MINISTRY OF FINANCE
MINISTRY OF LOCAL GOVERNMENT, RURAL DEVELOPMENT AND CO-OPERATIVES
CHITTAGONG WATER SUPPLY AND SEWERAGE AUTHORITY (CWASA)
THE PEOPLE'S REPUBLIC OF BANGLADESH

PREPARATORY SURVEY ON CHITTAGONG WATER SUPPLY IMPROVEMENT PROJECT IN THE PEOPLE'S REPUBLIC OF BANGLADESH

FINAL REPORT

VOLUME I

MAIN REPORT

MARCH 2013

JAPAN INTERNATIONAL COOPERATION AGENCY
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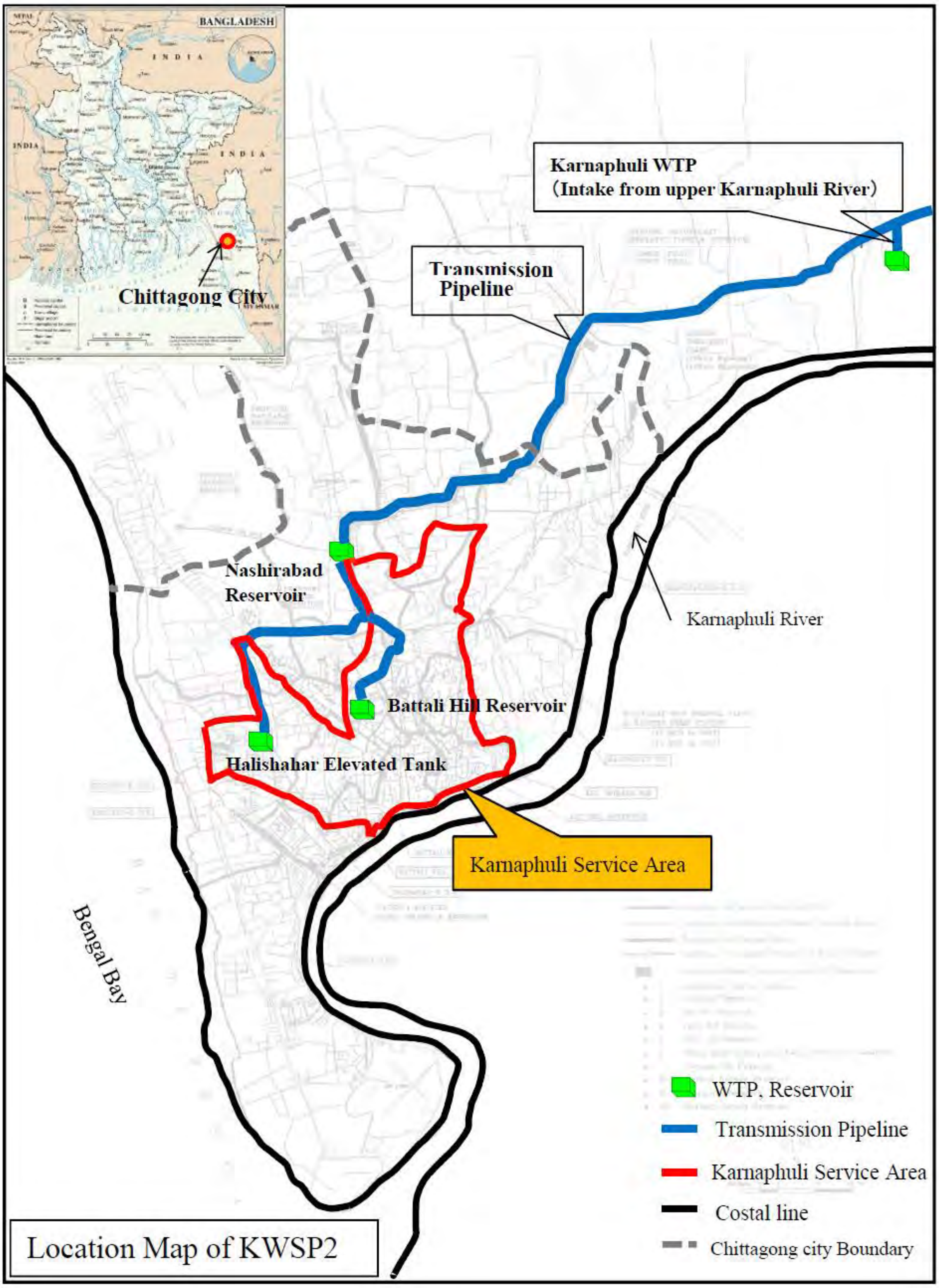
The cost estimate is based on the price level and exchange rate of December 2012.

The exchange rate is: Bangladesh Taka 1.00 = Japanese Yen 0.966


BANGLADESH
INDIA
Chittagong City
Karnaphuli WTP
(Intake from upper Karnaphuli River)
Transmission Pipeline
Nashirabad Reservoir
Battali Hill Reservoir
Halishahar Elevated Tank
Karnaphuli River
Karnaphuli Service Area
Bengal Bay
WTP, Reservoir
Transmission Pipeline
Karnaphuli Service Area
Costal line
Chittagong city Boundary
Location Map of KWSP2

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ACRONYMS

ADB	Asian Development Bank
ARIPO	Acquisition & Requisition Property Ordinance
BOD	Biological Oxygen Demand
BDT	Bangladeshi Taka
BWDB	Bangladesh Water Development Board
CCL	Cash Compensation under the Law
CCC	Chittagong City Corporation
CDA	Chittagong Development Authority
CDIA	City Development Initiative for Asia
COD	Chemical Oxygen Demand
CWASA	Chittagong Water Supply and Sewerage Authority
DF/R	Draft Final Report
DMA	District Metered Area
DMD	Deputy Managing Director
DOE	Department of Environment
DPHE	Department of Public Health Engineering, MLGRD&C
DWASA	Dhaka Water and Sewerage Authority
EA	Environmental Assessment
ECC	Environmental Clearance Certificate
ECCo	Environmental Clearance Committee
EIA	Environmental Impact Analysis
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
EOCC	Economic Opportunity Cost of Capital
EQS	Environmental Quality Standard
ERD	Economic Relations Division, Ministry of Finance
FCD/I	Flood Control Drainage and Irrigation
FGD	Focus Group Discussion
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
FOCC	Financial Opportunity Cost of Capital

F/R	Final Report
F/S	Feasibility Study
GI	Galvanized Iron
GDP	Gross Domestic Product
GOB	Government of Bangladesh
GOJ	Government of Japan
GRC	Grievance Redress Committee
HR	Human Resource
HRD	Human Resource Development
IC/R	Inception Report
IEE	Initial Environmental Examination
IIP	Interim Improvement Project
IT/R	Interim Report
IUCN	International Union for Conservation of Nature & Natural Resources
JBIC	Japan Bank of International Cooperation
JICA	Japan International Cooperation Agency
JTU	Jackson Turbidity Unit
JVIT	Joint Inventory Verification Team
LAP	Land acquisition Plan
LGD	Local Government Division, MLGRD&C
MARV	Maximum Allowable Replacement Value
MBBR	Moving Bed Bio-Reactor
MBR	Madaripur Beel Route
MD	Managing Director
MDG	Millennium Development Goal
MLGRD&C	Ministry of Local Government, Rural Development and Co-operatives
MoEF	Ministry of Environment and Forest
NCS	National Conservation Strategy
NEMP	National Environmental Management Plan
NOC	No Objection Certificate
NRW	Non-Revenue Water
NWMP	National Water Management Plan
NWP	National Water Policy
NWRC	National Water Resources Council
O&M	Operation and Maintenance

PAP	Project Affected People
PCU	Project Coordination Unit
PMO	Project Management Officer
PMU	Project Management Unit
PPTA	Project Preparatory Technical Assistance
PTW	Production Tube Well
P/R	Progress Report
RAP	Resettlement Action Plan
RO	Reverse Osmosis
RU	Resettlement Unit
SAPROF	Special Assistance for Project Formation
SCC	Site Clearance Certificate
S/C	Steering Committee
SIA	Social Impact Assessment
SPS	Safeguard Policy Statement
SPT	Standard Penetration Test
SRDI	Soil Resources Development Institute
S/W	Scope of Work
SWTP	Surface Water Treatment Plant
TA	Technical Assistance
TOR	Terms of Reference
UFW	Unaccounted for Water
USD	United States Dollar
WASA	Water and Sewerage Authority
WARPO	Water Resource Planning Organization
WTP	Water Treatment Plant
WUG	Water User Group

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. Background and Outline of the Survey

Chittagong city is the second largest city in Bangladesh, and the country's biggest industrial and port city. Provision of water supply, sewerage and drainage services in the city is the responsibility of Chittagong Water Supply and Sewerage Authority (CWASA). The gap between the demand for and supply of water in the city has increased rapidly due to population growth and expansion of industrial and commercial activities. In addition, the reported Non- Revenue Water (NRW) percentage is higher than a possible level with more than 30%, mainly caused by deteriorated distribution pipes.

The Government of Japan (GOJ) extended loan assistance through the Japan International Cooperation Agency (JICA) for the "Karnaphuli Water Supply Project (hereinafter referred to as the "Phase 1 Project")" to augment water supply capacity. The World Bank (WB) also has a plan to assist CWASA in the improvement of water supply (Chittagong Water Supply Improvement and Sanitation Projects). JICA is also providing technical assistance to CWASA for the reduction of NRW, through the "Project for Advancing NRW Reduction Initiative (PANI) of CWASA". Assistance for institutional development of CWASA is also in progress in the Phase 1 Project.

There are several key issues to be resolved for the improvement of water supply facilities to reduce NRW percentage and to meet future demand beyond the provision by Phase 1 Project (KWSP 1). In order to address these key issues, the Bangladesh and Japanese sides agreed to conduct the Preparatory Survey on the "Chittagong Water Supply Improvement Project（hereinafter referred to as the "Phase 2 Project" and/or KWSP 2）

The objective of the Phase 2 Project (target year 2030) is to increase sustainable access to safe water for the people in Chittagong city, by constructing water supply facilities and strengthening the capacity of CWASA, thereby contributing to the improvement of the living environment of the citizens.   The main objective of the Preparatory Survey (which covers the jurisdiction area of Chittagong City Corporation (CCC) and its surrounding areas, as necessary for planning of some facilities) is to provide information necessary for the evaluation of the feasibility of the proposed Phase 2 Project as a Japanese Government loan project.

