavas namely Bagerhat, Patuakhali and Bhola.
Not satisfactory in Barguna Pourashava (higher than the BDWQS).

03. WQP for Alkalinity and Chloride :
Satisfactory in 3 Pourashavas.
Not satisfactory in Barguna Pourashava (less than the BDWQS).

04 WQP – Suspended Solids :
Not satisfactory in all Pourashavas (less than the BDWQS).

05. WQP – Total Coliform :
Presence some extent in 4 Pourashavas.

06. WQP – Fecal Coliform :
Not presence in Barguna Pourashava. Presence some extent in other Pourashavas.

07. Water quality monitoring in Pourashava :
There is no arrangement for monitoring of water quality status in all Pourashavas. A few results vary from BDWQS which can be rectified by development regular monitoring system in the Pourashavas under study area.

CHAPTER VI

SANITATION CONDITION

6. 1 General

The word sanitation actually refers to all conditions that affect health, and according to World Health Organization may include such things as food sanitation, rainwater drainage, solid waste disposal and atmospheric pollution. Sanitation may be defined as the science and practice of effecting healthful and hygienic conditions. It also involves the study and use of hygienic measures such as safe water supply, proper drainage of waste water, proper disposals of human waste and prompt removal of all refuse. The increase in population and the movement of population into urban areas have intensified environmental control difficulties in those areas. The provision of safe water; collection and disposal of human excreta, domestic and industrial wastes are becoming more difficult day by day. The practice of sanitation can contribute to prevent the spread of infectious diseases that caused from the excreta of an infected person and are transmitted to healthy person. Government has taken initiatives through National Sanitation strategy 2005 for the goal to achieve 100 % sanitation coverage by 2010.

In this chapter, the overall status of sanitation including waste management, drainage status, sanitary latrine, health and hygienic condition in the selected Pourashavas namely, Bagerhat PS, Barguna PS, Patuakhali PS and Bhola PS are described with relevant information.

6. 2 Common Sanitation Parameters

Sanitation also called environmental sanitation, actually involves a number of parameters. The principal objectives of providing sanitation are (a) to improve public health and (b) to minimize environmental pollution. The study includes only the common sanitation parameters or activities practiced in all Pourashavas under study area as follows.

(a) Waste management.
(b) Drainage system.
(c) Sanitary latrine.
(d) Health and hygiene.

6.3 Waste Management

Waste management is a non–stop program for each and every Pourashava. In context of environmental sanitation, Pourashava has to manage and monitor mainly three types of wastes such as (1) Solid waste, (2) Waste water and (3) Sewage. In all Pourashavas, the Conservancy Section adopts operate the waste management. The common tasks of Conservancy Section in the Pourashava are (a) Collection and disposal of solid waste, (b) Cleaning solid and floating matters as well sediments from drain, (c) Killing dog if necessary.

The present staff position in Conservancy Section of the four Pourashavas under the study area is shown in the Table 6.01.

Table 6. 01 Staff position in Pourashava Conservancy Section in Jan - 2008 :

Name of post		Staff position (No.) in four Pourashavas :			
		Bagerhat	Barguna	Patuakhali	Bhola
01	Medical Officer *	0	0	0	0
02	Conservancy Inspector	1	0	1	1
03	Supervisor - sweeper	3	1	3	3
04	Sweeper	162	45	75	75

* Medical Officer is vacant always who is head of both Conservancy and Health Sections.

6.3.1 Solid Waste

Solid waste within urban areas is termed Municipal solid waste. In practical, municipal SWM is a complex and complementary task, which depends on both public and private sectors and their partners (households, communities, municipalities, private operators, service users, NGOs) many of which are directly or indirectly involved, affected and influenced, and also on the technology adopted.

In Pourashava, solid waste management program generally associates the activities like road sweeping, cutting /dressing road side grass / plant, cleaning the solid matters from drain, SW collection from every source (disposal bin, road side, market area, etc.), gather the collected SW in selected secondary spots, SW recycling and finally disposal in a safe environmental manner with due attention towards economy, aesthetics, energy and conservation.

The scenario of solid waste management activities in all Pourashavas under the study area is almost same. The practice for collection and disposal is similar in four Pourashavas. The activity status regarding SWM in the four Pourashavas is presented in the Table 6.02.

Table 6. 02 Status of solid waste management activities in four Pourashavas :

Activity on SWM		Status	In Pourashava.
01	Road sweeping.	No practice.	Four Pourashavas.
02	Cutting /dressing of road side grass / plant.	Irregular.	Four Pourashavas.
03	Cleaning solid matters from drain.	Irregular and inadequate.	Four Pourashavas.
04	SW collection from every source (Dustbin, road side, market area, etc.).	Regular.	Four Pourashavas.
05	Solid waste storage in secondary spot.	No practice.	Four Pourashavas.
06	SW disposal to the landfill.	Not accordingly.	Four Pourashavas.
07	SW recycling / composting.	Composting by NGO.	Patuakhali Pourashava.
		Not available.	Bagerhat, Barguna and Bhola Pourashavas.

The basic information regarding SWM in the four Pourashavas is presented in the Table 6.03.

Table 6.03 Basic information on solid waste management activities of four Pourashavas :

Information parameter		Unit	Status in the 4 Pourashavas as :			
			Bagerhat	Barguna	Patuakhali	Bhola
01	Dumping site /landfill.	No. Acre	One. 1.25	One. 1.50	Nil.	Two 1.00 & 1.54
02	Dustbin availability	No.	125	92	84	65
03	Daily collection of Solid Waste (SW)	Ton	6	3	7	7
04	Daily disposal of SW.	Ton	6	3	7	7
05	Daily generation of SW.	Ton	10	5	12	9
06	SW generation - Kg / capita / day.	--	0.14	0.135	0.15	0.15
07	Equipments for SWMP :					
	▫ Garbage Truck	No.	2	2	3	2
	▫ Tractor with tailor	No.	1	0	2	0
	▫ Trolley	No.	9	15	40	25
	▫ Rickshaw van	No.	4	5	7	8
08	SW composting. status	–	No	No	Yes	No

The table 6.03 represents that there is no selected dumping area of Patuakhali Pourashava. It is analyzed and presented in the above table that the SW generation is 0.144 Kg/capita/day (avg. of four PSs). It is seen in Pourashavas that solid waste is dumped sometimes here and there like a low land inside or and outside of Pourashava which cause pollution of the environment. The In practical, Pourashava can not collect daily total solid waste generated within the Pourashava due to lack of capability of Pourashava as well as unconsciousness of Pourashava inhabitants. This incapability arises mainly from limitation of fund. Above all, SWM is actually a complex and complementary task for Pourashava which depends on public and private sectors as well as other partners like households, communities, municipalities, private operators, service users and NGOs.

6.3.2. Waste Water

Waste water also called municipal sewage, is the liquid waste that includes generally domestic and industrial discharge as well as storm water, groundwater infiltration and in flow. Domestic discharge is the liquid waste sometimes refereed to as sanitary sewage originated from water closets, urinals, baths, sinks etc. of dwellings, commercial establishments and institutions in the Pourashava. Sullage is also a liquid discharge originate from kitchens, wash basin etc. which are less foul than domestic sewage.

Waste water is discharge through the open or partially covered drains in all Pourashavas under the study area. All houses and establishments adopted direct connection into the drains for discharging waste water. The drainage system in all Pourashavas does not have the capacity to convey storm water and surface runoff. As a result, water becomes stagnant for a long time in many areas including

important roads in the Pourashavas and peoples have to suffer that time. More over, it creates a vital issue regarding environmental pollution.

6.3.3 Sewage

Sewage is also termed as human excreta, human waste or night soil. It refers to only human excreta and urine which usually are not combined with other liquid or solid waste. There is no environmentally safe and selected place in the Pourashava to dispose of night soil. The owners of the house and the establishment dispose of their night soil into canal, river or big drain in Pourashava with the help of dome or sweeper on own cost. Many owners connect their septic tank direct into adjacent drains with a view to flow the liquid portion of human waste into Pourashava drains. Some households as well as slum dwellers connect their latrines direct with Pourashava drains and thus dispose their night soil into open drain. The Pourashava authority cannot lake legal action against them as they can make alternative solution for these types of practice. This is the real picture on sewage operation in the studied Pourashavas and the practice is an alarming condition on the point of environment pollution.

6.4 Drainage System

In all Pourashavas, there are (1) Primary drain, (2) Secondary drain and (3) Tertiary drain classified based on dimension or discharge capacity. Also, there are (1) RCC drain, (2) BW drain and (3) *Kacha* drain classified based on materials with which they are constructed. All the drains covey waste water up to the out let such as river or canal. The four Pourashavas under the study area possess all types of drains. The length of drains in the four Pourashava is collected from " National Database 2004 -05 for Pourashavas " prepared by Pourashava guided by UMSU, LGED which is presented in the Table 6.04.

Table 6. 04 Length of drain in four Pourashavas under study area :

Name of Pourashava	Area of PS (Km^2)	Total length (Km)	Length (Km) for type of drain		
			RCC	BW	Kacha
Bagerhat Pourashava	13.72	23.15	RNA	23.15	RNA
Barguna Pourashava	12.96	31.52	0.52	22.66	8.34
Patuakhali Pourashava	26.00	20.35	2.35	2.333	15.67
Bhola Pourashava	31.48	109.50	15.30	75.70	18.50

Note : RNA = record not available.

In all Pourashavas, there are adequate networks of canals and nalas with tidal effect that fall ultimately into the adjacent rivers and contribute much to the Pourashava drainage system. The whole drainage system is the only medium where waste water and human waste are allowed to dispose and also many households throw solid waste in drain. This is the real picture of drainage system in the four

Pourashavas which is an alarming condition on the point of environment pollution. Pourashava should adopt proper monitoring and legal action as well as awareness to overcome the said problem.

6.5 Sanitary Latrine

All Pourashavas manage sanitary latrine program to achieve 100 % sanitation coverage by 2010 as per goal for National Sanitation strategy 2005. Awareness is developed among the Pourashava inhabitants to use sanitary latrines. All Pourashavas prepared the list of unhygienic latrines and they supply sanitary latrine on free of cost to Pourashava inhabitants who are not capable to arrange sanitary latrine. The Engineering Section implements the sanitary latrine program with the assistance of the Heath Section of Pourashava. It can be assumes from the present status of sanitation coverage that all Pourashavas under the study area can achieve 100 % coverage of sanitary latrine during the year 2008. The present coverage of sanitary latrine is given in the Table 6.05.

Table 6. 05 Coverage of sanitary latrine in four Pourashavas up to Dec - 2007 :

Pourashava	Supplied to date (Nos.)	Coverage (%)	Average
Bagerhat Pourashava	3500	100	97%
Barguna Pourashava	926	95	
Patuakhali Pourashava	720	98	
Bhola Pourashava	1000	95	

6.6 Health and Hygiene

The health situation in Pourashavas is gradually improving with the gradual improvement of the sanitation coverage. This is due to reason for an intergraded approach of water, sanitation and hygiene education. It is important to understand that the improvement of health is not possible without sanitary disposal of human excreta. However, neither sanitation nor water supply alone is good enough for health improvement. It is now well established that health education or hygiene promotion must accompany sufficient quantities of safe water and sanitary disposal of excreta to ensure the control of water and sanitation related diseases. In all Pourashavas, the Health Section adopts some activities on health and hygiene. The common activities of Pourashava Health Section are (a) Ensured sanitary latrine, (b) Action against mosquitoes, (c) Action for national vaccination, vitamin A to the children, (d) TT vaccine for mothers' care, (e) Conducting National Days and campaign for public awareness on health and hygiene program, (f) Implementation of EPI, (g) Supply ARV to dog bitten person, etc.

The present staff position in Health Section of four Pourashavas is shown in the Table 6.06.

Table 6. 06 Staff position in Pourashava Health Section in Jan - 2008 :

Name of post		Staff position (No.) in four Pourashavas :			
		Bagerhat	Barguna	Patuakhali	Bhola
01	Medical Officer *	0	0	0	0
02	Sanitary Inspector	1	1	0	0
03	Slaughter Inspector	0	1	0	0
04	Moulavi	1	1	1	0
05	Health Assistant	4	3	2	1
06	LD -- Typist	0	1	0	1
07	Vaccinator Supervisor	1	1	1	1
08	Vaccinator	6	1	4	4
09	Health Visitor	0	0	0	0
10	MLSS	1	1	1	2

* Medical Officer is the head of both Conservancy Section and Health Section.

6.7 Summery of Findings

In this study, sanitation includes (a) Waste management; (b) Drainage system, (c) Sanitary latrine and (d) Health and hygiene program in Pourashava. The findings on sanitation issues in the four Pourashavas under the study area are summarized as follows :

01. Waste management in Pourashava :

Waste management involves solid waste, waste water and night soil activities in Pourashava. Conservancy section mainly operates solid waste management program in all Pourashavas under the study area.

The average quantity of solid waste collection or disposal is same and 64% of daily generation (*Table 6.03*).

The average solid waste generation in the study area ranges 0.135 to 0.15 Kg /capita /day (*Table 6.03)*.

The disposal task is not performed accordingly and pollutes the environment.

02. Drain in Pourashava :

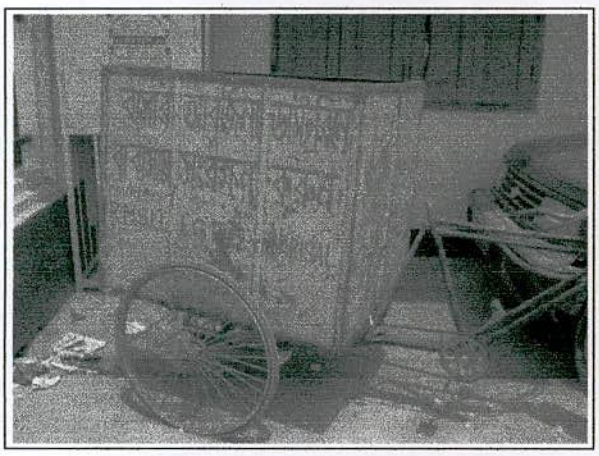
The drains are inadequate in Pourashavas (except Bhola). The drain becomes polluted due to direct connection for waste water and some where sewage in it

03. Sanitary latrine in Pourashava :

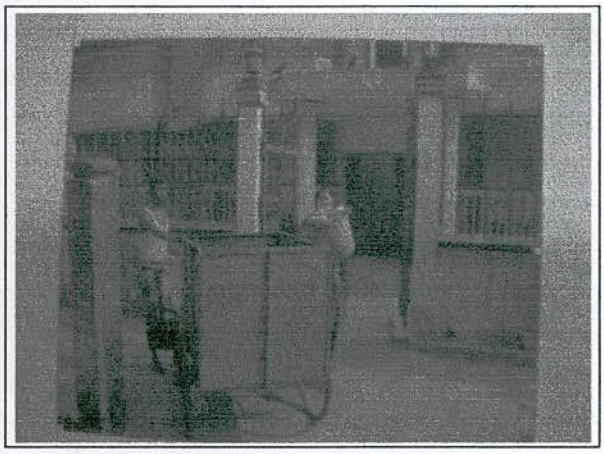
The provision of supplying sanitary latrines (rings with pan) in free cost is available to all Pourashavas. The coverage of sanitary larine is satisfactory in all Pourashavas which ranges from 95% to 100% (*Table 6.05*).