2. General Description of the Survey Area

<u>Natural Conditions</u> - The city is located in the south-eastern part of Bangladesh, and facing the Bay of Bengal. It is bordered to the south and east with the Karnaphuli River, the source of water for the project. Kaptai Lake which is located about 50 km north-east of the city was formed with the construction of the Kaptai Hydropower Dam and discharges water to the Karnaphuli River (water source of Karnaphuli Water Supply Project) at a controlled but variable rate. In recent years there have been several months when the average discharge from the dam in a month or part of a month was low; however, the average discharge is significantly in excess of the capacity of the intake for Phases 1 and 2 of the Karnaphuli Water Supply Project.

<u>Legislative Conditions</u> - The Government of Bangladesh (GOB) has adopted the following policies, which are relevant to the water supply sector:

- National Policy for Safe Water Supply and Sanitation (1998),
- National Water Policy (NWP) (1999),
- National Water Management Plan (NWMP) (2004),
- Sector Development Plan (SDP) (2011-2015)

- Partnership Framework among the Government of Bangladesh and Asian Development Bank (ADB), DANIDA, the Government of Japan (GOJ), the Government of the Republic of Korea (ROK), and World Bank (WD)
- National Policy for Arsenic Mitigation (2004)

Furthermore, the Environmental Conservation Act was promulgated in 1995 and the Environment Conservation Rules (ECR), which include standards for drinking water were stipulated in 1997.

Socioeconomic Conditions - There are several industrial estates in the city, including Chittagong Export Processing Zone (EPZ), Karnaphuli EPZ and a Korean Export Processing Zone. As of October 2012, about US $940 million has been invested in Chittagong EPZ since 1983-1984, with total exports from the EPZ up to the same date being US$ 14,867 million, with a maximum of about US$ 1,690 million in the current year up to the same date. Exports from Karnaphuli EPZ were about US$ 220 million in the current year (up to May 2012 only). Chittagong port handles about 92 % of the country's imports and exports.

In the Household Income and Expenditure Survey (HIES) 2010 urban poverty in Chittagong division was estimated at 11.8% using the upper poverty line, compared to the national average of 21.3% and 18.0% in Dhaka. Using the lower poverty line urban poverty in Chittagong division in the same year was estimated at 4.0%, second only to Dhaka at 3.8% and a significant reduction from 8.1% in 2005. There are essentially no sanitary sewerage systems in Chittagong and a significant portion of wastewater is discharged untreated to ponds, channels and drains and then to the sea via the Karnaphuli River. Solid Waste Management (SWM) in Chittagong is hampered by the absence of adequate national or local legislation relating to municipal SWM and the treatment and disposal of hazardous waste. CCC is responsible for collection and disposal of household waste and more than 95% of such waste is collected and dumped.

In Chittagong, there are two electricity boards which are REB (Rural Electrification Board) and PDB (Power Development Board). REB is responsible for rural areas and PDB mainly covers the city area. Power supply interruption is chronic problem in the city.

3. Existing Water Supply and On-going Water Supply Projects

(1) Existing Water Supply System and Facilities

The area covered by the CCC is about 155 square kilometres and consists of 41 wards, which are under the jurisdiction of CWASA for water supply services according to the city's ordinances. The current water sources are surface water, which is used at Mohara Water Treatment Plant (WTP) (approximately 91,000 m^3/d capacity) and ground water, which is treated at Kalurghat Iron Removal Plant (68,000 m^3/d capacity), supplemented by many tube wells (60,000 m^3/d capacity). The existing water supply network comprises 564 kilometres of transmission and distribution pipelines consisting of various materials (more than 20% of distribution pipelines are installed with asbestos cement pipes) and most of the networks were constructed prior to 1990. The networks directly serve about 45,000 households out of an estimated number of households of more than 600,000 in the CCC area, as well as hydrants.

(2) On-going and Planned Water Supply Studies and Projects

Karnaphuli Water Supply Project Phase 1 – includes intake from Karnaphuli River, WTP (production capacity 143,000 m^3/d), conveyance, transmission and distribution pipelines and reservoirs/tanks. Construction is in progress with contractual completion date of May 2014 for the last contract to be completed among 3 packages (construction of pipelines). The project also included an institutional development component.

PANI - the purpose of this on-going project is to provide CWASA staff with technology transfer for the improvement of capacity building for reduction of NRW. The area covered by the project is limited to four pilot areas/zones.

Chittagong Water Supply and Sanitation Project (financed by World Bank) – this project, which is at early stage of implementation, includes construction of a new WTP at Madunaghat (production capacity of 90,000 m^3/d), transmission pipelines and rehabilitation of existing facilities.

Emergency Water Supply Project financed by GOB - CWASA has been undertaking Emergency Water Supply Project financed by GOB from January, 2010 to complete in June, 2013. The project was designed to construct 30 deep wells in CCC area to produce a total of 20,000m^3/d.

(3) Organization and Activities of CWASA

CWASA has been vested to reorganize towards an autonomous corporate with the Gazette issued in May 2008. Under the WASA Act, the CWASA's equity is fully owned by the Government, and the CWASA's Management Board is organized with the Board Members appointed by the Government. 13 Board Members were officially appointed by LGRD&C on 31st July 2012, and the first Board Meeting was held on 1st Septe**m**ber 2012. The first Board Meeting determined to keep the present Managing Director and three Deputy Managing Directors in office, and the Government is in process of approval of the appointed Managing Director and Deputy Managing Directors. As such, CWASA's management has started a new era.

The current organization broadly comprises three departments, namely Engineering, Finance and Administration, and each department has a Deputy Managing Director in charge. There are 610 personnel in the organization, including the Managing Director, compared to 825 sanctioned. The number of billing staff per 1,000 connections is 1.2 persons (54 persons/ 45 thousand connections). The number of engineers who have experience of operation and maintenance of WTPs, water transmission and distribution systems is very limited.

Foreseeing that CWASA's business activities will substantially expand with the completion of the on-going Karnaphuli Water Supply Project and the implementation of the Phase 2 Project, the following issues are urgent tasks for CWASA:

1) Establish an appropriate organization and adequate staffing for the operation and maintenance of the Water supply facilities, which will be constructed under the Phase 1 and Phase 2 Projects, including the adoption of efficient operation and maintenance systems, recruiting experienced key engineers, and training of engineers, operators and technicians.
2) Reorganization of CWASA's overall organizational structures, administrative procedures and management systems

CWASA concluded the Performance Agreement with the GOB (LGRD&C) in early 2011 , setting the target for water service coverage to be attained up to the year 2015 (as shown in Table ES.1) and also for the improvement of its business operation. However, CWASA faces difficulty in achieving the targets due to various constraints including limited availability of adequate human resources. The table shows updated information on the concerned items in 2011. The figures in planned and actual ones in 2011 are within a certain range of accuracy.

Table ES.1 Performance Agreement up to year 2015

Item	2010	2011	2012	2013	2014	2015
Population in Chittagong city (mil.)	3.975	4.050 (4.000)	4.125	4.200	4.275	4.350
Population in CCC area (mil.)	2.98	3.00 (2.60)	3.10	3.20	3.40	3.60
Population served with piped water (mil.)	1.190	1.230 (1.222)	1.302	1.376	2.72	2.88
Service Coverage (%)	40%	41% (47%)	42%	43%	80%	80%
No. of Service Connections	49,000	51,000 (45,000)	54,000	56,500	61,500	66,500
NRW (%)	30%	29% (33%)	28%	27%	26%	25%

Note: Figures in parenthesis in 2011 show updated information

Institutional Development Consultants (IDC) employed under the on-going Phase 1 Project formulated the CWASA's Business Plan for five years from FY2011/12 to FY2015/16. CWASA has approved the proposed Business Plan with some amendments and submitted it to LGRD&C for their approval. IDC has started investigation of the CWASA's overall organization and will complete it by the end of November 2012. Restructuring of CWASA's organization will be implemented after IDC's recommendation for the restructuring. In addition, the following has been provided for CWASA.

- Legal and Regulation
- Water Supply for Slum Dwellers
- Computerization of Accounting System

(4) Financial Status of CWASA

Based on the audited financial statements for FY 2006/07, FY 2007/08 and FY 2008/09, water revenue increased by 14.0% in FY 2007/08 and 5.3% in FY 2008/09, and a net profit was recorded in each year. CWASA's financial position has remained in positive profit with contribution by operating revenue other than Water Revenue and non-operating income, even though the Water Revenue has been inadequate to recover the CWASA's overall costs and expenses with the Water Revenue not covering the overall costs and expenses. Furthermore CWASA's financial management has been heavily dependent on the financial subsidy provided by GOB in the form of grant or equity participation.

There are three factors affecting CWASA's financial structure, 1) Current tariff structure that is marginal to recover the operating and financial expenses, 2) Comparatively high NRW as reported at 33%, constraining the water revenue while increasing unit water cost and 3) Long tariff collection period recorded as 200 days, which affects cash flow and liquidity. It is essential that CWASA takes appropriate measures to improve the above.

The water revenue is the main source of CWASA's income, accounting for about 70% of annual revenue. The numbers of service connections increased from 48,146 in June 2010 to 53,152 in May 2012. Although this indicates progress in providing additional connections, in particular metered connections, acceleration in the rate will be required in order to utilize the substantial additional quantity of water that will be produced after the completion of the on-going Phase 1 project and after implementation of the Phase 2 Project.

The water tariff rates were set with an annual upward adjustment of 5%, which was the maximum range of increase allowed under the WASA Act 1996. CWASA's tariff rates in 2011 were BDT 6.26/m^3 BDT 17.73/m^3 for domestic and non-domestic customers, respectively. The tariff rates of Dhaka WASA are higher than those of CWASA by 6% and 25% for domestic and non-domestic, respectively. According to the HIES survey report in 2010 published by the Bangladesh Bureau of Statistics, the Average Monthly Household Nominal Income in Chittagong was BDT14,092, higher by 6.5% compared to BDT13,226 in Dhaka. The tariff of Dhaka WASA is much higher than the tariff of CWASA when the household income level is taken into account.

According to IDC's assessment of affordability and the socio-economic survey in this project, domestic customers seem to be able to pay at least four times the current tariff, considering that consumers may be affordable to pay water charges up to 3% of incomes.

Service connection fees are relatively high with those set on different connection sizes ranging from BDT7,225 for 20mm to BDT212,000 for 150mm. Foreseeing the needs for a significant increase in the number of service connections in order to meet the future water production volume, it would be prudent to review the current connection charges in order to ensure that the applied connection charges do not cause constraints in the planned increase in the number of service connections.