04. Health and Hygiene program in Pourashava :

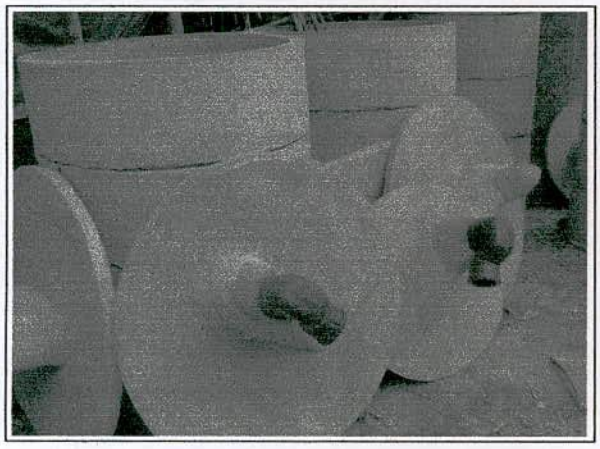
The regular activities conducted by Pourashava (a) Action for national vaccination to the children, (d) TT vaccine for mothers' care, (c) Conducting National Days and campaign, (d) Action against mosquitoes, (e) Supply ARV to dog bitten person.



A) Cycle Van for solid waste collection (Barguna PS).



B) Door– to– door for solid waste collection (Bhola PS).



C) Sanitary latrine for PS inhabitants (Bagerhat PS).

D) Vaccination to child by Health Section (Bhola PS).

Figure 6.01 Sanitation program in Pourashava under the study area.

CHAPTER VII

SOCIAL ASSESSMENT

7.1 General

For the sake of social assessment, a questionnaire was survey was conducted to explore the people's perception on water supply and sanitation condition in the four Pourashavas under the study area. The survey was conducted among 750 households in the four Pourashavas out of 38,166 households, therefore the perception should not be considered for the entire study namely Bagerhat, Barguna, Patuakhali and Bhola Pourashavas. In this chapter, respondents' comments are stated with pie charts / bar charts which reflect the practical feature on water supply and sanitation condition in the study area.

7.2 Questionnaire for People's Perception

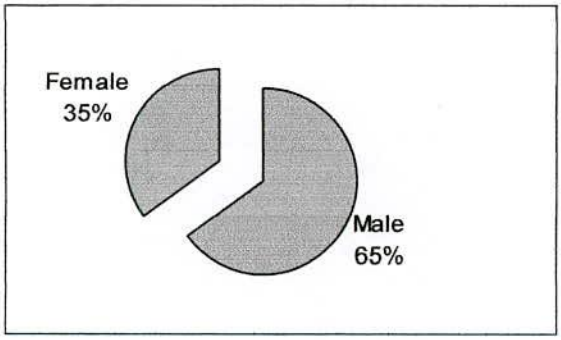
The questionnaire contained 41 questions with probable answers and option of comments regarding water supply and sanitation condition in the study area. The survey was conducted in random manner from the four Pourashava under the study area. The nos. of respondent was 750 in total from four Pourashavas such as (a) Bagerhat Pourashava – 200 Nos., (b) Barguna Pourashava -182 Nos., (c) Patuakhali -176 Nos., (d) Bhola Pourashava – 192 Nos.

The questionnaire was arranged on three major subjects as (a) Pourashava water supply -13 Nos., (b) Sanitary and Drainage -18 Nos. and (c) Solid waste management -10 Nos. The questionnaire was originally in the form of Bengali language attached as *APPENDIX - A*. The English version of the questionnaire is listed as *APPENDIX – B* of this report.

7.3 Characterization of Respondents

There were 750 nos. of respondents participated in the questionnaire survey in random manner from the four Pourashavas. A few characteristics of the participants or respondents are stated below.

(a) Sexes of respondents :



Among 750 respondents, the male and female were 485 and 265 nos. respectively.

The percentage of sexes of respondents is shown in Figure 7.01.

Figure 7.01 Sex categories of Respondents.

(b) Educational level of respondents :

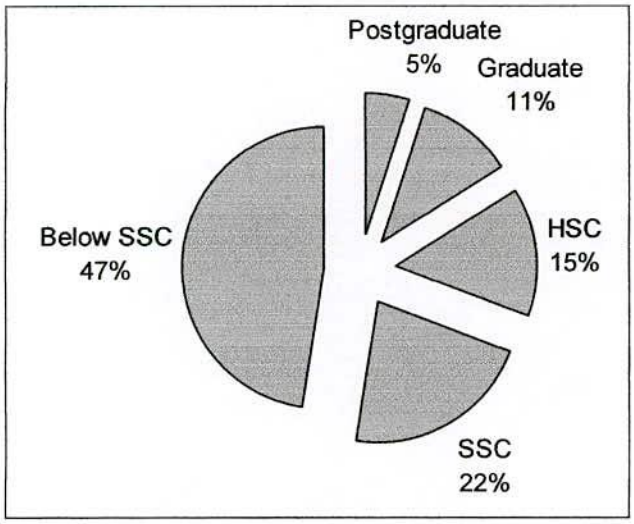


Figure 7.02 Educational levels of Respondents.

The questionnaire survey was conducted in random manner among 750 respondents where different educational levels were participated like postgraduate 38, graduate 82, HSC 112, SSC 162 and below SSC 356 from the four Pourashavas.

The percentage of educational levels is shown in Figure 7.02.

(c) Age level of respondents :

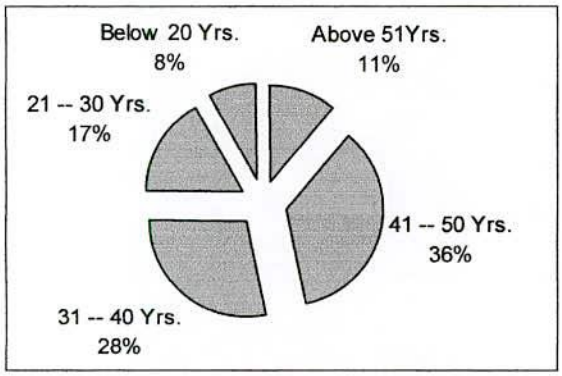


Figure 7.03 Age levels of Respondents.

The questionnaire survey was conducted in random manner among 750 respondents which are classified in five different age groups such as age below 20 Yrs, 21 – 30 Yrs, 31 – 40 Yrs, 41 – 50 Yrs and above 51 Yrs.

The percentage of respondents' age levels is shown in Figure 7.03.

(d) Professional status of respondents :

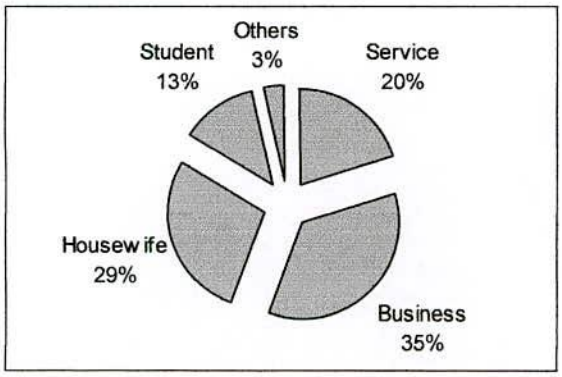


Figure 7.04 Professions of Respondents.

Among 750 respondents, the professional status was found in random manner like service 152, business 262, housewife 216, student 96 and others 24.

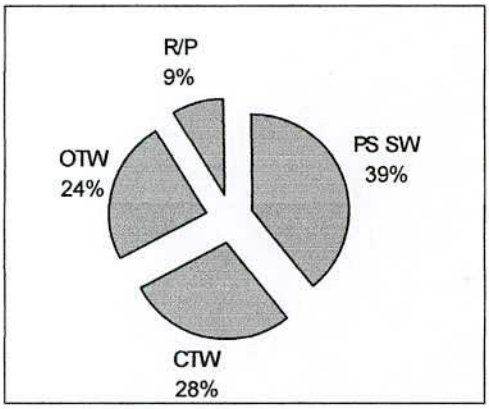
The percentage of profession is shown in Figure 7.04.

7.4 People's Perception on Water Supply Condition

There were 13 questions on Pourashava Water Supply and related issues listed as *APPENDIX. – B.* The answers of the questions from 750 respondents in the four Pourashavas namely Bagerhat, Barguna, Patuakhali and Bhola Pourashavas under study area are summarized in *APPENDIX. – C.*

Here, the people's perception has been reflected through pie chart / bar chart in percentage to understand the water supply condition in the study area.

(1) Sources of water for drinking /cooking :

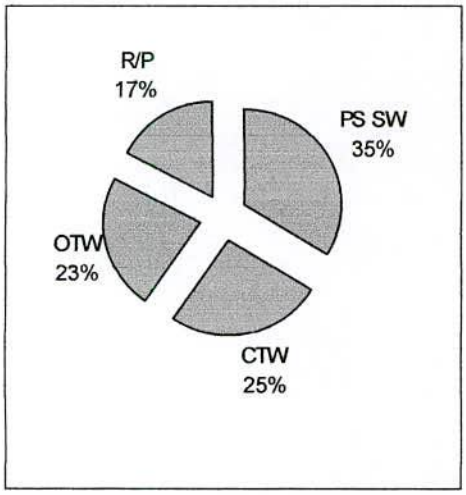


It is revealed from the figure that only 39% inhabitants depend on Pourashava supply water (PS SW) and 28% people collect water from community tube wells (CTW) for drinking or cooking purposes.

The remaining 33% (24% + 9%) inhabitants of Pourashava are to depend on own tube wells (OTW) and river or pond (R/P) for drinking or cooking purposes.

Figure 7.05 Respondents' perception (RP) on source of water for drinking /cooking.

(2) Sources of water for bathing, washing etc. (except - drinking /cooking) :

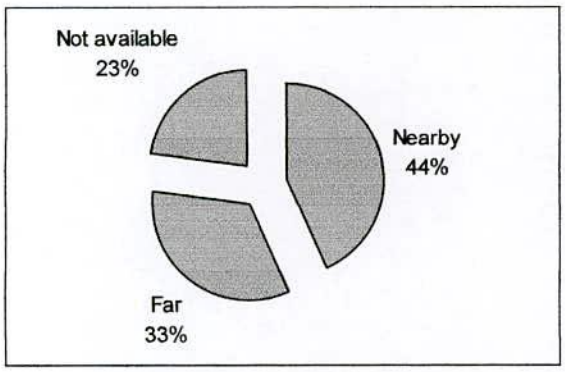


It is revealed from the figure that only 35% inhabitants depend on Pourashava supply water, 25% people collect water from community tube wells and 23% from own tube wells for bathing, washing etc (not for drinking or cooking purposes).

The remaining 17% inhabitants are to depend on river or pond water for the same (not for drinking or cooking purposes) i.e. river or pond water is almost double usage as compared to drinking purpose mentioned in the figure 7.05 placed before.

Figure 7.06 RP on sources of water for bathing, washing etc.

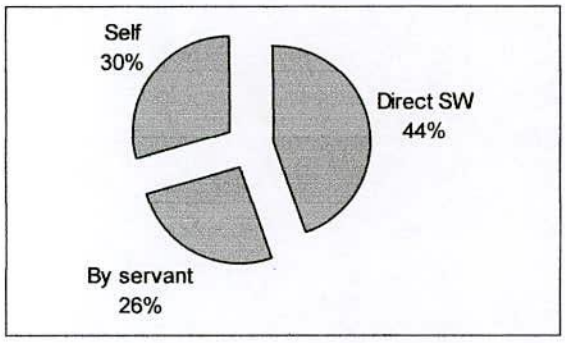
(3) Distance of PS tube wells from houses of respondents :



It is revealed from the figure that 35% respondents expressed nearby, 23% expressed far (distance about 100m) and 23% expressed not available of Pourashava tube well from their houses.

Figure 7.07 RP on distance of PS Community TW from their houses.

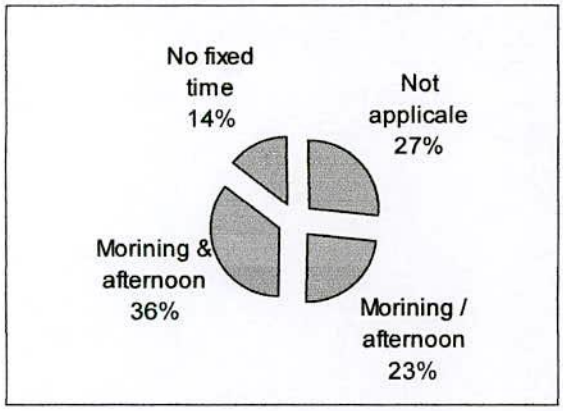
(4) Means of collection (how) water for respondents' houses :



It is revealed from the figure that 44% respondents expressed direct Pourashava supply water, 26% expressed by house servant and 30% expressed self for collection of daily need of water in their houses.

Figure 7.08 RP on means of collection (how) water for houses.

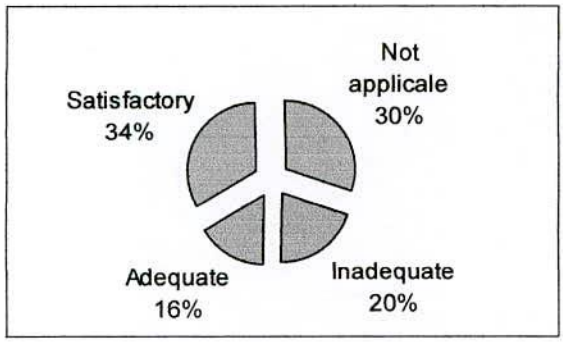
(5) Time of PS supply water in house :



It is revealed from the figure that 23% respondents expressed morning or afternoon, 36% expressed in morning and afternoon, 14% told no fixed time and 27% told not applicable regarding time for Pourashava supply water.

Figure 7.09 RP on time of PS supply water in their houses.

(6) Delivery status (quantity) of PS supply water :



It is revealed from the figure that 20% respondents expressed inadequate, 16% expressed adequate, 34% told satisfactory and 30% told not applicable regarding quantity of Pourashava supply water.

Figure 7.10 RP on delivery (status) of Pourashava supply water in their houses.

(7) Taste of PS supply water :

It is revealed from the figure 7.11 that 8% respondents expressed tasteless, 4% sweet, 2% salt, 58% normal and 28% no comments regarding taste of Pourashava supply water.

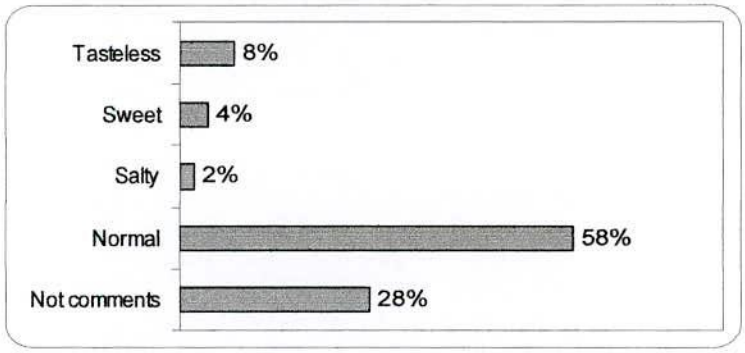


Figure 7.11 RP on taste of PS supply water in their houses.

(8) Odor of PS supply water :

It is revealed from the figure 7.12 that 56% respondents expressed normal odor, 21% odorless, 23% no comments regarding odor of Pourashava supply water.

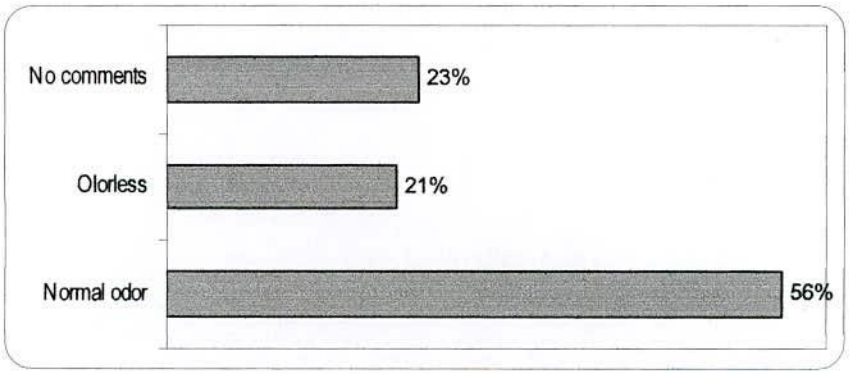


Figure 7.12 RP on odor of PS supply water in their houses.

(9) Daily water consumption for each family member :

It is revealed from the figure 7.13 that only 5% respondents mentioned specific quantity (ranges 50 to 100 liter), 61% told normal quantity 34% not known (no idea) regarding daily water consumption for each family member.

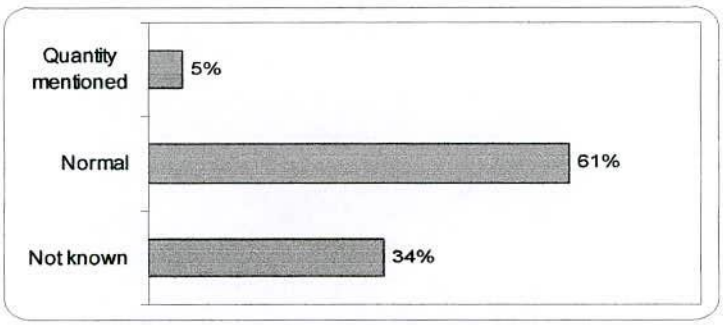


Figure 7.13 RP on water consumption for each family member.

(10) Comments on metering system for WS connection :

It is revealed from the figure 7.14 that only 53% respondents expressed good system, 28% told cost for water becomes expensive in metering system and 18% no comments regarding meter system for Pourashava water supply connection.

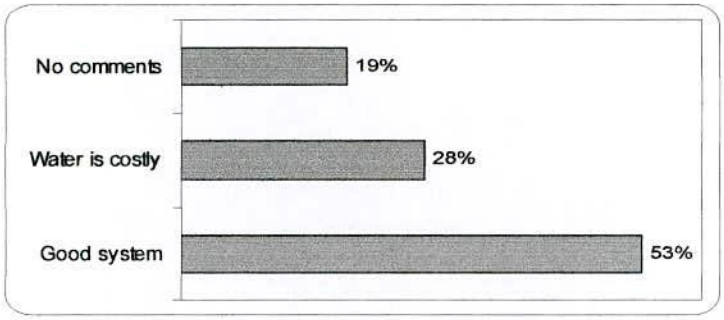


Figure 7.14 RP on metering system for WS connection.

(11) Monthly expenditure for household water :

It is revealed from the figure 7.15 that only 39% respondents mentioned PS rate (fixed rate, vide Table 4.08), 44% other comments (like N/A, not usage PS SW etc.) and 17% no comments regarding monthly expenditure for water in their houses.

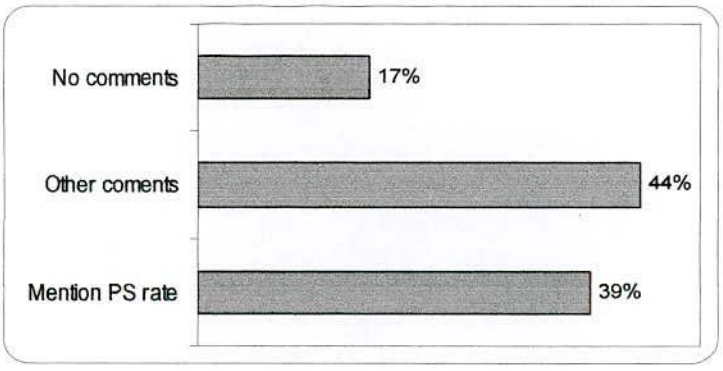


Figure 7.15 RP on monthly expenditure for household water.

(12) Increase of rate for PS SW to ensure sufficient supply :

It is revealed from the figure 7.16 that only 18% respondents expressed their disagreeness, 24% agree and 58% not applicable regarding rate in creases for PS supply water in their houses.

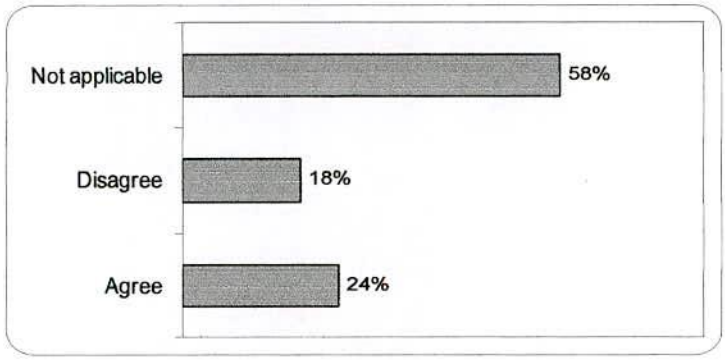
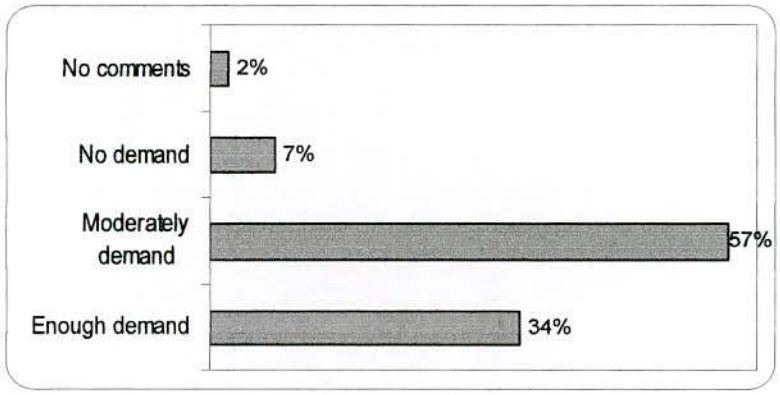


Figure 7.16 RP on Increase of rate for PS SW to ensure sufficient supply.

(13) Demand for new WS connection :

It is revealed from the figure 7.17 that 34% respondents told enough demand, 57% moderately demand, 7% no demand and 2% no comments regarding demand for new WS connection.



Here, the demand indicates the interest for taking new WS connection by the households (Art. 4.2.3).

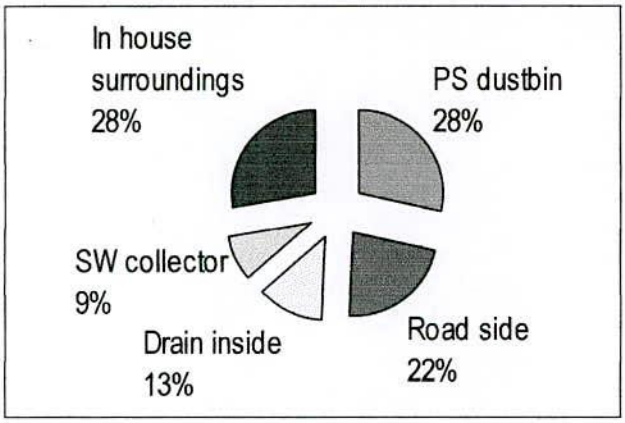
Figure 7.17 RP on demand of new water supply connection.

7.5 People's Perception on Solid Waste Management

There were 10 questions on Pourashava Solid Waste Management (SWM) listed as *APPENDIX. – B.* The answers of the questions from 750 respondents in the four Pourashavas namely Bagerhat, Barguna, Patuakhali and Bhola Pourashavas under study area are summarized in *APPENDIX. – D.*

Here, the people's perception has been reflected through pie chart / bar chart in percentage to understand the solid waste management in the study area.

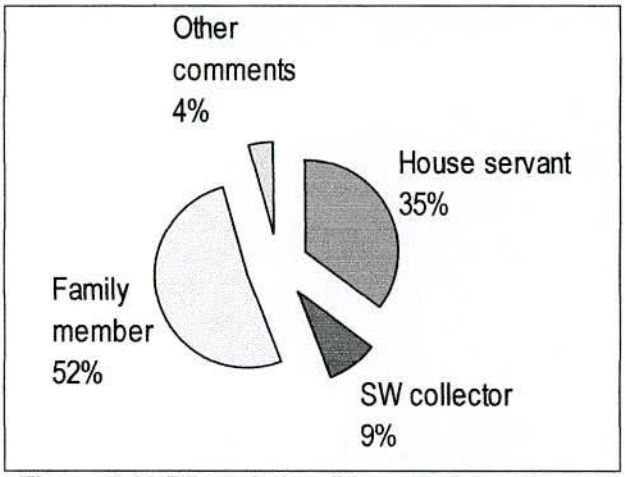
(1) Disposal place (where) of solid waste generated from house :



It is revealed from the RP reflected in the figure 7.18 that only 37% (28% and 9%) families dispose of their solid waste properly, 28% put on road side and remaining 41% (28% and 13%) adopt unsanitary means.

Figure 7.18 Respondents' perception (RP) on their solid waste disposal place (where).

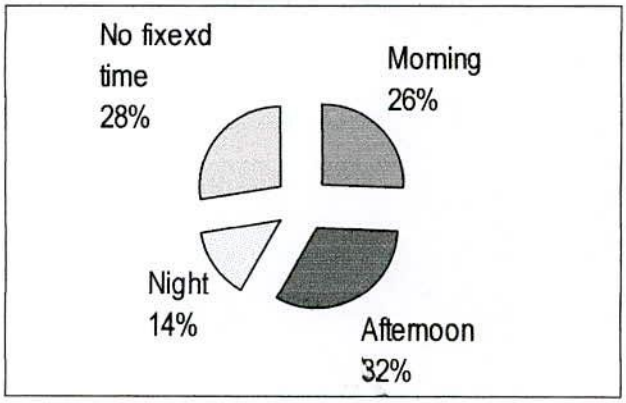
(2) Disposal means (how) of solid waste generated from house :



It is revealed from the RP reflected in the figure 7.19 that only 9% household solid waste is collected by SW collector (CBOs), 35% by servant, 52% by family members and 4% have no definite means.

Figure 7.19 RP on their solid waste disposal means (how).

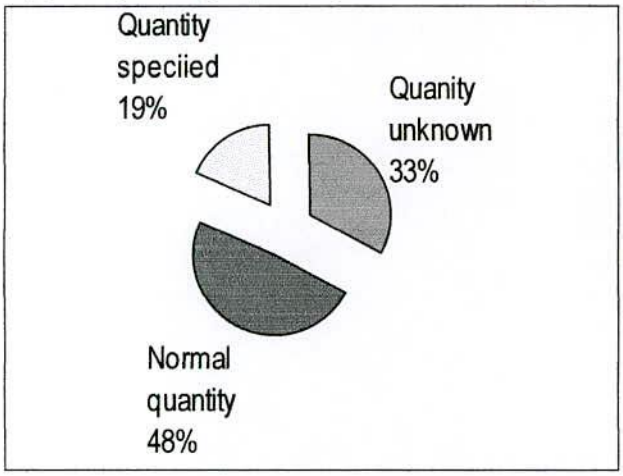
(3) Disposal time of solid waste from house :



It is revealed from the RP reflected in the figure 7.20 that 28% households maintain no fixed, 26% morning, 32% afternoon and 14% night for disposal their household solid waste. The question is only to know the practice regarding the time of SW disposal by the households.

Figure 7.20 RP on time for their solid waste disposal.

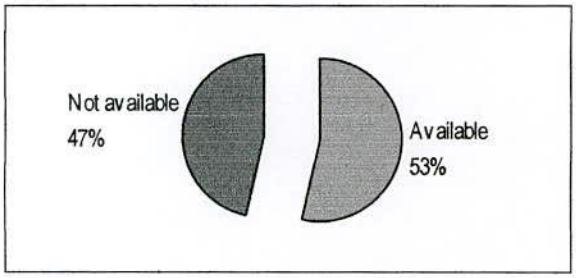
(4) Daily average quantity of solid waste generated from house :



It is revealed from the RP reflected in the figure 7.21 that only 19% households mention specifically the quantity of daily average solid waste generated from each house (ranges from 1 -- 5 Kg), 33% expressed quantity unknown and 48% told normal quantity (not know the correct quantity). .

Figure 7.21 RP on quantity of daily solid waste generated from house.

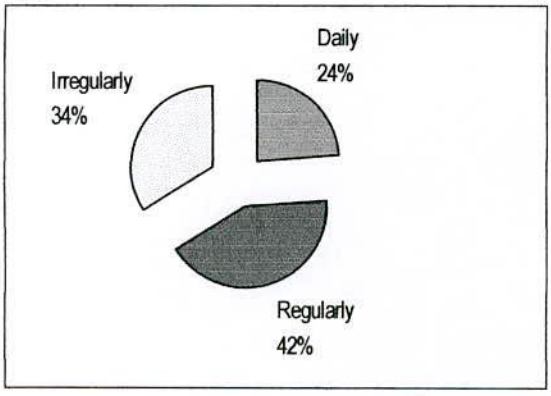
(5) Availability of dustbin nearby house :



It is revealed from the RP reflected in the figure 7.22 that 53% households mention the availability of dustbin and 47% mention not availability of dustbin nearby their houses.