4. Water Demand Projection in the Survey Area

In order to determine the extent of the area to be served by the Karnaphuli WTP (hereinafter referred to as the "Karnaphuli Service Area"), the water demand in the CCC area was projected ward by ward up to the target year 2030. Water demand at this year is forecast to be more than double that in the Year 2011, as shown in Table ES.2, which also shows the main criteria in calculating the demand. The NRW/ leakage percentage at the Year 2030, as well as in intermediate years, is based upon the experience gained in the PANI.

Table ES.2 Summary of Water Demand in CCC Area at Year 2030

Criteria	Unit	Quantity	
		Year 2011	Year 2030
Population	No	2,900,000	4,600,000
% of population served	%	47	95
Per capita water consumption	Lpcd	105	120
public hydrants/communal faucets demand	No	14,400	0
Domestic water demand	m^3/d	192,300	522,700
Non-domestic water demand	m^3/d	100,300	269,800
NRW	%	33	15
Leakage	%	25	10
Daily average water demand	m^3/d	408,900	880,800
Daily maximum water demand (as % of daily average water demand)		1.15	1.15
Daily maximum water demand	m^3/d	470,400	1,012,900
Peak hour water demand (as % of daily maximum water demand)		-	1.5

5. Establishment of Karnaphuli Service Area

(1) Justification of KSA

1) Major issues and problems on the existing water supply

Currently the water supply in the CCC area is provided by water from two WTPs (Mohara and Kalurghat). Under the present arrangements of water supply, CWASA has no option but to supply customers on a case by case basis without effective control of water supply from the WTPs to and throughout the distribution system.

The time required to address the above issues as well as to develop a functional and realistic hydraulic model of the existing system, which could then be used to develop an optimized and efficient water supply and distribution system for the long term, is likely to be several years. On completion of the above works several years would be required to implement the first phase of measures, allowing for arranging finance, design, procurement, construction, etc.

2) The reason for the establishment of KSA

The comprehensive and up to date Master Plan for water supply, including a construction plan for the distribution network to cover the entire Chittagong city does not exist up to now. However, operation of water supply facilities planned in the Phase 1 Project is scheduled to start in 2014. Once existing network receives water from KWSP 1, it is obvious to arise the following:

- Leakage will be more serious as existing network consists of old AC pipes, and
- Customers still cannot receive sufficient water as capacity of existing network is too small.

Therefore, it is urgent to construct distribution network to deliver water through the main/ sub-main distribution pipelines to be constructed by the Phase 1Project.

KWSP 1 and 2 cannot satisfy water demand in entire CCC area. In this case, CWASA has two choices as follows:

- Enough pressure and continuous supply with minimum water losses in the limited area. At the same time, CWASA has to consider countermeasures outside KSA.
- Low pressure and intermittent supply with considerable water losses in whole CCC area.

The water supply for KSA is planned to provide the customers with sustainable access to safe water with appropriate water pressure on a 24/7 basis in consideration of the water supply capacity of the Karnaphuli WTP (286,000m^3/d). The KSA should be independent from other water supply systems as a self-contained system, in order to ensure that the above mentioned service levels are met. There are a lot of cases of water supply system operated independently (except for in emergency cases) by dividing the overall system in the city into several sub-systems, which are supplied by different water sources/WTPs in order to achieve effective O&M of water supply facilities.

3) Manner of selection of the KSA and the establishment of Sectors and DMAs

KSA is selected to cover high priority area (PANI area) in consideration of the balance between water supply capacity from Karnaphuli WTPs and water demand in 2030 in the priority area. KSA boundary doesn’t have to follow ward boundary and not based on any hydraulic considerations.

The provisions of sectors and DMAs will allow for the monitoring and effective control of water supply in terms of water quality, flow rate and water pressure. In addition, information required to manage NRW will be easily collected through measurement of the flow rates in the system.

Each Sector will have only one inlet with a flow meter, a pressure gauge and a pressure regulating valve. This arrangement will allow for the adjustment of water pressure at the inlet chamber resulting in the promotion of equitable water distribution to all sectors. Flow and pressure measurement data will be transmitted on a continuous basis through a SCADA system to the Central Control Room located at Karnaphuli WTP. Instructions will be made, as required for the adjustment of the water pressure at the inlet pipe to each sector.

For the effective control of NRW, each sector will be further divided into a number of small DMAs. This arrangement will allow for the collection of accurate data on leakage and NRW in each DMA. For example, the quantity of leakage in a DMA can be estimated through measuring minimum night flow by using a vehicle on-board electro-magnetic flow meter.

4) The reason of new construction of distribution pipes in KSA instead of rehabilitation of existing pipes

As of today, the exact locations, material types and conditions of the existing distribution pipes as well as the interconnection details and location have not yet been determined. Therefore it is a pre-requisite for evaluation of the possibility for reusing existing pipelines to conduct extensive field investigations, including trial excavations. However, based on the difficulties encountered in the trial excavations carried out under the PANI (limited to a central part of the city), investigation covering a large service area is not realistic in terms of both time and cost requirements, aside from the huge magnitude of disturbances to the residents and traffic in the built up area. Even if existing pipes are found, reuse of deteriorated AC pipes in the areas with a high population density area may be difficult. In addition, the diameters of the existing pipes are not sufficient for the present demand because those pipes were thought to be installed more than 20 years ago. Furthermore, frequent and long interruptions to water supply in a large area would occur if rehabilitation of existing pipes is implemented. On the other hand, the time period for interruption of water supply can be minimized under construction of new distribution pipes up to the service connections because cut off of the water supply is necessary only when new service connection is connected to existing service pipes in the premises of each customer.

Accordingly, new construction of pipelines is advantageous in order to provide effective water supply facilities in terms of reduction of leakage from the start of operation of the system and without causing major problems during the construction period. The construction cost and period required are also reduced considerably as extensive trial excavations for existing pipes will not be required. However, existing distribution mains, which run through KSA and deliver water outside KSA, remain as they are (e.g. Mohara WTP –Patenga B.P).

(2) FAQs regarding KSA

1) Change of service area in the water supply plan from SAPROF/Phase 1 to Phase 2

Water supply improvement plan for two phases was prepared by SAPROF in 2005 and Detailed Design of Phase 1 facilities in 2008. After the previous study/design, preparatory survey for Phase 2 was conducted in 2012. According to the comparison of the planned service area between SAPROF and Phase 2, the following are identified.

KSA must be smaller than that in SAPROF, as

- CCC’s water demand in 2030 is 1.65 times as much as that in 2020, however,

- Production volume of KWSP 1& 2 is almost same.

It is not likely that WTPs are materialized as scheduled in SAPROF report except for KWSP 1&2. Current situation is different from what was planned in SAPROF

In addition, two reservoirs (Nashirabad and Battali Hill) are included in Karnaphuli water supply system in SAPROF. The capacity of the two reservoir isn't still sufficient for KSA, even though KSA doesn't receive Madunaghat WTP water. As for priority area to be covered, in KSA, it is considered to include priority areas where water demand is high and urgent measures are needed, while, in SAPROF, no consideration is given to priority area (Its service area is simply set at hillside area).

2) Needs of accurate GIS data and maps for hydraulic simulation and rehabilitation work

WB recognizes that existing GIS data and maps are not accurate in terms of location. Besides location, following data and information are required;

- Materials (AC pipes must be replaced, no matter how fine they look.)

- Diameter (which hydraulic model depends on, but there are no accurate data)

- Conditions (Leakage occurs everywhere in unreliable network, but only limited information is available)

We must recognize that all data and information necessary for hydraulic simulation and rehabilitation work aren't available at present. There are two options to solve this problems follows:

- Conduct trial excavation along all the pipelines laid in CCC area, then hydraulic simulation and rehabilitation work, or

- Abandon all existing network, then design completely brand-new network.

3) Expansion of water supply toward outside of KSA

It will take a longer time for CWASA to construct water supply systems required to cover the entire Chittagong city. Therefore, it is reasonable for CWASA to apply a staged construction of water supply systems with priority for different areas. If the planned quantity of water for the KSA (286,000m^3/d) is used for the entire city area, some improvements such as a longer supply time (than presently practiced) may be expected. However, such arrangement will mean that the service levels for the KSA in terms of drinking water quality, adequate water pressure on a 24/7 basis will never be met. It is an obligation of CWASA to provide customers with safe and sufficient water supply services.

It should be noted that the water currently supplied from Mohara and Kalurghat WTPs to planned KSA (more than half of the quantity of water, i.e. more than 100,000m^3/d) will be used in the future in the areas outside of the KSA due to the change in the water source and supply. This shall contribute to the improvement of water supply service in terms of the quality and quantity of water supplied to areas around KSA. Figure ES.1 shows projected expansion of water supply services in provision of KWSP 1 and 2 from present to year 2020.

On the other hand, before effective design and construction such as KSA are achieved in the areas around KSA, careful and effective operation should be basically kept to avoid the deterioration of water supply service in KSA because sudden reduction in water pressure as well as the outflow of a large amount of water without flow control would occur if water supply to the surrounding area of KSA would be made by opening the valve(s) installed to stop the outflow to neighboring distribution systems (in the target year 2030). Except for emergency cases, water supply systems between KSA and neighboring distribution areas should be kept independent to maintain the control of the service level for KSA and surrounding areas.

All water supply systems to be constructed in the city shall be managed independently and at the same time operated comprehensively, supplementing each other and in consideration of countermeasures in emergency cases for each water supply system.

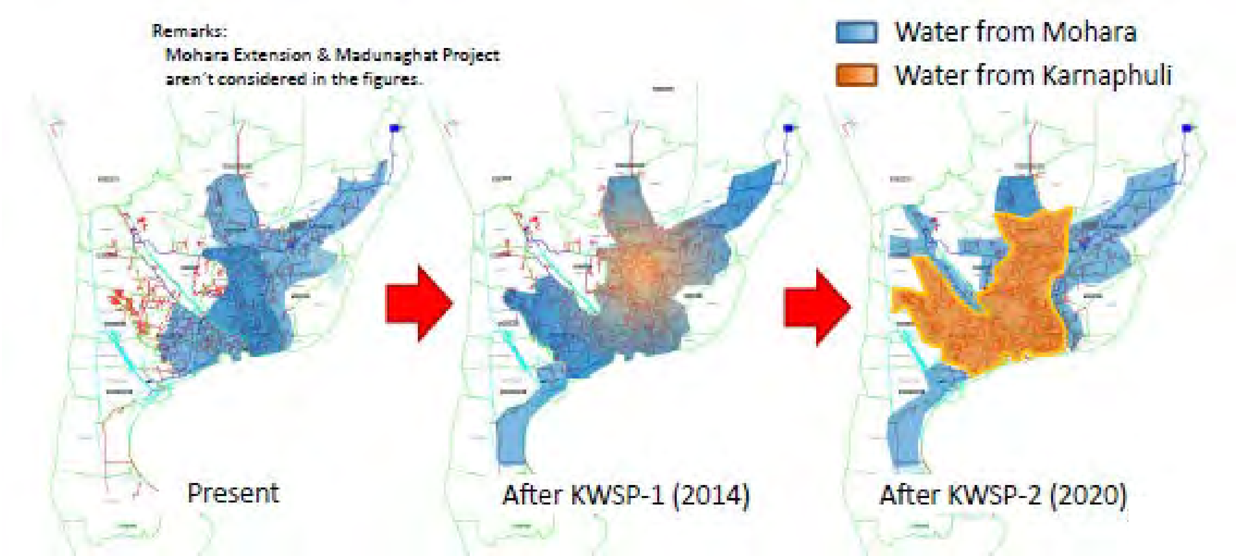


Figure ES.1 Contribution of KWSP 1 & 2 to the areas outside of KSA

4) Huge social impact of different water supply quality inside and outside of KSA

Service boundary shall be established anyway both in JICA study and WB study unless supply capacity can satisfy the entire water demand of whole CCC area. CWASA shall make efforts to establish the appropriate water supply areas outside KSA with support from GOB and/or donors.

Water supply service will be significantly improved even outside KSA after completion of KWSP 1 and 2. The supply conditions outside KSA can be further improved if additional supply from the Madunaghat WTP is materialized.

5) Combination of new network and existing not abandoned in KSA

The new pipes in KSA are planned to be connected to existing pipes in some locations. However, the two areas; the KSA and the areas served by the existing pipes (outside of the KSA) will be under different and independent water supply systems separated by valves.

If water supply in surrounding areas of the KSA is highly necessary, CWASA may conduct water supply to such areas as a temporary measure until the year 2030.

Figure ES.2 shows the manner of switching of service connection from old pipe to new pipe.

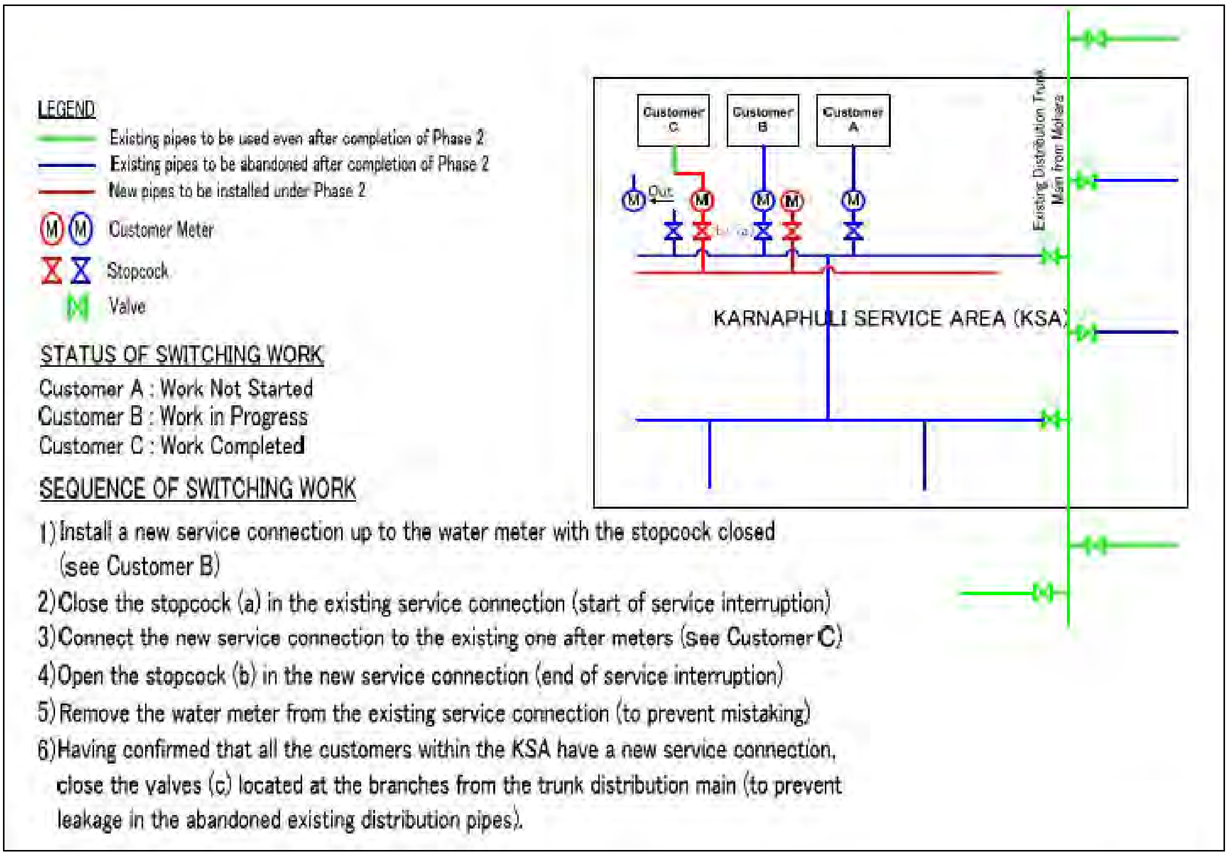


Figure ES.2 Service connection

6) Countermeasures to reduce leakage in KSA in early stage

KWSP 2 will give a construction priority to the priority sectors in PANI to commence normal water supply starting from year 2016, as shown in FigureES.3.

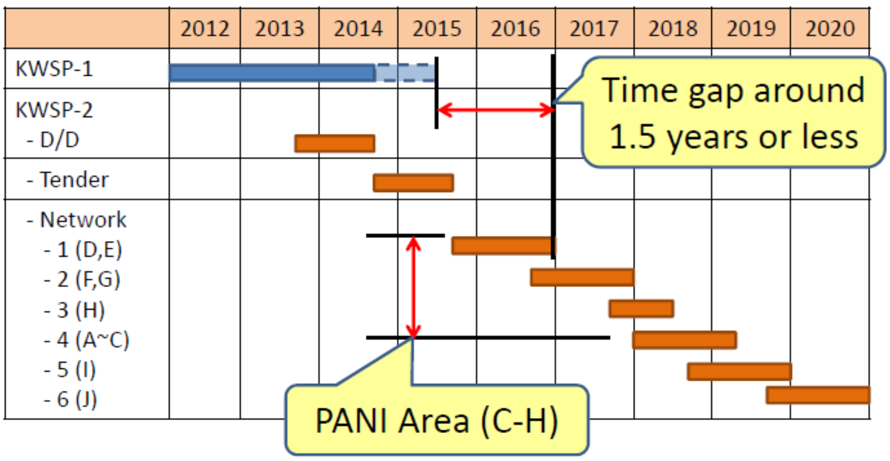


Figure ES.3 Construction Schedule of Distribution Network to expedite Water Delivery to Priority Areas

The area (wards) to be included in the KSA is based on giving priority to the following areas: PANI Area, (2) planned area to be covered with main/sub-main pipelines by the Phase 1 Project and (3) wards with a high demand (more than 100m^3/d/ha), which are geographically continuous from the PANI Area. A total of 21 wards with an area of 3,063 ha and a served population of 1,504,200 (more than 95% of the population in KSA) at the year 2030 were selected to be included in the KSA, based on the above criteria, with the locations shown in Figure ES.4.

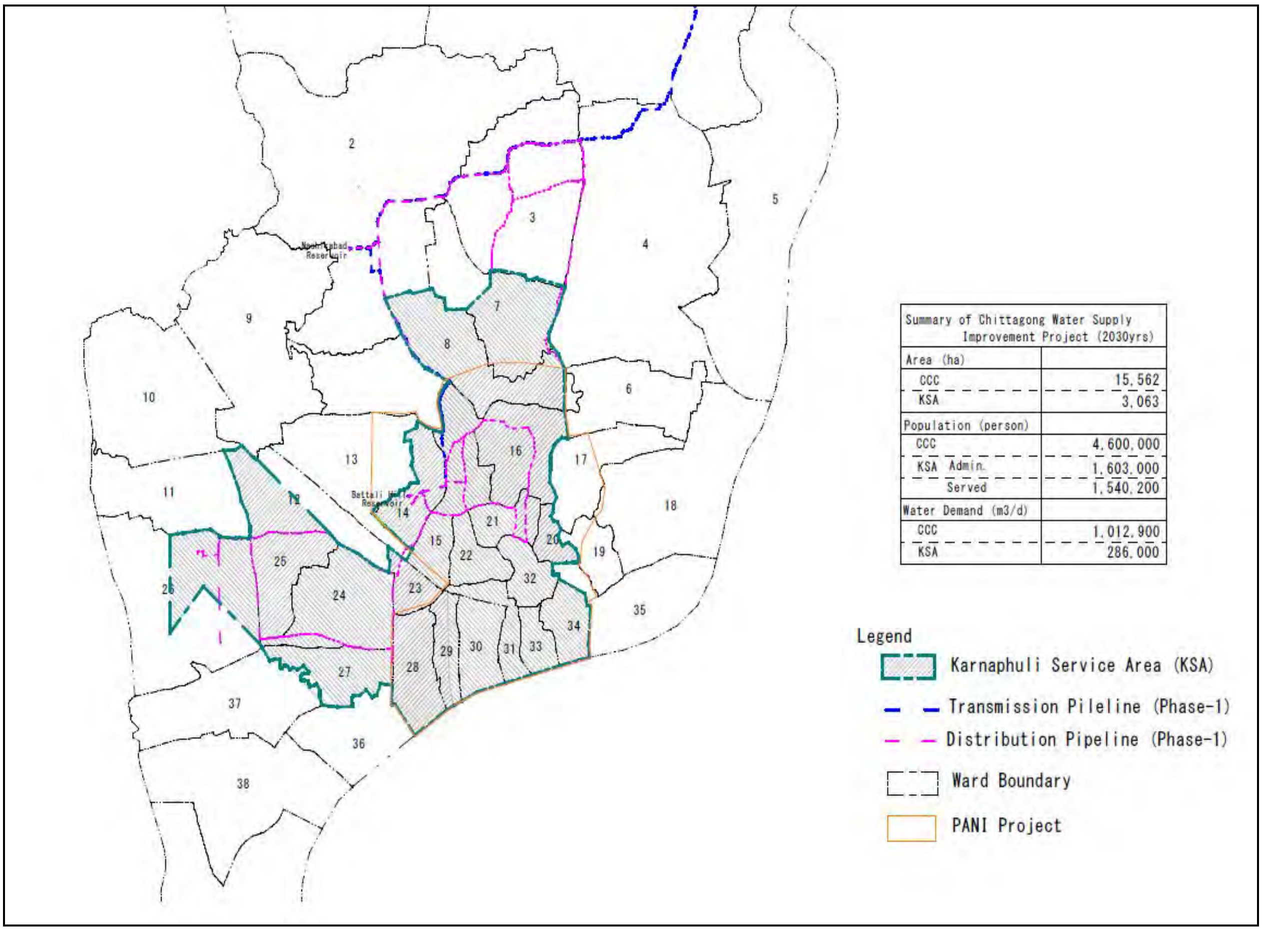


Figure ES.4 Locations of Wards included in KSA

6. Distribution System

The main objectives to be followed in the planning of the distribution network within the KSA are "equitable distribution" and "control of non-revenue water". In order to achieve this the area is divided into hydraulically independent 'Sectors', with each Sector further sub-divided into a number of small District Metered Areas (DMAs) for the effective control of NRW. Furthermore based on an assessment of the investigation results from the PANI, an entirely new distribution network is proposed, as this is more effective than rehabilitating the existing network.