Figure 7.22 RP on availability of dustbin nearby their houses.

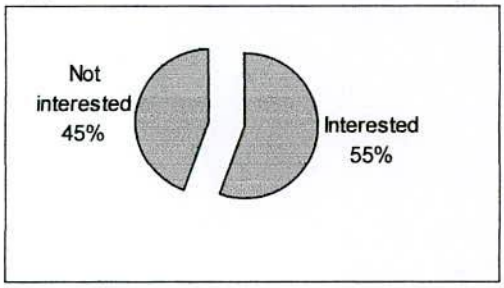
(6) Solid waste collection from dustbin by Pourashava workers :



It is revealed from the RP reflected in the figure 7.23 that 24% households expressed daily, 42% regularly and 34% irregularly for solid waste taken from dustbin by PS workers for final disposal.

Figure 7.23 RP on solid waste collection from dustbin for final disposal.

(7) Comments on alternative arrangement of dustbin :



It is revealed from the RP reflected in the figure 7.24 that 55% households are interested for alternative arrangement of dustbin i.e. they do not like dustbin due to uncleanness condition of dustbin. The remaining 45% are not interested to avoid dustbin.

Figure 7.24 RP on alternative arrangement of dustbin.

(8) Monthly expenditure for disposal of household SW :

It is revealed from the RP reflected in the figure 7.25 that 84% households expressed not applicable, 12% taka 10/= and 4% taka 15/= for monthly expenditure for disposal of their household solid waste.

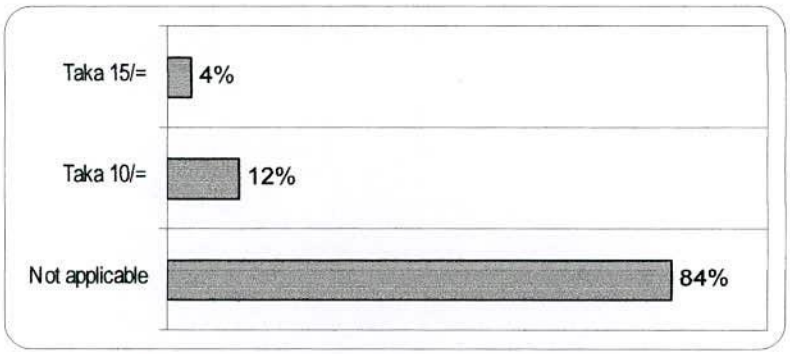


Figure 7.25 RP on monthly expenditure for disposal of household solid waste.

(9) Consciousness of PS inhabitants about SW disposal :

It is revealed from the RP reflected in the figure 7.26 that 29% expressed enough, 40% moderate and 29% poor regarding consciousness of Pourashava inhabitants about solid waste disposal.

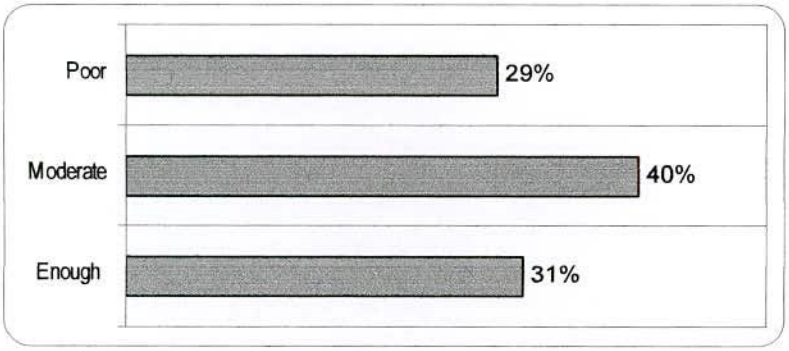


Figure 7.26 RP on consciousness of PS inhabitants about solid waste disposal.

(10) Overall status of SWM program in Pourashava :

It is revealed from the RP reflected in the figure 7.27 that 34% expressed good, 35% moderate and 31% unsatisfactory regarding overall status of Pourashava solid waste management (SWM) program.

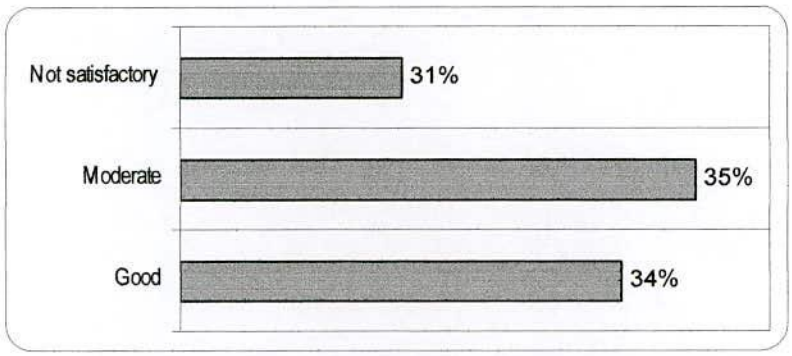


Figure 7.27 RP regarding overall status of SWM program in Pourashava.

7.6 People's Perception on Sanitary and Drainage condition

There were 18 questions on Pourashava Sanitary and Drainage condition listed as *APPENDIX. – B.* The answers of the questions from 750 respondents in the four Pourashavas namely Bagerhat, Barguna, Patuakhali and Bhola Pourashavas under study area are attached as *APPENDIX. – E.*

Here, the people's perception has been reflected through bar chart in percentage to understand the sanitary and drainage condition in the study area.

(1) Type of Latrine in house :

It is revealed from the RP reflected in the figure 7.28 on type of latrine is that 59% households use water sealed latrine, 28% pit latrine, 7% bucket type and 6% direct into drain. So, 87% (59% + 28%) households use sanitary latrine, where as only 13% used unsanitary larine in the study area.

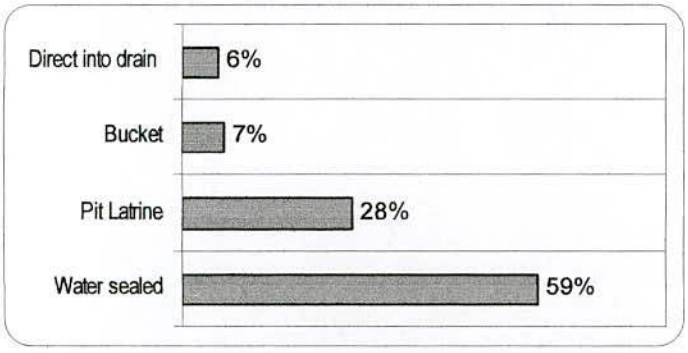


Figure 7.28 Respondents' perception (RP) regarding type of latrines in their hoses.

(2) Comments on sanitary latrine in Slum area.

Regarding availability of sanitary latrines in slum areas, it is revealed from the RP reflected in the figure 7.29 that 35% expressed yes (available), 23% no (not available), 32% inadequate and 10% not known.

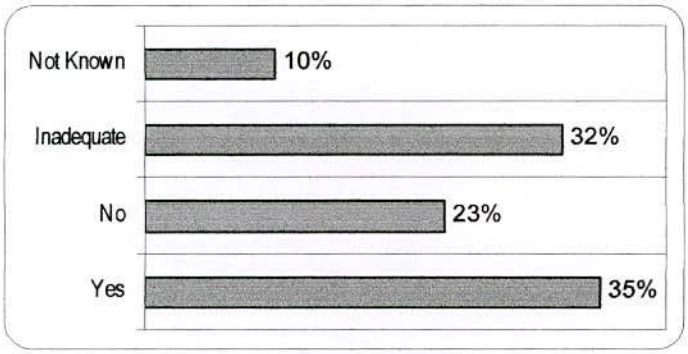


Figure 7.29 RP on sanitary latrine in Slum area.

(3) Latrine usage of younger member in the family :

It is revealed from the RP reflected in the figure 7.30 that 12% expressed not applicable, 58% told in house latrine and 30% expressed special arrangement regarding latrine usage of younger member. The status of said practice is satisfactory.

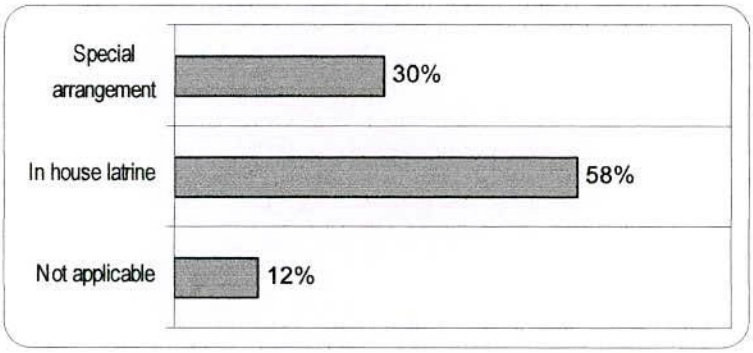


Figure 7.30 RP on usage of latrine by younger member in the family.

(4) By whom pan of latrine clean in house :

It is revealed from the RP reflected in the figure 7.31 that 12% expressed servant, 58% expressed self and 30% expressed no comments regarding cleaning the pan of latrine in their houses. The status of said practice is satisfactory.

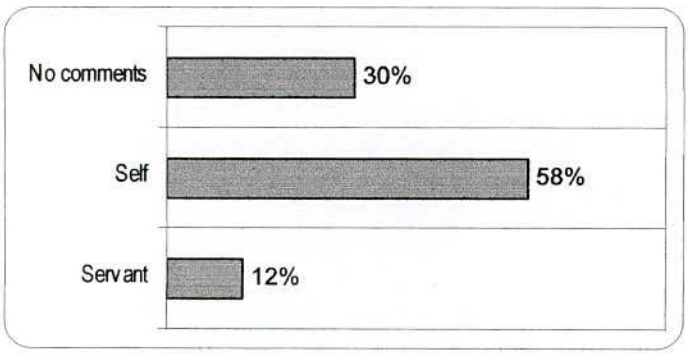


Figure 7.31 RP on cleaning of pan of latrine by whom in house.

(5) Hand washing material after usage latrine :

It is revealed from the RP reflected in the figure 7.32 that 82% expressed soap, 10% expressed water only and 8% expressed no comments regarding washing of hands after usage. The status of said practice is satisfactory.

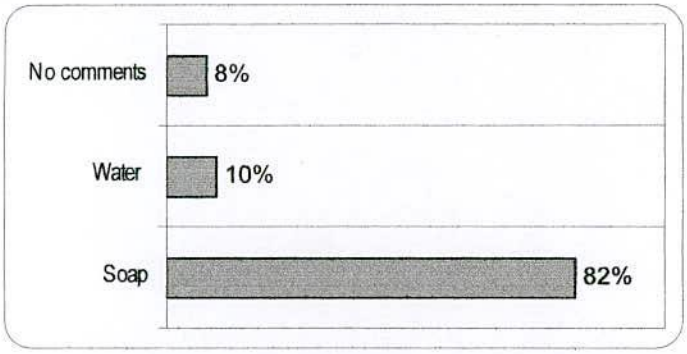


Figure 7.32 RP on hand washing materials after usage latrine.

(6) Consciousness of PS inhabitants for usage sanitary latrine :

regarding consciousness of PS inhabitants for using sanitary latrine, it is revealed from the RP reflected in the figure 7.33 that 28% expressed enough, 57% moderate and 15% expressed very poor. The status of said practice is satisfactory.

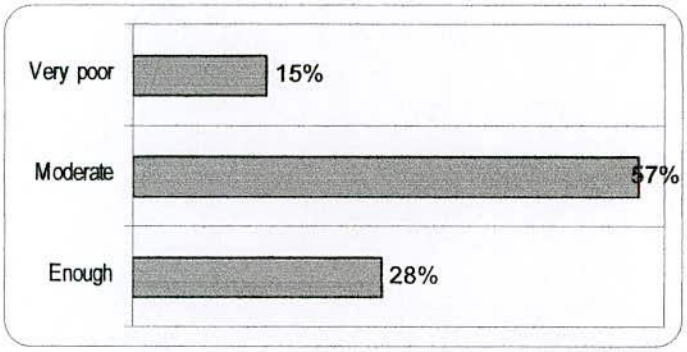


Figure 7.33 RP on consciousness of PS inhabitants for usage sanitary latrine.

(7) Providing sanitary latrine at free of cost by Pourashava :

Regarding sanitary latrine given by Pourashava at free of cost, it is revealed from the RP reflected in the figure 7.34 that 51% expressed yes, 27% expressed inadequate and 22% expressed not known.

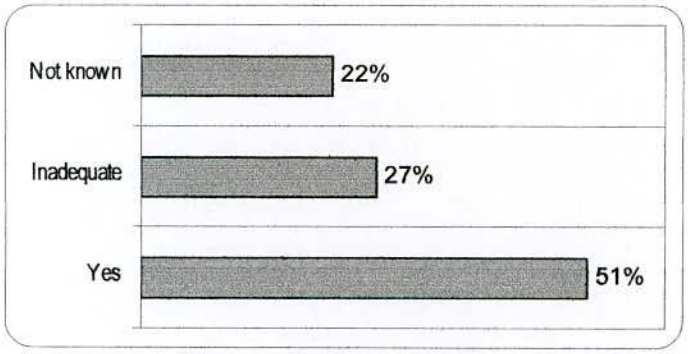


Figure 7.34 RP on providing cost free latrine by Pourashava.

(8) Disease attacked during the year 2004 :

It is revealed from the RP reflected in the figure 7.35 that 23% expressed not applicable, 7% expressed diarrhea, 4% expressed typhoid and 66% mentioned cold /fever /cough regarding attack by diseases during the year 2004. The status is not a serious problematic one.

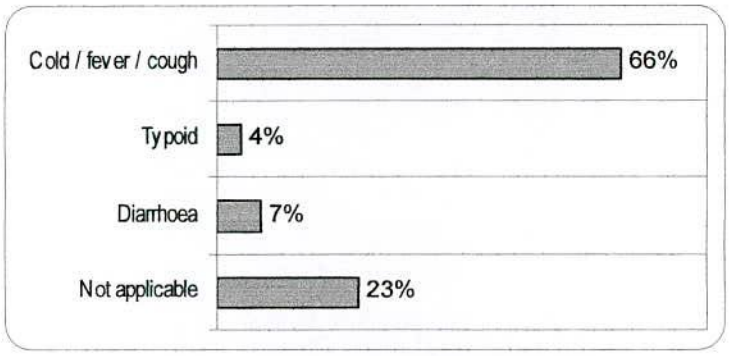


Figure 7.35 RP on disease attacked during the year 2004.