The KSA is divided into 10 sectors (A to J) in consideration of the following factors: (a) locations of wards, (b) topographical conditions, (c) locations of major infrastructure, (d) distribution main pipeline routes planned in the Phase 1 Project and (e) the daily maximum water demand per sector should generally be in the range from 20,000m^3/d to 50,000m^3/d. Geographically the KSA consists of the Northern (A to C), Central (D to G) and Western (H to J) areas.

Two alternative distribution systems were studied in consideration of (a) effective use of the facilities in the Phase 1 project, (b) limited space in the road for construction of pipelines and (c) service areas to be covered for areas with a higher ground elevation. The selected system allows gravity flow to all areas, with the three areas above served by respective reservoir/elevated tanks; the Northern area by Nashirabad

Elevated Tank, the Central area by Battali Hill Reservoir and the Western area by Halishahar Elevated Tank. Figure ES.5 shows schematic configuration of main pipelines with inlets to sectors.

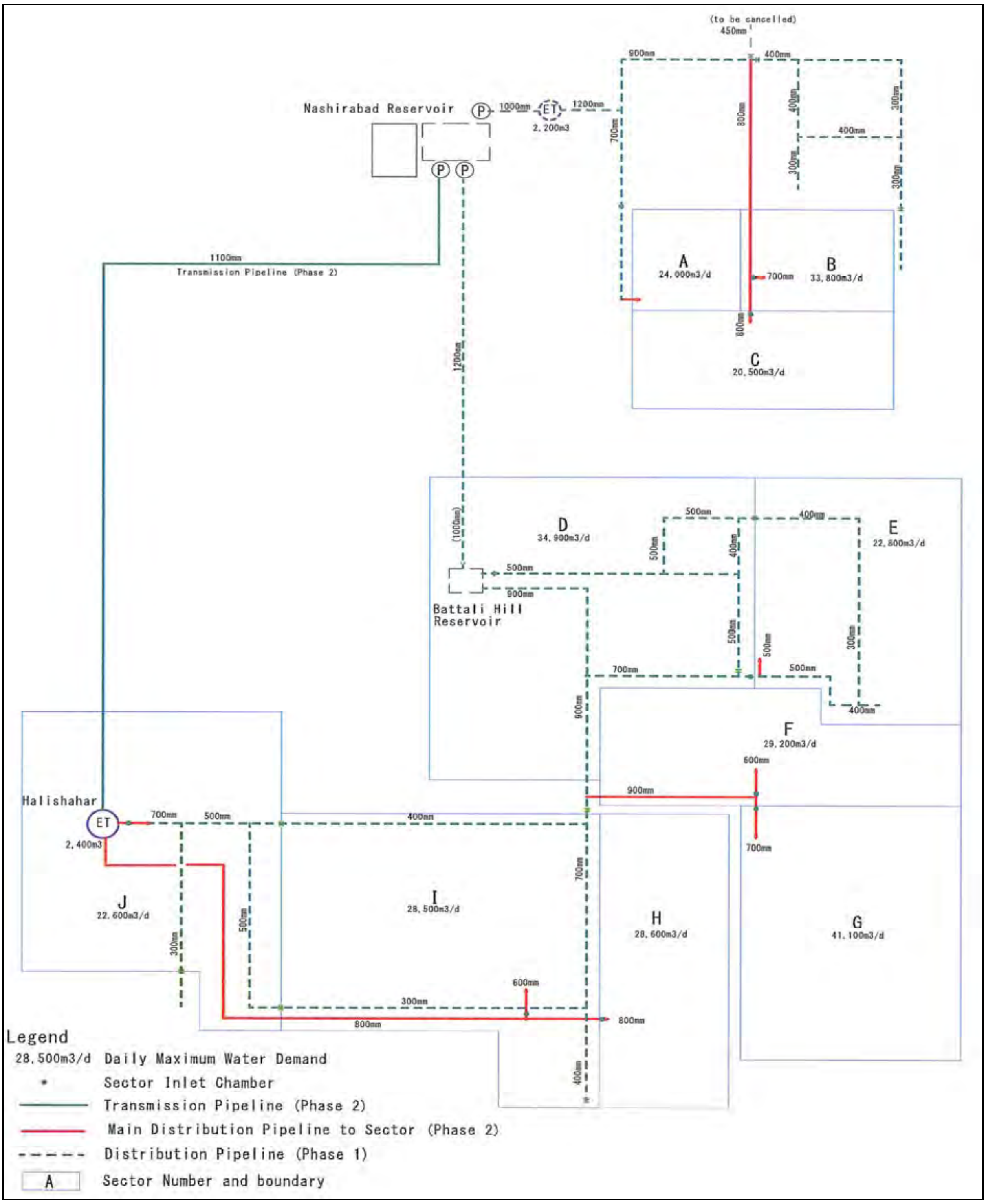


Figure ES.5 Schematic Configuration of Main Pipelines with Inlets to Sectors

7. Preliminary Design of the Water Supply Facilities

Problems with the existing system to be solved through the implementation of planned projects are as follows:

1) Limited Service Coverage with 47% of the water demand in CCC area,
2) Dilapidated and Inadequate Distribution pipes in the significant parts of the existing networks that are in need of replacement and
3) Considerable Non-Revenue Water (NRW) as reported by CWASA at 33%, but survey results by PANI in 2012 concluded with more than 50%

The Phase 2 Project is the expansion of the Phase 1 Project except for the arrangements of the distribution system. Table ES.3 summarizes the facilities in each phase and Figure ES.6 presents location of major facilities for the both phases.

Table ES.3 Outline of Karnaphuli Water Supply Project by Phase

Facilities		Phase 1	Phase 2
1	Intake	C/A: 300,000m^3/d M/E: 150,000m^3/d	C/A: - M/E: 150,000m^3/d
2	Conveyance Pipeline	DN1200mm, L=3.6 km (including surge tank)	DN1200mm, L=3.6 km (including surge tank)
3	WTP	Production Capacity = 143,000m^3/d	Production Capacity =143,000m^3/d
4	Transmission Pipeline 1	DN1200mm, 24.4km (including surge tank)	DN1200mm, 24.4km (including surge tank)
5	Nashirabad Reservoir	Reservoir:26,300m^3 Elevated Tank: 2,200m^3	Reservoir:24,800m^3
6	Transmission Pipeline 2	Nashirabad – Battali Hill: L=5.2km DN1200/1000mm	Nashirabad – Halishahar: L=10km DN1100mm
7	Halishahar Elevated tank	-	2,400m^3
8	Optical Fiber Cable	L=37km	L=20km
9	Primary and Secondary Distribution Pipeline	Northern, Central & Southern areas, DN300-DN1200mm L= 42.8km	Distribution Reservoir/ Elevated Tank to the ten (10) Sectors Primary Distribution (Upstream from Sector Valve to Reservoir); L= 7.9km Secondary Distribution (Downstream from Sector Valve to DMA; L=107.5km
10	Tertiary distribution pipeline	-	3,063ha (L=367.6km)
11	Service connection with water meter	-	About 51,360 connections

Land acquisition is not required. Details of important parts of the facilities are as follows.

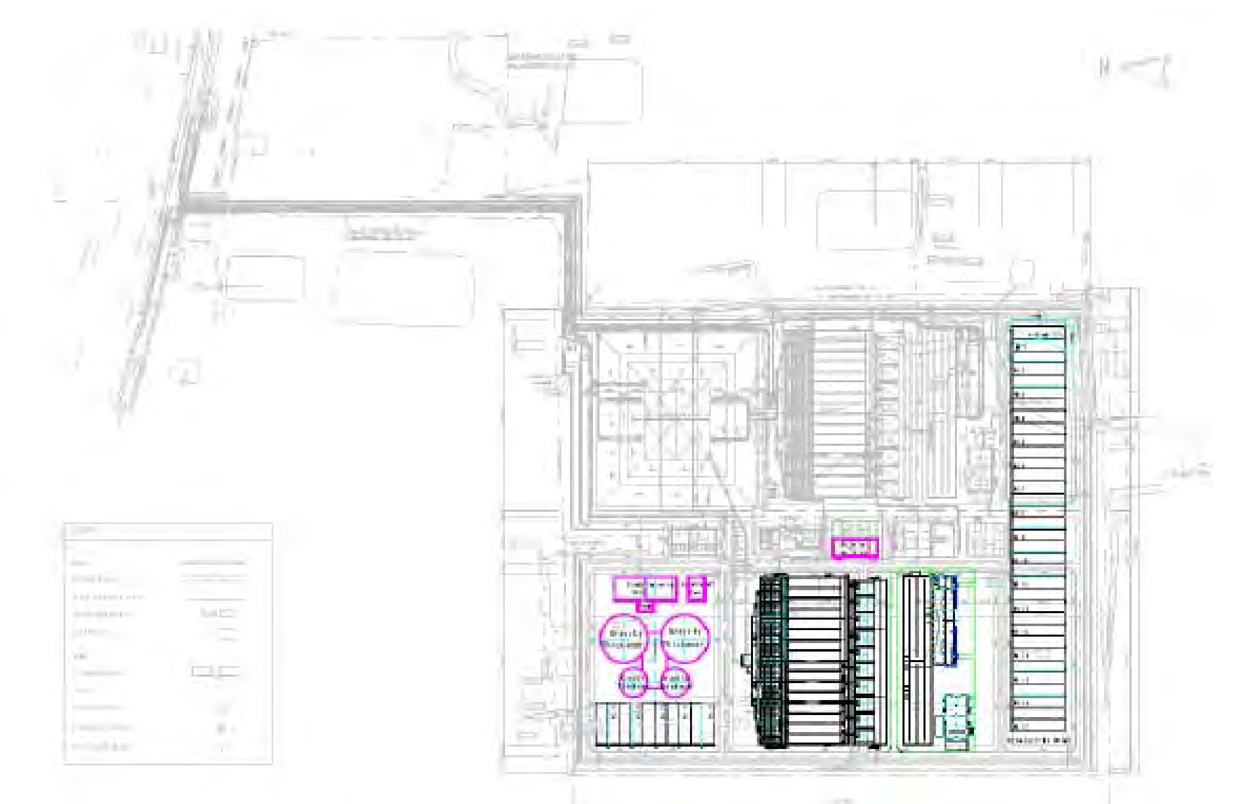


Figure ES.6 Location of Major Facilities of Phase 1 & 2 Projects

(1) Water Treatment Plant

The water treatment process for Phase 2 is basically the same as that for Phase 1 in application of rapid sand filter method (flocculation/coagulation-sedimentation- filtration).