(9) Disease attacked to respondent's family member in 2004 :

It is revealed from the RP reflected in the figure 7.36 that 24% told not applicable, 10% expressed male, 17% told female and 49% mentioned child regarding attack by diseases during the year 2004.

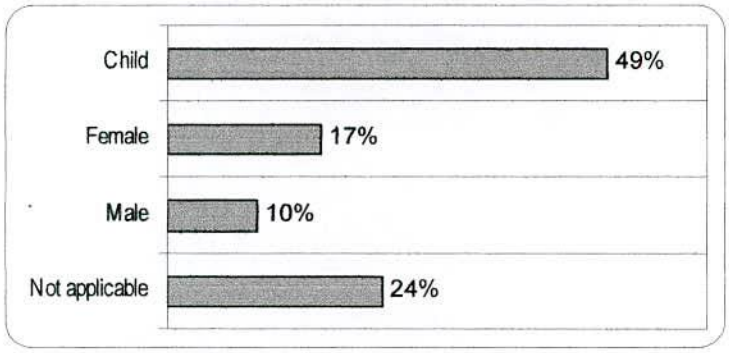


Figure 7.36 RP on disease attacked to family member during the year 2004.

(10) Reason for attack by disease :

It is revealed from the RP reflected in the figure 7.37 that 15% expressed not applicable, 32% expressed water pollution, 34% expressed solid waste pollution and 19% mentioned season change regarding attack by diseases during the year 2004.

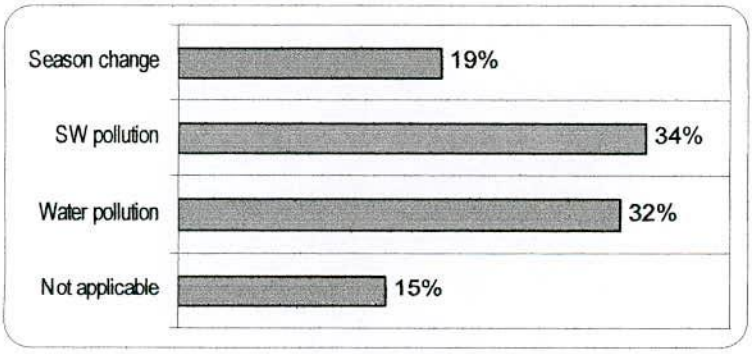


Figure 7.37 RP on reason for attacking disease during the year 2004.

(11) Disturbance by mosquito in the locality :

It is revealed from the RP reflected in the figure 7.38 that 6% expressed no disturbance, 50% expressed moderate, 44% expressed much regarding disturbance by mosquito in the locality.

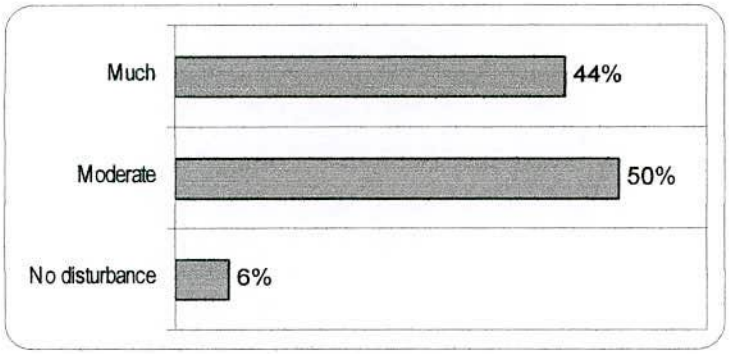


Figure 7.38 RP on disturbance by mosquito in the locality.

(12) Time period of disturbance by mosquito :

It is revealed from the RP reflected in the figure 7.39 that 5% expressed not applicable, 29% rainy, 10% winter, 21% summer and 35% expressed almost the year for disturbance by mosquito.

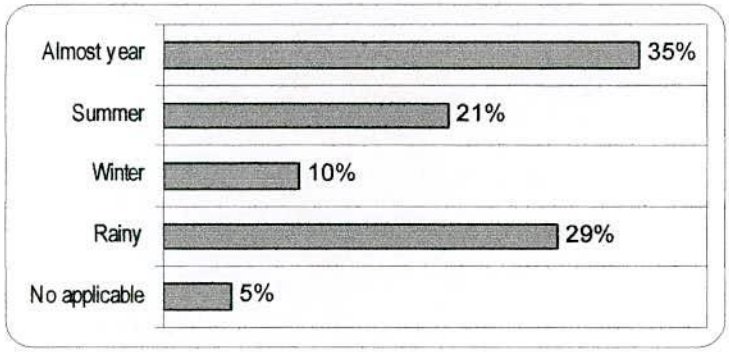


Figure 7.39 RP on time period of disturbance by mosquito.

(13) Reason for mosquito produce :

It is revealed from the RP reflected in the figure 7.40 that 33% expressed drainage problem, 24% solid waste (SW) problem, 37% told both drainage and SW problems and 6 no comments regarding reason for mosquito produce.

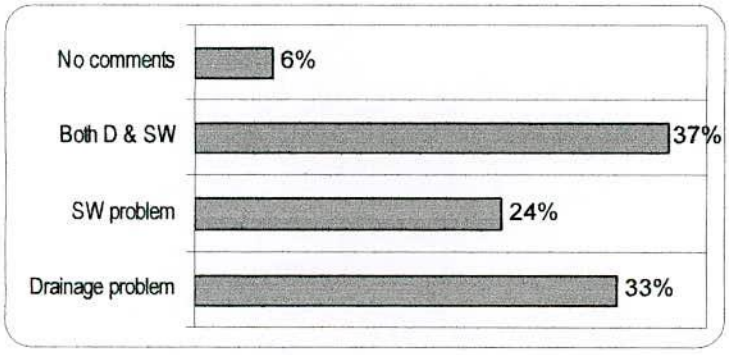


Figure 7.40 RP on reason for mosquito produce.

(14) Where the liquid waste from house fall in :

It is revealed from the RP reflected in the figure 7.41 that 29% expressed Pourashava drain, 14% river /canal 47% told in house low land regarding the liquid waste from houses fallen.

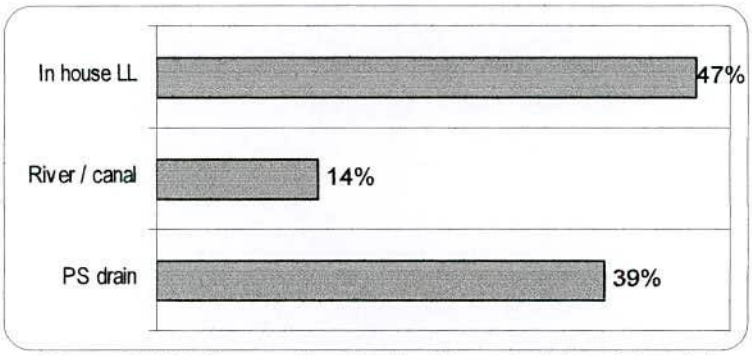


Figure 7.41 RP regarding the liquid waste fallen (where) from houses fallen.

(15) Connection of household latrine into drain :

It is revealed from the RP reflected in the figure 7.42 that 29% expressed positive (yes), 35% negative (no) and 43% not known regarding connection of household latrine into drain.

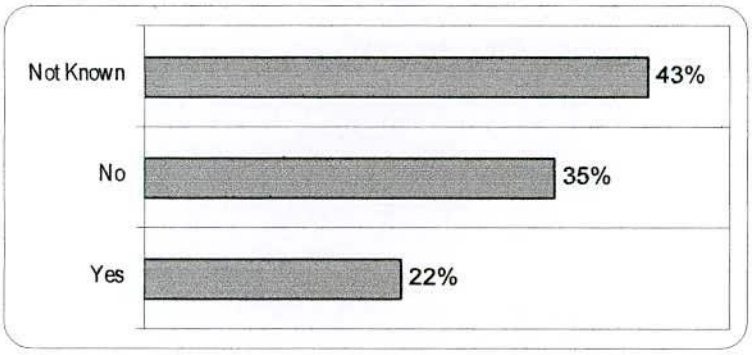


Figure 7.42 RP regarding connection of household latrine into drain.

(16) Status of drain cleanness in the locality :

It is revealed from the RP reflected in the figure 7.43 that 22% expressed good, 35% moderate and 43% expressed not satisfactory regarding cleanness status of drain in the locality.

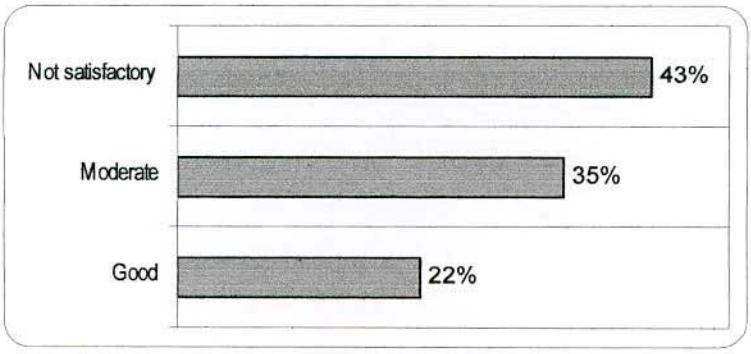


Figure 7.43 RP on cleanness status of drain in the locality.

(17) Overflow of drain water during rainy season :

It is revealed from the RP reflected in the figure 7.44 that 22% expressed overflow, 35% not overflow and 43% expressed sometimes overflow regarding drain water overflow in the rainy season.

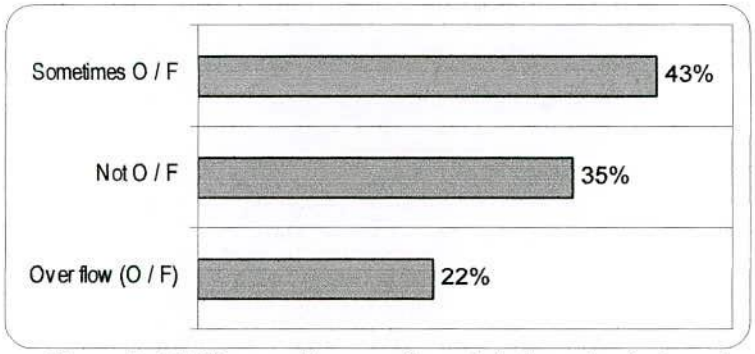


Figure 7.44 RP regarding overflow of drain water during rainy season.

(18) Out fall for drain water in Pourashava :

It is revealed from the RP reflected in the figure 7.45 that 72% expressed river /canal, 13% low land and 15% expressed not known regarding outfall for drain water in Pourashava.

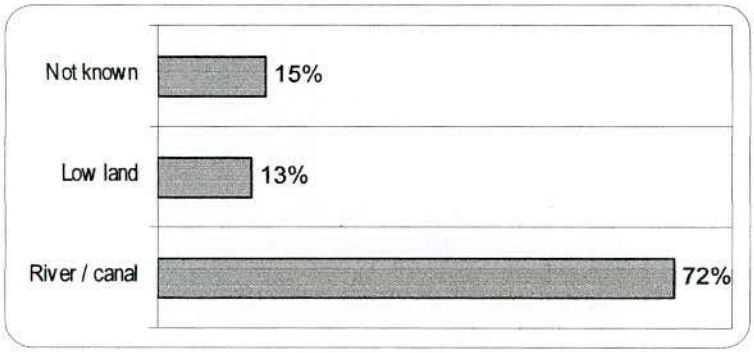


Figure 7.45 RP regarding out fall for drain water in Pourashava.

7.7 Summery of Findings

The findings from questionnaire survey among the Pourashava inhabitants on various issues regarding water supply and sanitation conditions in the four Pourashavas namely Bagerhat, Barguna, Patuakhali and Bhola under the study area are summarized as follows :

01. Water supply service from Pourashava :

- 35% inhabitants depend on Pourashava (PS) supply water (SW).
- 25% depend on water from Community hand tube well (CHTW) for all purposes.
- 17% inhabitants depend on pond, river or canal for all purposes.
- 50% water consumers express their satisfaction on adequate quantity of PS SW.
- Metering system is appreciated by 53% respondents.
- 91% respondents (without PS SW connection) are interested to get the same.
- 23% respondents do not depend on PS SW who possess own tube well (OTW).

02. Solid waste management :

- 37% inhabitants throw their solid waste properly and remaining 63% do unsanitary means.
- 34% respondents reported that dustbin is cleaned irregularly by Pourashava workers and 55% respondents are interested for alternative arrangement like door to door collection.
- 29% respondents expressed "poor consciousness" of Pourashava citizens about solid waste operation.
- 69% respondents expressed satisfaction on SWM condition and rest 31% not satisfaction.

03. Sanitary latrine :

- 87% respondents use sanitary latrines.
- About 50% latrine is unsanitary in slum.
- 85% inhabitants are conscious for usage of sanitary latrine.

04. Common disease attacked :

50% family members (only children) were attacked by common diseases like cold, fever, cough, diarrhoea etc. from pollution of solid waste and water as per respondents' perception.

05. Disturbance by mosquitoes :

96% respondents expressed on disturbance by mosquitoes among them 35% expressed on disturbance for almost the year.

06. Drainage status :

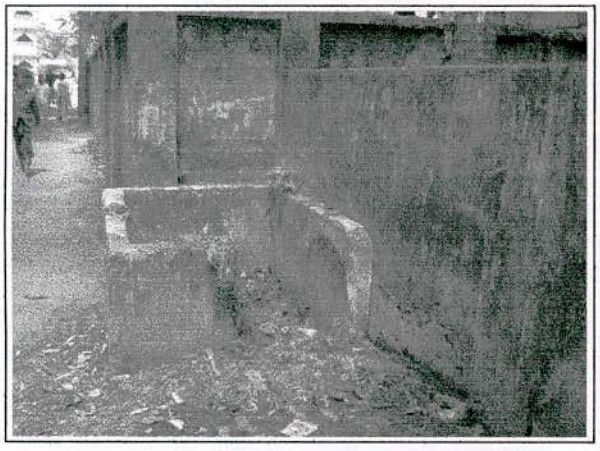
- 22% households connect their latrines into drain of Pourashava.
- 57% respondents expressed satisfaction on cleanness of drain in their locality.
- About 50% respondents expressed regarding overflow of drain during rainy season.

(A) Dustbin in Barguna Pourashava.

The photograph represents the followings :
▫ The dustbin is contracted on the road, ▫ Solid waste is cast outside of dustbin, ▫ The condition is before cleaning by conservancy worker of Pourashava.

(B) Dustbin in Patuakhali Pourashava.