The Pre-Sedimentation basin planned in the Phase 1 project will be commonly used for both Phases 1 and 2 in the case where the inflow has a high turbidity. For sludge treatment the process; Sedimentation Basin - Gravity type Sludge Thickener - Sludge Drying Beds – Disposal will be used, as this can be accommodated on the available land and the capital and O&M costs of this solution are lower than for the alternative technical solution considered.

(2) Transmission Pipeline

Transmission pipelines are planned along Kaptai Road for both Phase 1 and 2 Projects between the WTP and Nashirabad Reservoir, and Nashirabad reservoir to service reservoirs (Nashirabad Elevated Tank and Battali Hill Reservoir). A transmission pipeline from the Nashirabad Reservoir to Halishahar Elevated Tank is also planned for Phase 2 Project to supply the western area of the KSA.

Some faucet systems along the transmission pipeline along Kaptai Road shall be provided for the residents to mitigate complaints. City Government shall also extend assistance for the water supply in the area, such as construction of deep wells, which is practiced by the City Government.

(3) Distribution facilities

The distribution system consists of ten (10) Sectors and is divided into three (3) sub-systems, the northern, central and western areas. These areas are served by the Elevated Tank at Nashirabad site, Battali Hill Reservoir, and Halishahar Elevated Tank, respectively.

(4) Distribution Pipelines

Water from the three (3) main distribution facilities, namely the Elevated Tank at Nashirabad site, Battali Hill Reservoir and Halishahar Elevated Tank, is distributed to ten (10) sectors. Furthermore, water is supplied to District Meter Areas (DMAs).

The approximate lengths of distribution pipelines are summarized in table ES. 4 from the distribution reservoir/elevated tank to the sector valves, from the sector valves to the DMAs, and within the DMAs in the KSA. New distribution pipes in DMAs should be laid in the road near housing and the length of the service connection pipes should be minimized.

Table ES.4 Length of distribution pipeline in KSA

Unit: m

	Upstream to Sector Valve					Downstream of Sector Valve to DMA							DMA
Dia.(mm)	600	700	800	900	1000	200	300	400	500	600	700	800	100
Length	44	91	2,428	2	5,367	74,883	18,055	5,056	2,968	4,776	668	1,058	367,560

New distribution pipes in DMAs should be laid in the road near to house, business establishments, etc. and the length of the service connection pipes should be minimized.

(5) Water Distribution Control System

For the purpose of enhancing equitable distribution, the KSA is divided into 10 numbers of hydraulically independent ‘Sectors’. Each Sector will have only one inlet which is provided with a flow meter, a pressure gauge and a pressure regulating valve. Flow and pressure measurement data will be transmitted through SCADA system to the Central Control Room located at the Karnaphuli water treatment plant for monitoring and recording purposes on a 24/7 basis. Pressure regulating valves will automatically adjust the pressure at the outlet to match a set point, which can be changed by operators in the Central Control Room.

For the effective control of non-revenue water, each Sector will be further divided into a number of District Metered Areas (DMAs). DMAs will be designed so that whenever it is necessary they can be hydraulically isolated from the rest of the distribution network by closing 3 to 4 valves of known location.

Treated water at Karnaphuli WTP is transmitted to Nashirabad Reservoir at first and reserved, then transmitted to the service reservoirs by transmission pumps. Water in the service reservoirs is distributed to each distribution sector by gravity. The number of sector is ten and pipe size is about 600mm to 700mm, so a valve chamber will be relatively large due to installation of an electromagnetic flow meter and control valve. A valve chamber at the inlet of sector and a control panel will be required on the ground near the valve chamber.

8. Construction Plan of Water Supply Facilities

The construction plan has been developed considering environmental and social impacts, and security problems during the construction work. Important points are as follows.

(1) Intake/Conveyance Facilities - At the Intake connections to the Phase 1 facilities shall be carried out such that the facilities operate continuously (except for short term interruptions to the power supply), when the Phase 1 standby generator shall be utilized. The conveyance pipeline from the Intake to the WTP will be installed in Kaptai Road using open-cut method of construction and laid in the opposite side of the road to the Phase 1 pipeline with appropriate traffic control during pipe laying.

(2) WTP - Construction of the facilities shall be planned such that adequate sludge treatment is provided at all times during the change in the method of sludge treatment. Connections to the Phase 1 facilities (for example pre-sedimentation basin, sludge treatment, electrical works), shall be carried out such that the Phase 1 WTP operates continuously (except for short term interruptions to the power supply) and without adversely affecting the treated water quality. In the case when the power supply has to be interrupted the standby generator which is provided under Phase 1 shall be utilized, such that interruptions are short.

(3) Transmission Facilities -The transmission pipeline from the WTP will be laid in Kaptai Road, in the opposite side of the road to the Phase 1 pipeline. Appropriate traffic control shall be provided for this and other pipelines.

(4) Distribution Facilities – measures to mitigate environmental impacts and prevent public nuisance, such as noise and vibration shall be taken. These shall include traffic control and diversions, where necessary. For the construction of tertiary distribution pipelines and service connections with meters, all customers should be informed sufficiently in advance of the timing of works to change the connection pipe, such that they can make arrangements for the storage of water and the works required to be undertaken by the customer. The construction method for pipe laying with the diameter less than 400mm may be determined in consideration of alternatives; open-cut or trench less methods, during detailed design stage. Works should be carried out timely such that disturbance to customers and the duration of the cut off in supply are minimized.

(5) Distribution Pipeline – Nearly 9,000m^2 of stock yard for pipe materials are assured in the CWASA property near Bayazid Bostami Road. During construction, the contractor may encounter AC pipes, for which removal and disposal shall be properly and safely carried out. If construction machine break AC pipes, broken pieces shall be treated carefully so that direct contact with the pipes does not occur and exposure to airborne asbestos fibers is in accordance with the prevailing standards and legislation with regard to Permissible Exposure Levels. Broken pieces of pipe shall be packed safely and collected to storage areas, prior to final disposal from the site. Workers shall be equipped with eye-protection glasses, masks and rubber/leather gloves.

About 52,000 connections are planned in the Phase 2 project. After water pressure test of tertiary distribution main pipe, service connections will be installed as the last work in the series of pipe laying process before backfilling.

When new connections are installed, some problems may occur. Joint planning and work among concerned parties, including CWASA staff is indispensable. Before the installation of service connections, CWASA staff shall prepare a map showing the exact location of the water meter for each consumer. The contractor (for package 3: construction of distribution pipelines) will install the service connection up to the construction boundary (i.e. up to a short distance inside the private land from the boundary between public and private land; refer to Figure ES.2).

The project cost includes installation cost of service connections; however, connection fee to be collected from customers later will be utilized for the maintenance of service connections by CWASA. CWASA may reduce some connection fee considering the cost required to connect between CWASA pipe and private pipe in switching work from old connection pipe to new one.

9. Operation and Maintenance of Water Supply Facilities

The organization for O&M of the Karnaphuli Water Supply System is recommended from functional view point as a total system for Phases 1 and 2, taking into account the changes required as a result of the Phase 2 project (such as use of SCADA system and leakage monitoring and control in DMAs). The requirements for administrative, engineering (planning and design), commercial/ marketing and public relations are regarded to be managed by CWASA head office, as common services to all water supply systems in the city. Therefore, the Karnaphuli Water Supply System Office has an independent function for O&M of the facilities.

The organization for O&M consists of two divisions (broken down into two groups among the major facility components), one for the Intake, WTP, Conveyance and Transmission pipelines, and the other for the Distribution Facilities. System management from Intake to the entrances to the sectors of the distribution main pipelines will be undertaken by monitoring and control staff under the Assistant KWS System Manager, who will report to the KWS System General Manager. A total of 164 staff is required for O&M of the system, not including support staff.

The Deputy Manager of O&M for the Distribution Facilities will manage concerned sections consisting of (1) reservoir/elevated tank and (2) main & sub-main Pipelines with Sector Inlet chambers, DMA networks with DMA chambers.

Main pipe/Section Inlet chamber & DMA Section includes (1) 10 Sector offices, (2) Leakage Detection Teams for the three sub- distribution systems which cover 10 sectors and (3) Water Meter Maintenance Center, which will be commonly used for all established Water Supply System in Chittagong City. The Water Meter Center is engaged in the water meter accuracy test, periodical on-site meter calibration and replacement of broken meters.

The field office of each sector shall be established before completion of respective DMAs to manage the water supply business in their territories including marketing, water tariff collection, and monitoring/control of water use and repair of facilities (leakages). For the establishment of comprehensive management for the water supply in the KSA, incentives to staff members and appropriate compensation shall be provided through the competition on the performance of the sectors.

10. Environmental and Social Considerations

The Karnaphuli Water Supply Project was classified during Phase 1 as a “Red” category project and this is still the case in accordance with the prevailing legislation. An IEE report and an EIA report were prepared for the Karnaphuli Water Supply Project and both were submitted to the Department of Environment (DOE) to obtain the necessary approvals. The descriptions in both reports cover Phases 1 and 2 of the project.

Approvals by DOE include various conditions, such as requirements for proper mitigation countermeasures and monitoring for site preparation, construction and operation stages. In addition “the Project Proponent (CWASA) shall apply for Environmental Clearance Certificate after installation of the plant as well as other pollution control facilities and equipment”.

With reference to the Phase 2 Project, CWASA sent a letter to DOE Chittagong to obtain “Environmental Site Clearance (ESC)” on September 20, 2012. DOE Chittagong replied to CWASA on September 20, 2012 about the need for the site clearance certificate for Phase 2 of KWSP with requisite fees. After submission of the requirements by CWASA, DOE Chittagong issued the ESC for Phase 2 Project on November 13, 2012.

(1) Environmental and Social Aspects in the Project Sites

There is no need for additional land and resettlement for the construction of water supply facilities for Phase 2 project. The land required for Phase 2 will be managed within the area obtained during the project preparation stage for Phase 1 and/or owned by CWASA. However, before commencement of the Phase 1 Project, six households (about 40 persons) resided at the south-eastern edge of the WTP site, were relocated.

Public consultation as a means of integration of local people's concerns into the Environmental Assessment process was conducted during the preparation stage of Phase 1 Project.

In general, the local people's response to the Karnaphuli Water Supply Project was positive and they were interested to receive the benefits of the project. Most of the people who live close to the treatment plant had no objection towards the implementation of the project, but they expressed concern about the loss of agricultural and productive land. The people in the city area welcomed the project with great interest as it is likely to alleviate the problems of acute shortage of water from which they are suffering.

In the recent survey all of the respondents requested CWASA to provide improved water supply services in terms of 24/7 service, sufficient water pressure and water quality for drinking purposes.

During construction work for the Project inconvenience to the people's lives may occur. Disruption to traffic and congestion, mainly caused by pipe laying in and beside roads is potentially the reason for the highest number of complaints. In order to minimize complaints traffic management measures in major roads, such as Kaptai Road will be provided, with working areas limited to 100 meters long in order to minimize disturbance to traffic flow. Inconvenience to residents may also occur during the construction of the distribution network in built up areas.

To mitigate inconvenience, residents' complaints and opinions should be collected at timely public meetings in the concerned areas. Public meetings can be opportunities for building mutual understanding between residents and the Contractor/ CWASA, and people's participation in the project as well.

Residents along the conveyance and transmission pipelines (outside the CWASA service area) are not served by this Project, although they may be inconvenienced by construction work along Kaptai Road. For their benefit, community faucet systems are planned to be installed along the transmission pipeline route. Assistance by the City Government shall also be sought.

According to the public consultation, residents were concerned that assembly of people during project activities may adversely influence the local environment. The problem can be negligible in the case where local residents are employed in the Project. Public meetings shall be timely conducted before and during construction work to concerned people.

The following items/issues should be carefully considered to avoid, minimize and/or mitigate possible negative impacts due to the project in terms of physical environment (natural environment and items related to environmental pollution).

- Location of Project Sites in and Vicinity of the Protected Areas and Environmentally Sensitive Area
- Vegetation, Animals and Valuable and Endangered Species
- Rich Fish Resources and Fishery Activity
- Specific Hydrological Conditions of Karnaphuli River and its Tributaries due to Coastal and tidal Effect
- Air Pollution
- Surface Water Quality
- Ambient Noise
- Solid Waste Disposal

(2) Identification of Possible Environmental Impacts and Necessary Measures

The following are studied.

- Identify possible negative and positive impacts caused by the project
- Study possible mitigation methods and prepare Environmental Management Plan (EMP) and environmental monitoring plan.

As a result of identification of possible impacts shown, the major possible negative impacts are as follows:

- Pre-Construction Stage

1) Change in land use and utilization of local resources

- Construction Stage

1) Nuisance and/or disturbance of business activities and living conditions affected by the construction work. In particular work for laying pipelines along existing roads may cause traffic congestion, resulting in nuisance and/or disturbance to business activities and living conditions in the project area.
2) Public health condition
3) Working condition
4) Accidents
5) Surface soil erosion
6) Hydrological condition
7) Air pollution
8) Water pollution
9) Noise and vibration
10) Solid waste disposal

- Operation Stage

1) Air pollution
2) Water pollution caused by sludge treatment at WTP
3) Noise and vibration caused by pump operation
4) Chlorine leakage from chlorine storage and injection facilities
5) Sewage volume increase according to the increase of water uses

- All Stages

1) Acceptability by people and local communities
2) Occurrence of conflict and discord within community due to worker's staying in the area and unfairness of benefits
3) Impact to Habitat of flora, fauna and endangered species
4) Impact to fishery resources

(3) Environmental management Plan

The following items are considered.

1) Institutional arrangement with staffing
2) Compliance with Bangladesh Laws, Standards and Regulations as well as the JICA Guidelines
3) People's Participation
4) Preparation of Implementation Plan

(4) Environmental Monitoring Plan

In the terms and conditions, which accompanied the Issuance of ESC and Approval of EIA Report on Karnaphuli Water Supply Project by DOE, following matters are required for environmental monitoring.

1) Record of monitoring
2) Monitoring items and timing
3) Reporting
4) Notification of Environmental Harm

Environmental Checklist both in Bangladesh and JICA was prepared.

11. Implementation Plan and Construction Cost Estimates

The implementation Plan is established referring to the lessons from the Phase 1 Project, which is scheduled to be completed in 2015. The Phase 1 project does not include pipeline systems in the DMAs and these pipes up to the service connections in the DMAs are included in the Phase 2 Project, covering the entire Karnaphuli service area.

Construction of pipelines in the DMAs shall be given priority for the PANI area where population density is high with high water demand, while, there are a lot of dilapidated pipes and AC pipes in the area, which requires providing urgent countermeasures. On the other hand, accurate information/data on the existing underground facilities in the area has been accumulated through the implementation of the PANI and this information is useful for the design of the distribution network. This arrangement will provide not only effective water supply service in the KSA, but also help in increasing the income of CWASA.

(1) Contract Packaging and Procurement Method

Four packages are proposed as follows.

Package 1:

Package 2:

Package 3:

Non-Disclosure Information

Package 4:

Package 3 is a very urgent component in the overall Karnaphuli Water Supply Project in order to provide water supply at an early stage in a cost effective manner. The period for D/D will be reduced to a minimum in recognition of this.

The following is the procurement method for both Consultants and Contractors.

Procurement	**Scope of Work**	**Manner of Procurement with required process/ events**
Consultants	One consultancy package: D/D & C/S for all packages of work	ICB (PQ, Bid, Approval)

Procurement	**Scope of Work**	**Manner of Procurement with required process/ events**
Contractors	Construction of facilities (Package 1, 2, 3 and 4, respectively)	ICB (PQ, Bid, Approval)

(2) Implementation Schedule

A temporary Implementation Schedule is shown in Table ES.5, based on assumed loan agreement schedule as shown below.

Appraisal of the Project	December, 2012
Pledge of JICA Loan	February 2013
Exchange of Note between GOB and GOJ	March 2013
Signing of Loan Agreement	March 2013

Table ES.5 Temporary Implementation Schedule

Item	Date
Expected Completion of Phase 1 Project	May 2015
Project Appraisal/Loan Agreement	December 2012/ March 2013
Selection of Consultant	9 months, December 2012 to August 2013
Detailed Design	13 months, September 2013 to September 2014
Selection of Contractor	
Package 1	August 2014 to November 2015
Package 2	Ditto
Package 3	Ditto
Package 4	February 2014 to September 2014
Construction stage	
Package 1	36 months December 2015 to November 2018
Package 2	36 months December 2015 to November 2018
Package 3	62 months December 2015 to January 2021
Completion of Project including defects liability period	January 2022

Note: Package 4, Procurement of equipment and vehicles, is included in the part of consulting services.

During the consulting services major investigations (a long period is required to conduct excavation at about 1,200 locations) to finalize pipeline design are trial excavations along planed primary and secondary pipeline routes, since there are no data available as of today. In consideration of this and the large amount of work for Package 3 requiring many engineers and construction working teams, timely completion of the consulting services with absolute conditions (dry season period for trial excavation), careful preparation and arrangements are indispensable.

(3) Project Implementation Unit (PIU)

CWASA will be the primary agency responsible for executing and supervising the Project and a Project Implementing Unit (PIU) in CWASA shall be established. In the PIU under the Project Director and Deputy Project Director, there shall be four sections, which are Procurement, Accounting, Environment and Public Relations. In addition, three groups (excepting for environmental specialist), one for each construction package shall be organized and each group should be vested with a formation from Executive Engineer to Site Engineers. The PIU will consist of 18 core staff from Project Director to Assistant Engineer level, supported by about 80 staff members, all of whom shall be full-time on the assignment.

(4) Consulting Services for Detail Design, Assistance for Bidding, Procurement of equipment and Construction Supervision

CWASA will procure consulting services through ICB, with the consultants' team consisting of international and local professional and supporting staff. A total of NDI man-months of international and NDI man-months of local engineers are proposed, taking into account of the requirements for the design of Package 3, in particular. Consultants will be selected through a short list method to avoid lowering of quality and in accordance with the "Guidelines for the Employment of Consultants under Japanese ODA Loans".

The total cost for the consulting services is estimated at approximately NDI million yen (Foreign portion: NDI million yen, Local portion: NDI million Taka), as shown in Table ES.6.

Table ES.6 Estimated Cost for Consulting Services

BDT 1 = JPY 0.966

		Unit	Qty.	Foreign Portion		Local Portion		Combined Total
				JPY		BDT		JPY
				Rate	Amount ('000)	Rate	Amount ('000)	('000)
A. Remuneration								
1	Professional (A)	M/M						
2	Professional (B)	M/M						
3	Supporting Staffs	M/M						
	Subtotal of A							
B. Direct Cost								
1	International Airfare							
2	Domestic Airfare							
4	Domestic Travel							
5	Accommodation Allowance							
	Professional (A)	Month						
	Professional (B)	Month						
	Supporting Staffs	Month						
6	Vehicle Rental	Month						
7	Office Rental	M/M						
8	International Communications	M/M						
9	Domestic Communications	M/M						
10	Office Supply	M/M						
11	Office Furniture and Equipment	Ls						
12	Report Preparation	Month						
13	Topographic & Soil Survey	Ls						
14	Trial Digging	Ls						
	Subtotal of B							
	Total							

Non-Disclosure Information

(5) Preliminary Cost Estimates for the Project

The following are assumptions to estimate the cost requirements according to the implementation schedule.