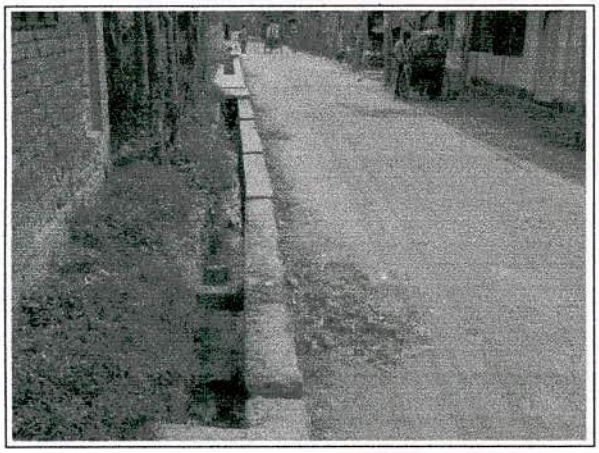
The photograph represents the followings :
▫ The dustbin is constructed beside the road far off from residence and so it is now useless, ▫ Weeds exist around the dustbin.



(C) Dustbin in Bhola Pourashava.

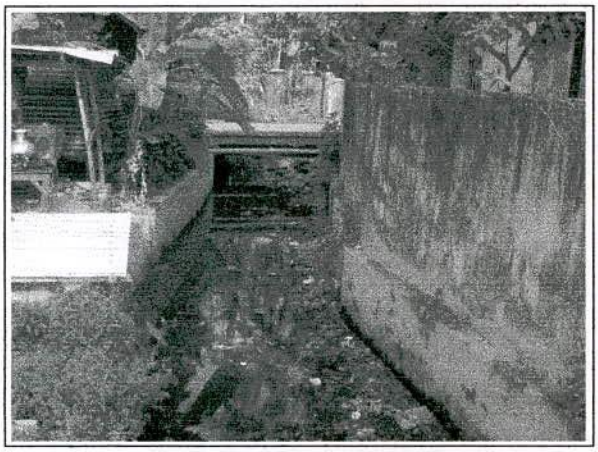
The photograph represents the followings :
▫ The dustbin is contracted adjacent the road, ▫ Solid waste is cast outside of dustbin and becomes very much dirty place, ▫ The condition is before cleaning by Pourashava.

Figure 7.46 Dustbin before cleaning in the study area.



(A) Drain beside road (Barguna Pourashava).

The photograph represents the followings :
▫ Weeds /grass exist beside the drain which is not cleaned regularly, ▫ Solid waste is thrown on road beside the drain, ▫ Solid waste exists all though the side of roar and drain, ▫ The cleanness status of the drain is not satisfactory.



(B) Drain through residential area (Patuakhali Pourashava).

The photograph represents the followings :
▫ Weeds exist beside the drain, ▫ Solid waste is thrown in the drain, ▫ The cleanness status of the drain is not satisfactory.

(C)Drain beside road (Bhola Pourashava).

The photograph represents the followings :
▫ Weeds exist beside the drain, ▫ Solid waste is thrown in the drain, ▫ The cleanness status of the drain is not satisfactory.

Figure 7.47 Drain in the study area.

(A) Canal in Barguna Pourashava.

The photograph represents the followings :
▫ People are taking bath in the canal, ▫ Boats flows in the canal, ▫ Waste water from drain is also allowed to fall into the canal, ▫ There exists the tidal effect in canal.

(B) Canal in Bhola Pourashava.

The photograph represents the followings :
▫ Drain water is allowed to fall into the canal, ▫ Weeds exist beside the canal, ▫ There exists the tidal effect in canal.

(C) Private pond beside road in Barguna Pourashava.

The photograph represents the followings :
▫ The pond is not used by people for daily usage, ▫ Water–hyacinth coves the pond fully, ▫ There exists also weeds beside the pond.

Figure 7.48 Canal / pond in the study area.

CHAPTER VIII

CONCLUSION AND RECOMMENDATION

8.1 General

The main objectives of this study are to investigate the existing condition of Pourashava supply water with quality and sanitation conditions. The findings revealed from the study have already been stated in the respective section. In this chapter, the summery of findings are concluded and necessary recommendations are suggested.

8.1 Conclusion

The notable issues regarding water supply and sanitation condition revealed from the research study in the four Pourashavas namely Bagerhat, Barguna, Patuakhali and Bhola are concluded as follows :

1. The average of water delivery or consumption range 0.90 to 1.77 M^3/HH/day in the four Pourashavas (PSs) under study area where the highest value is in Bhola PS.

   The estimated water supply quantity can serve for 29% population in average of the 4 PSs..

   The yearly average increase of water supply connection is 6.3% to 14.42% in the area where water supply network is available where the highest value is in Bagerhat PS

   The average supply water coverage in the four PSs based on household ranges 13% to 73% and the coverage based on service area ranges 60% to 75%. The highest coverage for both cases is in Bagerhat Pourashava.

   The estimated monthly cost of water consumption is 303 Tk /HH in Patuakhali PS which is 1.5 to 4 times with respect to other three Pourashavas.

   The payment status by the consumer for supply water in the four PSs ranges 80% to 98% where the highest value is in Barguna Pourashava Yearly net income status of supply water is not so high that it can be possible to improve and expand the PS water supply system.

2. According to people's perception (PP), only 35% inhabitants depend on Pourashava water supply. The remaining inhabitants 65% meet up their water requirement from community tube wells (25%), own tube wells (23%) and from river, pond etc. (17%) as per PP.

   50% of respondents agree to increase their monthly cost for adequate supply of water (except Patuakhali PS) as well as appreciate for metering system.

3. There is no monitoring step on water quality status in the studied Pourashavas.

   Twelve water quality parameters were tested under the study and found following status :

   Five (Turbidity, TDS, pH, Iron & Manganese) were found satisfactory in all Pourashavas.

   Four (Color, Hardness, Alkalinity & Chloride) were found satisfactory in different three PSs.

   Two (SS and TC) were not satisfactory in all Pourashavas.

   One (FC) was not satisfactory in three Pourashavas.

   Therefore, no Pourashava possesses the BDWQS in full swing.

4. The average quantity of solid waste collection or disposal in the study area is same and 64% of daily generation. The average solid waste generation in the study area ranges 0.135 to 0.15 Kg /capita /day.

   According to people's perception (PP), 29% respondents expressed "poor consciousness" of Pourashava inhabitants on solid waste disposal and 31% respondents expressed " not satisfactory" on solid waste management in Pourashava.

5. The drain is seriously polluted due to direct connection of waste water line and somewhere sewage into drain. According to PP, 22% households connect their latrines direct into drain.

   57% respondents expressed their satisfaction on cleanness of drain and almost 50% expressed regarding overflow of drain during rainy season in their locality.

6. Pourashava supplies sanitary latrine (rings with pan) at free of cost to ensure 100% sanitation by 2010. The coverage of sanitary larine in the study area ranges 95% to 100%.

   As per PP, 85% inhabitants are conscious for usage sanitary latrine.

7. Pourashava conducts a few activities on health and hygiene. According to PP, 49% children were attacked by common diseases like cold, fever, cough, diarrhoea etc due to pollution of solid waste and water. Regarding disturbance by mosquitoes, 96% respondents expressed "much disturbance" and 35% of them mentioned the period for almost the year.

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APPENDIX A

Survey Questionnaire on Water Supply and Sanitation Condition

- **Purpose :** Thesis work under M. Sc. Engg. (Environment).
- **Student :** Syed Nesar Ahammed (Mbe : 0171-131448).

নিচের প্রশ্ন গুলির উত্তর দিবার জন্য টিক (✓) চিহ্ন ব্যবহার করুন এবং প্রযোজ্য ক্ষেত্রে আপনার মন্তব্য লিখুন (একই পরিবারের একজন):

পৌরসভার নাম : ----------

বিষয় : আবর্জনা সংরক্ষণ ও অপসারণ কার্যক্রম (Solid Waste Storage & Disposal)

০১. আপনার বাসার আবর্জনা কোথায় ফেলা হয় ? ☐ পৌর ডাস্টবিনে ☐ রাস্তার পাশে ☐ ড্রেনের ভিতরে ☐ বাড়ীর আশেপাশের ফাঁকা জায়গায় ☐ সংগ্রহকারী কর্মী নিয়ে যায়

০২. আপনার বাসার আবর্জনা কিভাবে ফেলা হয় ? ☐ সংগ্রহকারী কর্মী নিয়ে যায় ☐ বাসার কাজের লোকের দ্বারা ☐ নিজেদের দ্বারা

০৩. আপনার বাসার আবর্জনা কখন ফেলা হয় ? ☐ সকালে ☐ দুপুরে ☐ বিকালে ☐ রাত্রে ☐ সময় ঠিক নাই ☐ .....

০৪. আপনার বাসা থেকে প্রতিদিন গড়ে কি পরিমান আবর্জনা ফেলা হয় ? ☐ জানা নাই ☐ .....কেজি (আনুমানিক)

০৫. আপনার বাসার কাছাকাছি পৌরসভার ডাস্টবিন আছে ? ☐ আছে ☐ নাই

০৬. আপনার এলাকার (ডাস্টবিনের) আবর্জনা পরিষ্কার করা হয় - ☐ প্রতিদিন ☐ নিয়মিত ☐ অনিয়মিত

০৭. ডাস্টবিন তুলেদিয়ে বিকল্প ব্যবস্থা গ্রহনে আপনি আগ্রহী কিনা । ☐ আগ্রহী ☐ আগ্রহী নয় ☐ .....

০৮. আপনার বাসার আবর্জনা সংগ্রহের জন্য নিযুক্ত কর্মীকে মাসিক কত টাকা প্রদান করেন ? ☐ প্রযোজ্য নয় ☐ ৫ টাকা ☐ ১০ টাকা ☐ ..... টাকা

০৯. যথাযথভাবে আবর্জনা অপসারণের ব্যাপারে পৌরবাসীদের সচেতনতা কেমন ? ☐ যথেষ্ট ☐ মোটামুটি ☐ খুবই কম

১০. আপনার এলাকার সার্বিক আবর্জনা ব্যবস্থাপনা কার্যক্রম কেমন ? ☐ বেশ ভালো ☐ ভালো ☐ সন্তোষজনক ☐ সন্তোষজনক নয়

বিষয় : স্বাস্থ্য ও নর্দমা নিষ্কাশন অবস্থা (Sanitary & Drainage Condition)

১১. আপনার পরিবারে কি ধরনের পায়খানার ব্যাবস্থা আছে ? ☐ Water seal ☐ Pit ☐ Bucket ☐ Hanging ☐ Open place ☐ Direct into drain ☐ .....

১২. পৌরসভার বস্তিসমূহে স্বাস্থ্য সম্মত পায়খানা আছে কি ? ☐ আছে ☐ নাই ☐ অপর্যাপ্ত আছে

১৩. আপনার পরিবারের ছোট সন্তানরা কোথায় পায়খানা করে ? ☐ প্রযোজ্য নয় ☐ বাসার পায়খানায় ☐ বিশেষ ব্যবস্থায় ☐ .....

১৪. আপনার বাসার পায়খানার প্যান কে পরিষ্কার করে ? ☐প্রযোজ্য নয় ☐বাসার যে কোন সদস্য/ মহিলা সদস্য/ পুরুষ সদস্য ☐কাজের লোক

১৫. বাসার পায়খানা ব্যাবহারের পর যা দিয়ে হাত পরিষ্কার করেন ? ☐ সাবান ☐ ছাই ☐ শুধু পানি ☐ .....

১৬. স্বাস্থ্য সম্মত পায়খানা ব্যবহারে পৌরবাসীদের সচেতনতা কেমন ? ☐ যথেষ্ট ☐ মোটামুটি ☐ খুবই কম

১৭. স্বাস্থ্য সম্মত পায়খানা সরবরাহ করার জন্য পৌরসভা বা অন্য কোন সংস্থার কোন কার্যক্রম ছিল/ বর্তমানে আছে কিনা ? ☐ আছে ☐ অপর্যাপ্ত আছে ☐ ছিল ☐ অপর্যাপ্ত ছিল ☐ জানা নাই

১৮. আপনার পরিবারে গত (২০০৪) বছর কি কি সাধারন অসুখ হয়েছিল ? ☐ প্রযোজ্য নয় ☐ ডাইরিয়া ☐ টাইফয়েড ☐সর্দি/ জ্বর/ কাঁশি ☐ .....

১৯. আপনার পরিবারে গত (২০০৪) বছর যে সদস্যের সাধারন অসুখ হয়েছিল ? ☐ প্রযোজ্য নয় ☐ শিশু ☐ পুরুষ ☐ মহিলা

২০. পরিবারে উক্ত সাধারন অসুখের কারন কি বলে আপনি মনে করেন ? ☐ প্রযোজ্য নয় ☐ পানি দূষন ☐ আবর্জনা দূষন ☐ .....

২১. আপনার এলাকায় মশার উপদ্রব কেমন ? ☐ নাই ☐ মোটামুটি ☐ অত্যান্ত

২২. মশার উপদ্রব কখন বেশী হয় ? ☐ প্রযোজ্য নয় ☐সারা বছর ☐প্রায় সারা বছর ☐ বর্ষাকালে /শীতকালে /গরমকালে /কাল জানা নাই

২৩. মশার উপদ্রবের কারন কি বলে আপনি মনে করেন ? ☐ প্রযোজ্য নয় ☐ ড্রেনে জলাবদ্ধতা ☐ আবর্জনা দূষন ☐ .....

অ : পৃ : দ্র :

২৪. আপনার বাসার বাথরুমের/ রান্নাঘরের তরল আবর্জনা কোথায় অপসারন করেন ? ☐ পৌর ড্রেনে ☐ নদীতে/ খালে
☐ বাড়ীর ভিতর নীচু জায়গায়/ গর্ত করে ☐ .....

২৫. আপনার এলাকায় কেহ পায়খানার বহি:সংযোগ পৌরসভার ড্রেনে দিয়ে থাকেন কিনা ? ☐ হ্যাঁ ☐ না ☐ জানা নাই

২৬. আপনার এলাকায় পৌর ড্রেনের সার্বিক পরিষ্কার-পরিচ্ছন্নতা কেমন ? ☐ বেশ ভালো ☐ ভালো ☐ সন্তোষজনক ☐ সন্তোষজনক নয়

২৭. বর্ষাকালে পৌর ড্রেনের পানি উপচে পড়ে কিনা ? ☐ উপচে পড়ে না ☐ উপচে পড়ে ☐ .....

২৮. পৌর ড্রেনের তরল ময়লা চূড়ান্ত পর্যায়ে কোথায় গিয়ে পড়ে ? ☐ খালে ☐ নদীতে ☐ নীচু জায়গায় ☐ জানা নাই ☐ .....

বিষয় : পৌর পানি সংক্রান্ত (PS Water Supply)

২৯. আপনার বাসার খাবার/ রান্নার পানির উৎস কি ? ☐ পৌর পাইপ লাইন ☐ কমুনিটি টিউব ওয়েল
☐ নিজস্ব টিউব ওয়েল ☐ পুকুর / নদী/ খাল/ ....

৩০. আপনার বাসায় অন্যান্য ব্যবহারের **(গোছলের-১ /থালা-বাসন ধৌতকরন-২ /কাপড় ধৌতকরন-৩ / পায়খানা ব্যাবহার-৪)** পানির উৎস কি ?
☐ পৌর পাইপ লাইন ☐ কমুনিটি টিউব ওয়েল ☐ নিজস্ব টিউব ওয়েল ☐ পুকুর / নদী/ খাল/ ....

৩১. আপনার বাসা থেকে পৌর টিউবওয়েল কত দূরে ? ☐ কাছে ☐ দূরে ☐ বেশী দূরে ☐ এলাকায় নাই ☐ .....

৩২. আপনার বাসার ব্যবহারের পানি কিভাবে সংগ্রহ করেন ? ☐ পৌর পাইপ লাইন ☐ কাজের লোক দ্বারা ☐ পরিবারের সদস্য দ্বারা

৩৩. আপনার বাসায় কখন পৌর সরবরাহকৃত পানি পেয়ে থাকেন ? ☐ প্রযোজ্য নয় ☐ সকালে ☐ দুপুরে ☐ বিকালে
☐ রাত্রে ☐ সময় ঠিক নাই ☐ .....

৩৪. আপনার বাসায় পৌর সরবরাহকৃত পানির ঘাটতি আছে কিনা ? ☐ প্রযোজ্য নয় ☐ ঘাটতি নাই ☐ ঘাটতি আছে ☐ সরবরাহ সন্তেষজনক

৩৫. পৌর সরবরাহকৃত পানির স্বাধ কেমন ? ☐ স্বাভাবিক স্বাধ ☐ লোনা ☐ মিষ্টি স্বাধ ☐ স্বাধ বিহীন ☐ .....

৩৬. পৌর সরবরাহকৃত পানির গন্ধ কেমন ? ☐ স্বাভাবিক গন্ধ ☐ গন্ধ বিহীন ☐ .....

৩৭. আপনার বাসার প্রতি সদস্যের জন্য দৈনিক কত পরিমান পানি প্রয়োজন ? ☐ জানা নাই ☐ স্বাভাবিক পরিমান ☐ ..... লিটার/ কেজি

৩৮. মিটারিং পদ্ধতিতে পানির বিল প্রনয়ণে পানির অপচয় রোধ হয় এবং সবসময় পানি পাওয়া যায় --এ ব্যাপারে আপনার সমর্থেনের সাথে অন্য কোন মন্তব্য আছে কিন ? ☐ নাই ☐ থাকলে লিখুন.....

৩৯. পানি সংগ্রহ বাবদ আপনার পরিবারের মাসিক খরচ মোট কত টাকা ? ☐ ..... টাকা ☐ .....

৪০. আপনার বাসায় সন্তোষজনক পরিমানে পানি পাবার জন্য মাসিক ব্যয় বৃদ্ধি করতে রাজি আছেন ? ☐ হ্যাঁ ☐ না ☐ প্রযোজ্য নয়

৪১. পৌর পানি পাবার জন্য নতুন লাইন নেবার চাহিদা কেমন ? ☐ যথেষ্ট চাহিদা আছে ☐ মোটামুটি চাহিদা আছে ☐ চাহিদা নাই

৪২. উল্লেখিত বিষয়সমূহে আপনার অন্য কোন মন্তব্য আছে কিনা ? ☐ নাই ☐ থাকলে সংক্ষেপে লিখুন :

উত্তর দাতার ব্যক্তিগত তথ্যাদি :

(০১) নাম : ..... **(০২) বয়স (বছর) :**.....

(০৩) ঠিকানা : ..... **(০৪) ফোন নং :**.....

(০৫) অত্র পৌরসভায় বসবাস : ..... **(বছর) / স্থানীয় বাসিন্দা** **(০৬) পৌর ওয়ার্ড নং :**.....

(০৭) পরিবারে সদস্য সংখ্যা : পুরুষ ....., **মহিলা** ....., **শিশু** .....; **মোট =** .....**জন**

(০৮) শিক্ষাগত যোগ্যতা : প্রাথমিক/ নিম্ন মাধ্যমিক/ মাধ্যমিক/ উচ্চ মাধ্যমিক/ স্নাতক/ স্নাতকোত্তর/ .....

(০৯) পেশা : ব্যবসা /গৃহিনী / চাকুরী...../.....

(১০) ঐচ্ছিক তথ্যাদি : জন প্রতিনিধি / শিক্ষক / উকিল / .....

APPENDIX B

Questionnaire of survey for people's perception :

Question No.	Subject wise Question No.	
Solid waste management		
01	01	Where the SW of your house is disposed of ?
02	02	How the SW of your house is disposed of ?
03	03	When the SW of your house is disposed of ?
04	04	Mention the daily average quantity of SW generated from your house ?
05	05	Is there disposal bin (dustbin) nearby your house ?
06	06	When the SW is taken over from the dustbin for final disposal ?
07	07	Do you prefer alternative arrangement instead of disposal bin ?
08	08	How much money do you pay per month to SW collector from your house ?
09	09	Mention the consciousness of the PS citizen regarding SW disposal ?
10	10	Mention the over all situation of SWM program in your locality ?
Sanitary and Drainage condition		
11	01	Mention the type of latrine used for your family members?
12	02	Is there sanitary latrine for the slum people in the Pourashava?
13	03	Where do younger members of your family go for latrine?
14	04	Who clean the latrine pan of your house?
15	06	What is used for washing the hands in your family after usage latrine?
16	05	Mention the inhabitants' consciousness about using sanitary latrine?
17	07	Is this your observation about supply of sanitary latrine in your locality from Pourashava or any other organization?
18	08	What are common diseases attacked in your family last year (2004)?
19	09	Who was attacked in your family by the common disease last year (2004)?
20	10	What is the reason you suppose for the same?
21	11	How much the disturbance of mosquito in your locality?
22	12	When the disturbance of mosquito is much more?
23	13	What is the reason of mosquito you suppose?
24	14	Where the liquid waste of your bathroom/ kitchen is passed out?
25	15	Does anybody connect the outlet of latrine directly in the drain in your locality?
26	16	Mention the over all situation of drain cleanness in your locality?
27	17	Is the drain water overflow during rainy season in your locality?
28	18	Where the drain water is fallen finally?
Pourashava water supply condition		
29	01	Mention the source of water for drinking /cooking in your family?
30	02	Mention the source of water for other usages in your family?
31	03	How much distance of the PS tube well from your house?

Question No.	Subject wise Question No.	
32	04	How do you collect water for your house?
33	05	When do you get PS supply water in your house ?
34	06	Is the PS supply water in your house inadequate?
35	07	Mention about the taste of PS supply water in your house?
36	08	Mention about the odor of PS supply water in your house?
37	09	Mention the quantity of water, needed daily for each member in your family?
38	10	Misusage of water can be controlled by adopting metering system and then water can be got all time - Do you support to this statement and comment please if any?
39	11	How much money do you spend for water monthly in your family?
40	12	Do you eager to increase the rate of water for sufficient supply in your house?
41	13	How much demand is there for new connection for PS supply water?

APPENDIX C

Peoples' perception on Solid Waste Management condition in Pourashava.

Question No. 01 1 of 41

Where the SW of your house is disposed of ?

Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status (Nos.)**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) PS dustbin	32	68	92	22	**214**
b) Road side	66	85	11	5	**167**
c) Drain inside (/canal)	34	12	17	34	**97**
d) SW collector	00	9	34	21	**64**
e) In house surroundings	68	8	22	110	**208**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 02 2 of 41

How the SW of your house is disposed of ?

Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status (Nos.)**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) House servant	67	76	54	67	**264**
b) SW collector	0	9	34	22	**65**
c) Family member	133	87	66	103	**389**
d) Other comments	0	10	22	0	**32**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 03 3 of 41

When the SW of your house is disposed of ?

Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status (Nos.)**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) Morning	44	58	38	53	**193**
b) Afternoon	46	76	58	62	**242**
c) Night	20	24	42	20	**106**
d) No fixed time	90	24	38	57	**209**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 04 4 of 41

Mention the daily average quantity of SW generated from your house ?

Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status (Nos.)**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) Unknown	110	23	28	84	**245**
b) Normal	63	114	116	72	**365**
c) Quantity mentioned	27	45	32	36	**140**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 05

Is there disposal bin (dustbin) available nearby your house? 5 of 41

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status (Nos.)
a) Available	63	110	109	118	**400**
b) Not available	137	72	67	74	**350**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 06

When the SW is taken over from the dustbin for final disposal? 6 of 41

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status (Nos.)
a) Daily	60	32	28	60	**180**
d) Regular	83	58	102	72	**315**
c) Irregular	57	92	46	60	**255**
Total Nos. =	**200**	**183**	**176**	**192**	**750**

Question No. 07

Are you interested for alternative arrangements of disposal bin? 7 of 41

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status (Nos.)
a) Interested	86	152	57	120	**415**
d) Not interested	114	30	119	72	**335**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 08

How much money do you pay per month to SW collector from your house? 8 of 41

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Not applicable	173	173	142	139	**627**
b) Taka 10/=	18	9	26	40	**93**
c) Taka 15/=	9	0	8	13	**30**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 09 Mention the consciousness of the PS citizen regarding SW disposal?					9 of 41
Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status Nos.**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) Enough	138	46	28	17	**229**
b) Moderate	32	106	85	84	**307**
c) Poor	30	30	63	91	**214**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 10 Mention the over all situation of SWM program in your locality?					10 of 41
Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status Nos.**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
c) Good	117	38	57	41	**253**
d) Moderate	43	62	74	84	**263**
e) No satisfactory	40	82	45	67	**234**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

APPENDIX D

Peoples' perception on Sanitary and Drainage condition in Pourashava.

Question No. 01 11 of 41

Mention the type of latrine used for your family members?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Water sealed	68	167	119	89	**443**
b) Pit latrine	72	15	57	65	**209**
c) Bucket	34	0	0	20	**54**
d) Direct into drain	26	0	0	18	**44**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 02 12 of 41

Is there sanitary latrine for the slum people in the Pourashava?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Yes	60	96	72	31	**259**
b) No	53	26	42	52	**173**
c) Inadequate	74	34	40	94	**242**
d) Not known	13	26	22	15	**76**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 03 13 of 41

Where do younger members of your family go for latrine?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Not applicable	33	8	11	34	**86**
b) In house latrine	97	136	102	103	**438**
c) Special arrangement	70	38	63	55	**226**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 04 14 of 41

Who clean the latrine pan of your house?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Servant	47	15	28	135	**225**
b) Self	133	153	136	53	**475**
c) No comments	20	14	12	4	**50**
Total Nos. =	**210**	**182**	**176**	**192**	**750**

Question No. 05 15 of 41

What is used for washing the hands in your family after usage latrine?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Soap	128	162	152	170	**612**
b) Water only	35	15	17	5	**72**
c) No comments	37	5	7	17	**66**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 06 16 of 41

Mention the inhabitants' consciousness about using sanitary latrine?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Enough	87	45	34	41	**207**
b) Moderate	80	122	114	108	**424**
c) Very poor	33	15	28	43	**119**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 07. .17 of 41

Is this your observation about supply of sanitary latrine in your locality from Pourashava or any other organization?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Yes	76	116	112	79	**383**
b) Inadequate	84	36	42	43	**205**
c) Not known	40	30	22	70	**162**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 08 18 of 41

What are common diseases attacked in your family last year (2004)?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Not applicable	40	20	74	38	**172**
b) Diarrhoea	30	2	6	12	**50**
c) Typhoid	20	0	4	5	**29**
d) Cold / fever / cough	110	160	92	137	**499**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 09 19 of 41

Who was attacked in your family by the common disease last year (2004)?

Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status Nos.**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) Not applicable	47	20	74	38	**179**
b) Male	30	8	18	19	**75**
c) Female	36	38	26	31	**131**
d) Child	87	116	58	104	**365**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 10 20 of 41

What is the reason you suppose for the same?

Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status Nos.**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) Not applicable	47	15	23	31	**116**
b) Water pollution	73	45	51	74	**243**
c) SW pollution	66	38	74	70	**248**
d) Seasonal change	14	84	28	17	**143**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 11 21 of 41

How much the disturbance of mosquito in your locality?

Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status Nos.**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) No disturbance	13	15	0	12	**40**
b) Moderate	67	91	62	157	**377**
c) Much	120	76	114	23	**333**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 12 22 of 41

When the disturbance of mosquito is much more?

Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status Nos.**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) Not applicable	13	15	0	12	**40**
b) Rainy	42	76	45	56	**219**
c) Winter	12	15	21	28	**76**
d) Summer	35	53	46	23	**157**
e) Almost the year	98	23	64	73	**258**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 13 23 of 41

What is the reason of mosquito you suppose?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Drainage problem	90	64	52	42	**248**
b) SW pollution	55	30	54	41	**180**
c) Both of b/c.	45	76	62	97	**280**
d) No comments	10	12	8	12	**42**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 14 24 of 41

Where the liquid waste of your bathroom/ kitchen is passed out?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) PS drain	102	60	57	70	**289**
b) River /canal	14	30	34	30	**108**
c) In house low land	84	92	85	92	**353**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 15 25 of 41

Does anybody connect the outlet of latrine directly in the drain in your locality?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Yes	40	38	45	43	**166**
b) No	67	52	62	79	**260**
c) Not known	93	92	69	70	**324**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 16 26 of 41

Mention the over all situation of drain cleanness in your locality?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Good	98	61	17	17	**193**
b) Moderate	25	83	68	77	**253**
c) Not satisfactory	77	38	91	98	**304**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 17 Is the drain water overflow during rainy season in your locality?					27 of 41
Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status Nos.**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) Overflow	36	60	131	84	**311**
b) Not overflow	134	85	11	72	**302**
c) Sometimes overflow	30	37	34	36	**137**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 18 Where the drain water is fallen finally?					28 of 41
Respondents' answer : Segregation of answer /comment in figure for four Pourashavas.					**Over all status Nos.**
Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	
a) River /canal	143	120	148	130	**541**
b) Low land	30	24	17	29	**100**
c) Not known	27	38	11	33	**109**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

APPENDIX E

Peoples' perception on Water Supply condition in Pourashava

Question No. 01 :
Mention the source of water for drinking /cooking in your family? — 29 of 41

Respondents' answer :
Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Overall status Nos.
a) PS supply water	120	76	57	41	**294**
b) Community TW	46	61	34	70	**211**
c) Own TW	24	23	68	64	**179**
d) River or pond	10	22	17	17	**66**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 02
Mention the source of water for other usages in your family? — 30 of 41

Respondents' answer :
Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Overall status Nos.
a) PS supply water	120	60	34	41	**255**
b) Community TW	26	53	57	55	**191**
c) Own TW	24	23	68	58	**173**
d) River or pond	30	46	17	38	**131**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 03
How much distance of the PS tube well from your house? — 31 of 41

Respondents' answer :
Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Near by	47	91	80	108	**326**
b) Far	50	61	68	72	**251**
c) Not available	103	30	28	12	**173**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 04
How do you collect water for your house? — 32 of 41

Respondents' answer :
Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Direct SW	120	114	34	67	**335**
b) By servant	34	23	57	79	**193**
c) Self	46	45	85	46	**222**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 05 33 of 41

When do you get PS supply water in your house ?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Not applicable	80	34	40	48	**202**
b) Morning or afternoon	38	58	21	55	**172**
c) Morning and afternoon	56	80	53	79	**268**
d) No fixed time	26	10	62	10	**108**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

- From 2006, SW in Patuakhali PS is available for 24 hours with metering system..

Question No. 06 34 of 41

Is the PS supply water in your house inadequate?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Not applicable	80	34	40	72	**226**
b) Inadequate	35	40	16	57	**148**
c) Adequate	56	32	17	17	**122**
d) Satisfactory	29	76	103	46	**254**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 07 35 of 41

Mention about the taste of PS supply water ?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) No comments	56	34	40	79	**209**
b) Normal	132	114	119	74	**439**
c) Salty	0	0	0	12	**12**
d) Sweet	12	12	0	5	**29**
e) Tasteless	0	22	17	22	**61**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 08 36 of 41

Mention about the odor of PS supply water in your house?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) No comments	12	34	40	89	**175**
b) Normal	105	130	114	69	**418**
c) Odorless	83	18	22	34	**157**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 09 37 of 41

Mention the quantity of water, needed daily for each member in your family?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Not known	56	42	36	120	**254**
b) Normal quantity	134	132	128	65	**459**
c) Mention quantity *	10	8	12	7	**37**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

- Mentioned no reasonable quantity.

Question No. 10 . 38 of 41

Misusage of water can be controlled by adopting metering system and then water can be got all time - Do you support to this statement and comment please if any?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Good system	132	80	64	120	**396**
b) More costly	28	68	78	36	**210**
c) No comments	40	34	34	36	**144**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 11 39 of 41

How much money do you spend for water monthly in your family?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) PS rate *	120	76	57	41	**294**
b) Other comments	24	84	93	124	**325**
d) No comments	56	22	26	27	**131**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

- PS rate is mentioned in tables 3.08, 3.09 and 3.10 of this report.

Question No. 12 40 of 41

Do you eager to increase the rate of water for sufficient supply in your house?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Agree	85	40	35	19	**179**
b) Disagree	35	36	32	32	**135**
c) Not applicable	80	106	109	141	**436**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

Question No. 13

How much demand is there for new connection for PS supply water?

Respondents' answer :

Segregation of answer /comment in figure for four Pourashavas.

Answer Option	Bagerhat	Barguna	Patuakhali	Bhola	Over all status Nos.
a) Enough demand	76	62	45	72	**255**
b) Moderately	102	120	114	96	**432**
c) No demand	12	0	14	24	**50**
c) No comments	10	0	3	0	**13**
Total Nos. =	**200**	**182**	**176**	**192**	**750**

APPENDIX F

Test results of water samples collection from Study area.

01. Location Water Samples in Bagerhat Pourashava :

A) Dashani CWR of Bagerhat Pourashava.
B) Water Supply Office-Res. Bhaban.
C) Pourashava Office Bhaban.

Test Results for samples of Bagerhat Pourashava

Sl. No.	Test parameter	Unit	Test Period	Results			
				A	B	C	Average
01	Color	Hazen	Jan -04	10	10	10	10
			Apr -04	10	10	10	10
			Sep -04	5	5	5	5
03	Turbidity	NTU	Jan -04	12	10	8	10
			Apr -04	0.4	0.2	0.33	0.31
			Sep -04	2.48	1.56	2.39	2.14
03	Dissolved Solids	mg /l	Jan -04	745	824	783	784
			Apr -04	864	925	950	913
			Sep -04	686	720	742	716
04	Suspended Solid	mg /l	Jan -04	15	10	14	13
			Apr -04	25	20	24	23
			Sep -04	38	42	40	40
05	pH	--	Jan -04	8.2	8.2	8.2	8.2
			Apr -04	8.2	8.2	8.2	8.2
			Sep -04	8.1	8.1	8.1	8.1
06	Hardness	mg /l	Jan -04	416	448	444	436
			Apr -04	386	410	428	408
			Sep -04	474	536	556	522
07	Alkalinity	mg /l	Jan -04	275	250	255	260
			Apr -04	150	150	160	250
			Sep -04	335	322	354	337
08	Chloride	mg /l	Jan -04	125	130	140	135
			Apr -04	184	168	161	171
			Sep -04	214	240	245	233
09	Iron	mg /l	Jan -04	0.6	0.7	0.8	0.7
			Apr -04	0.2	0.2	0.2	0.2
			Sep -04	0.5	0.5	0.5	0.5
10	Manganese	mg /l	Jan -04	0	0	0	0
			Apr -04	0	0	0	0
			Sep -04	0	0	0	0
11	Total Coliform	N /100 ml	Jan -04	0	0	0	0
			Apr -04	10	15	17	14
			Sep -04	0	0	2	2
12	Fecal Coliform	N /100 ml	Jan -04	0	0	0	0
			Apr -04	10	15	17	14
			Sep -04	0	0	0	0

02. Location Water Samples in Barguna Pourashava :

A) Taltala Pump No.6
B) H/O. Md. Nurul Huda Tinku (Commissioner), Besides WAPDA Road.
C) H/O. Harun –or- Rashid, Beside BRAC Office.

Test Results for samples of Barguna Pourashava

Sl. No.	Test parameter	Unit	Test Period	Results			
				A	B	C	Average
01	Color	Hazen	Jan -04	15	15	15	15
			Apr -04	40	40	40	40
			Sep -04	10	10	10	10
03	Turbidity	NTU	Jan -04	2.08	2.40	2.66	2.38
			Apr -04	1.04	1.00	1.02	1.02
			Sep -04	0.65	0.70	0.60	0.65
03	Dissolved Solids	mg /l	Jan -04	630	580	707	639
			Apr -04	830	845	854	843
			Sep -04	555	595	560	570
04	Suspended Solid	mg /l	Jan -04	25	25	25	25
			Apr -04	44	45	49	46
			Sep -04	78	85	86	83
05	pH	–	Jan -04	8.2	8.2	8.2	8.2
			Apr -04	8.3	8.3	8.3	8.3
			Sep -04	7.8	7.6	7.7	7.7
06	Hardness	mg /l	Jan -04	59	58	54	57
			Apr -04	88	90	83	87
			Sep -04	32	34	30	32
07	Alkalinity	mg /l	Jan -04	547	586	598	577
			Apr -04	340	335	324	333
			Sep -04	510	475	485	490
08	Chloride	mg /l	Jan -04	35	35	35	35
			Apr -04	48	56	52	52
			Sep -04	56	60	58	58
09	Iron	mg /l	Jan -04	04.	0.4	0.4	0.4
			Apr -04	0.1	0.1	0.1	0.1
			Sep -04	0.3	0.3	0.3	0.3
10	Manganese	mg /l	Jan -04	0	0	0	0
			Apr -04	0	0	0	0
			Sep -04	0	0	0	0
11	Total Coliform	N /100 ml	Jan -04	1	2	0	1
			Apr -04	1	1	1	1
			Sep -04	2	1	0	1
12	Fecal Coliform	N /100 ml	Jan -04	0	0	0	0
			Apr -04	0	0	0	0
			Sep -04	0	0	0	0

03. Location Water Samples in Patuakhali Pourashava :

A) Thana Para Pump No.2
B) Charpara,Sanibar Road, Pourashava Tap.
C) Charpara, Kumar Patty, H/O. Ranjit Pal.

Test Results for samples of Patuakhali Pourashava

Sl. No.	Test parameter	Unit	Test Period	Results			
				A	B	C	D
01	Color	Hazen	Jan -04	5	5	5	5
			Apr -04	5	5	5	5
			Sep -04	5	5	5	5
03	Turbidity	NTU	Jan -04	0.98	1.2	1	0.98
			Apr -04	1.44	1.42	1.40	1.42
			Sep -04	0.42	0.44	0.43	0.43
03	Dissolved Solids	mg /l	Jan -04	474	496	882	484
			Apr -04	532	546	530	536
			Sep -04	364	382	376	374
04	Suspended Solid	mg /l	Jan -04	2	2	2	2
			Apr -04	20	16	18	18
			Sep -04	56	58	54	56
05	pH	--	Jan -04	7.6	7.5	7.4	7.5
			Apr -04	7.7	7.7	7.6	7.7
			Sep -04	7.7	7.7	7.7	7.7
06	Hardness	mg /l	Jan -04	275	282	262	273
			Apr -04	165	170	175	170
			Sep -04	25	25	25	35
07	Alkalinity	mg /l	Jan -04	255	250	275	260
			Apr -04	290	325	315	310
			Sep -04	330	335	331	332
08	Chloride	mg /l	Jan -04	157	145	139	147
			Apr -04	184	198	176	186
			Sep -04	24	22	23	23
09	Iron	mg /l	Jan -04	0.6	0.6	.06	0.6
			Apr -04	0.6	0.5	0.5	0.5
			Sep -04	0.7	0.7	.06	0.7
10	Manganese	mg /l	Jan -04	0	0	0	0
			Apr -04	0	0	0	0
			Sep -04	0	0	0	0
11	Total Coliform	N /100 ml	Jan -04	3	0	5	4
			Apr -04	2	2	2	2
			Sep -04	3	2	3	3
12	Fecal Coliform	N /100 ml	Jan -04	3	3	3	3
			Apr -04	1	2	0	1
			Sep -04	2	1	2	2

04. Location Water Samples in Bhola Pourashava :

A) Pourashava Pump No. 5
B) Street Tap, R/S of Abahaoa Office.
C) Goldar Vila, Abahaoa Office Road.

Test Results for samples of Bhola Pourashava

Sl. No.	Test parameter	Unit	Test Period	Results			
				A	B	C	Average
01	Color	Hazen	Jan -04	5	5	5	5
			Apr -04	5	5	5	5
			Sep -04	5	5	5	5
03	Turbidity	NTU	Jan -04	0.98	1.2	0.94	0.98
			Apr -04	0.17	0.20	0.16	0.18
			Sep -04	1.20	1.30	1.25	1.25
03	Dissolved Solids	mg /l	Jan -04	624	654	624	634
			Apr -04	730	700	730	720
			Sep -04	530	556	57	554
04	Suspended Solid	mg /l	Jan -04	15	17	12	15
			Apr -04	24	32	25	27
			Sep -04	40	44	42	42
05	pH	--	Jan -04	7.6	7.5	7.6	7.6
			Apr -04	7.5	7.5	7.4	7.5
			Sep -04	7.8	7.7.	7.8	7.8
06	Hardness	mg /l	Jan -04	286	259	274	273
			Apr -04	150	173	14	157
			Sep -04	355	350	348	351
07	Alkalinity	mg /l	Jan -04	248	252	238	246
			Apr -04	186	210	183	193
			Sep -04	245	250	255	250
08	Chloride	mg /l	Jan -04	142	144	152	146
			Apr -04	260	268	258	262
			Sep -04	190	200	195	195
09	Iron	mg /l	Jan -04	0.6	0.5.	0.6	0.6
			Apr -04	0.5	0.5	0.5	0.5
			Sep -04	0.7	0.6	.07	0.7
10	Manganese	mg /l	Jan -04	0	0	0	0
			Apr -04	0	0	0	0
			Sep -04	0	0	0	0
11	Total Coliform	N /100 ml	Jan -04	5	3	6	5
			Apr -04	0	0	0	0
			Sep -04	0	0	0	0
12	Fecal Coliform	N /100 ml	Jan -04	1	2	1	3
			Apr -04	0	0	0	0
			Sep -04	0	0	0	0

APPENDIX G

Summery results of water quality parameters.

Sl. No.	Parameter	Name of Pourashava	Results in three seasons			Bangladesh standards
			Jan -04	Apr -04	Sep -04	
01	Color (Hazen)	Bagerhat	10	10	5	15
		Barguna	15	40	10	
		Patuakhali	5	5	5	
		Bhola	5	5	5	
02	Turbidity (NTU)	Bagerhat	10	0.31	2.14	5
		Barguna	2.38	1.02	0.65	
		Patuakhali	0.98	1.42	0.43	
		Bhola	0.98	0.18	1.25	
03	Dissolved solids (mg /l)	Bagerhat	784	913	716	1000
		Barguna	639	843	570	
		Patuakhali	484	536	374	
		Bhola	634	720	554	
04	Suspended solids (mg /l)	Bagerhat	13	23	40	10
		Barguna	25	46	83	
		Patuakhali	2	18	56	
		Bhola	15	27	42	
05	pH	Bagerhat	8.2	8.2	8.1	6.5 - 8.5
		Barguna	8.2	8.3	7.7	
		Patuakhali	7.5	7.7	7.7	
		Bhola	7.6	7.5	7.8	
06	Hardness as $CaCO_3$ (mg /l)	Bagerhat	436	408	522	200 - 500
		Barguna	57	87	32	
		Patuakhali	273	170	35	
		Bhola	273	157	351	
07	Alkalinity (mg /l)	Bagerhat	260	250	337	400
		Barguna	577	333	490	
		Patuakhali	260	310	332	
		Bhola	246	193	250	
08	Chloride (mg /l)	Bagerhat	135	171	233	150 – 1000 (For CA)
		Barguna	35	52	58	
		Patuakhali	147	186	23	
		Bhola	146	262	195	
09	Iron (mg /l)	Bagerhat	0.7	0.2	0.5	0.3 - 1.0
		Barguna	0.4	0.1	0.3	
		Patuakhali	0.6	0.5	0.7	
		Bhola	0.6	0.5	0.7	
10	Manganese (mg /l)	Bagerhat	0	0	0	0.1
		Barguna	0	0	0	
		Patuakhali	0	0	0	
		Bhola	0	0	0	
11	Total Coliform (N /100 ml)	Bagerhat	0	14	2	0
		Barguna	1	1	1	
		Patuakhali	4	2	3	
		Bhola	5	0	0	
12	Fecal Coliform (N /100 ml)	Bagerhat	0	14	0	0
		Barguna	0	0	0	
		Patuakhali	3	1	2	
		Bhola	3	0	0	

THE END