1) Construction Cost

1)	Base Year	December, 2012
2)	Exchange Rate	1 Taka = 0.966 Japanese Yen 1 USD = 81.7 Taka 1 USD = 79.0 Japanese Yen
3)	Price Escalation Rate per annum	Foreign Currency = 2.1%, Local Currency = 4.9%
4)	Physical Contingency	5%

2) Administration Cost and Service Tax

1)	Administration Cost	5% (of the Eligible Portion)
2)	VAT for local currency	15% (of the expenditure in local currency of the eligible portion)
3)	VAT for foreign currency	15% (of the expenditure in foreign currency of the eligible portion for Consulting Service)
4)	Import tax	30% (of the expenditure in foreign currency of the eligible portion for Procurement/Construction)

The construction cost (including consulting services) is summarized in Table ES.7

Table ES.7 Construction Cost (mil. Yen)

Item		Total (million)		
		FC (JPY)	LC(BDT)	Total(JPY)
A. ELIGIBLE PORTION		Non-Disclosure Information		
I) Procurement / Construction				
1	Intake facilities, WTP, reservoirs and elevated tanks			
2	Conveyance and transmission pipeline			
3	Distribution pipeline and service connections			
4	Procurement of goods			
5	Project Implementation Support Unit			
	Base cost for JICA financing			
	Price escalation			
	Physical contingency			
II) Consulting services				
	Base cost			
	Price escalation			
	Physical contingency			
Total (I + II)				
B. NON ELIGIBLE PORTION				
a	Procurement / Construction			
	Base cost for JICA financing			
	Price escalation			
	Physical contingency			
b	Land Acquisition			
	Base cost			

	Price escalation	Non-Disclosure Information
	Physical contingency	
c	Administration cost	
d	VAT	
e	Import Tax	
f	Banking charge	
Total (a + b + c + d + e + f)		
TOTAL (A+B)		
C. Interest during Construction		
	Interest during Construction(Const.)	
	Interest during Construction (Consul.)	
D. Commitment Charge		
GRAND TOTAL (A+B+C+D)		
E. JICA finance portion (A)		

3) Performance Indicators

The performance indicators (covering CCC area) to be monitored during project implementation to assess project progress toward project objectives, and for evaluation of project accomplishments after project implementation are shown in Table ES.8 Service coverage is estimated using served population and projected population (Population in 2023 is about 40% higher than that in 2012). Therefore, service coverage in 2023 is 51%, but it is about 70% against the population in 2012

Table ES.8 Performance Indicators

Indicator	2012	2023 (2 years after completion of facility)	
Water Production (Phase 1 + Phase 2) m^3/d	219,000	505,000	
Population Served/to be served (person)	1,363,000	2,008,500	90% in KSA Deep well; 343,000 persons
Daily maximum water consumption (m^3/d)	146,700	388,900	
Service coverage (%)	47	51	70% to present population
Water Supply per Capita (l/person/day)	107	120	
Percentage of facility utilization (%)	100	100	
NRW	33%	23%	

Note) 1) 2012;
Population in CCC = 2,900,000 person
Population Served =1,363,000person (51,000connection x 20person/connection +343,000person)
Service coverage = 47% (including deep well supply)
2) 2023;
Population in CCC= 3,964,000 person
Population in KSA =1,272,800 person
Population Served = 1,272,800 person x 90% + (51,000connection-25,000connection) x 20person/connection + 343,000person= 2,008,500person
Service coverage = 2,008,500 / 3,964,000 = 51% (70% to present population,
NRW% in 2023= (0.33x.43+0.15x0.57)x 100=23%

12. Financial and Economic Considerations

(1) Budgetary Plan

The fund requirements and financing plan for the Phase 2 Project are as follows:

Particulars	FC Portion (JPY mil.)	LC Portion (BDT mil.)	Combined Total in JPY (mil.)	Combined Total in BDT (mil.)
Fund Requirements	Non-Disclosure Information			
Financing Plan				
JICA Loan				
GOB Fund				
Total				

(2) Forecast of Financial Position of Phase 1 and Phase 2 Projects

The base-line forecast indicates that the annual operating income for the Phase 1 Project (which has also been considered in the financial and economic analysis) will be negative every year during the initial 13 years from FY2016 until FY2028 and the annual operating income for the Phase 2 Project similarly will be negative every year during the initial 18 years from FY2021 until FY2038, since the water revenue income is adequate to recover the O & M costs, but not adequate to recover depreciation.

There are three options for possible measures to be taken for strengthening the sustainable financial structures of the Phase 1 and 2 Projects, as follows:

Option 1: To raise the tariff rates as follows:

1) To raise the tariff rates in FY2016 to BDT30.22 per m^3 for domestic consumers and BDT85.61 per m^3 for non-domestic consumers (4.6 times of the rates in FY2012) and then rise by 3.0% every year until FY2020.
2) To raise the rates in FY2021 by 1.4 times of the FY2020 rates for domestic and non-domestic consumers, and then rise by 2% every year until FY2025.
3) To raise the rates in FY2026 by 10% of the FY2025 rates for domestic and non-domestic consumers.
4) No need to raise the rates in FY2027 onwards, unless any external conditions change.

Option 2: To relax lending terms of GOB's subsidiary loan as follows:

1) To provide grant and/or equity participation for the whole amount of the funds required for the Phase 1 Project, which is equivalent to about 30% of the total fund requirements for the Phase 1 and 2 Projects.
2) For the Phase 2 Project, relaxing the lending terms as follows:
    a) Repayment of loan with 30 years installments after a 10 years grace period
    b) Interest rate at 1% per annum for both the Foreign and Local Loan Portions
    c) Capitalize interest accrued during the initial 10 years so that annual payment of interest can be released during these years

Option 3: Intermediate arrangement between Option 1 and Option 2

It is recommended to consider taking one of the above measures in order to make the Phase 1 and 2 Projects financially sustainable.

(3) Financial Evaluation of the Phase 2 Project

The financial internal rate of return (FIRR) and financial net present value (FNPV) of the Phase 2 Project are computed for the financial evaluation. The computation is made on the basis of discounted cash-flow taking cash outflow based on initial capital costs, replacement costs and annual O&M costs, while taking cash inflow based on annual water revenue. All inputs are in terms of 2021 constant prices.

The base case indicates an FIRR of 7.07% (negative) and an FNPV of BDT Non-Disclosure Information. The analysis implies that the water revenue is adequate to recover O&M costs but inadequate to recover the capital investment costs due to the current water tariff rates set comparatively lower.

A sensitivity analysis indicates that an increase in the tariff rates by 170% to BDT26.22/m^3 for domestic consumers and BDT74.28/m^3 for non-domestic consumers in 2021 constant prices results in a FIRR of 0.79% and FNPV of BDT NDI, satisfying the financial opportunity cost of capital (FOCC), which is estimated as 0.78%. However, as such an increase becomes to be higher by 252% than the 2012 rates; it seems difficult to adopt such higher tariff rates. Considering economic benefits that may be brought about by the Project, it is recommended for the Government to consider providing financial support as discussed in 12.2.4 (2) even though gaining adequate financial returns on investment.

(4) Economic Evaluation of Phase 2 Project

The economic internal rate of return (EIRR) and economic net present value (ENPV) of the Phase 2 Project are computed to evaluate the economic effectiveness of the Phase 2 Project. The computation is made on the basis of discounted cash-flow taking cash outflow based on economic capital costs, economic replacement costs and annual economic O&M costs, while taking cash inflow based on two economic benefits, namely, direct benefit in terms of Willing To Pay (WTP) value of water distributed from the Phase 2 Project and indirect benefit in terms of the value of consumers' water cost saving with the supply of water from the Project. All inputs are in terms of 2021 constant prices.

All economic costs are estimated by converting financial cost values with SCF (Standard Conversion Factor) of 0.9. WTP value is deemed to be equivalent to the water revenue used for the financial evaluation, while the value of consumers' water cost saving is estimated assuming that consumers may spend much higher costs for getting water from alternative sources if the Project is not realized.

The base case indicates an EIRR of 11.87% and an ENPV of BDT NDI at a 10% discount rate. In light of the economic opportunity cost of capital (EOCC), which is estimated at between 10 and 12%, the Phase 2 Project is evaluated to have a justifiable economic return on investment.

The Phase 2 Project, as well as the Phase 1 Project will contribute significantly in responding to public needs for an improved water supply and also in the improvement of the sanitary environment and public health. In view of the quantitative economic return on investment and these qualitative effects, the Phase 2 Project is strongly justifiable, although the financial position is difficult.

CHAPTER 1

BACKGROUND AND OUTLINE OF THE SURVEY

CHAPTER 1 BACKGROUND AND OUTLINE OF THE SURVEY

1.1 Introduction

The water supply in the People's Republic of Bangladesh (hereinafter referred to as "Bangladesh") is not adequate at present in terms of quality, quantity and levels of service. The Government of the Republic of Bangladesh (hereinafter referred to as "GOB") decided to improve water supply using surface water and reduce the use of groundwater, due to arsenic contamination and lowering of the groundwater level.

Chittagong city is the second largest city in Bangladesh, and the county's biggest industrial and port city. The gap between demand for and supply of water in Chittagong city has increased rapidly due to population growth and expansion of industrial and commercial activities. In addition, the reported Non-Revenue Water (NRW) percentage is higher than a possible level with more than 30%, mainly caused by deteriorated distribution pipes. Chittagong Water Supply and Sewerage Authority (hereinafter referred to as "CWASA") presently supplies an average of 219,000m^3/day to the served area, while the requirement is estimated at an average of 408,900m^3/day.

The Government of Japan (hereinafter referred to as "GOJ") extended loan assistance for "Karnaphuli Water Supply Project (hereinafter referred to as the "Phase 1 Project")" to augment water supply capacity (Production amount of 143,000m^3/day). The World Bank also has a plan to assist CWASA in the improvement of water supply in the future (Chittagong Water Supply Improvement and Sanitation Projects). In addition to the countermeasures for physical improvement, Japan International Cooperation Agency (hereinafter referred to as "JICA") has been providing technical assistance to CWASA for the reduction of NRW through the "Project for Advancing NRW Reduction Initiative (PANI) of Chittagong WASA". Assistance for the institutional development of CWASA is also in progress in the Phase 1 Project (refer to the details in 3.3.3 Current Activities for Institutional Improvement of CWASA).

Although a significant increase in water supply capacity is expected in the near future (such as from the construction of Madunaghat WTP and expansion of Mohara WTP including from the Phase 1 Project), there are several key issues to be resolved such as improvement of transmission and distribution systems and future expansion of the Karnaphuli water treatment plant to meet future demand. In order to address these key issues, the Bangladesh and Japanese sides agreed to conduct the Preparatory Survey on the "Chittagong Water Supply Improvement Project（hereinafter referred to as the "Phase 2 Project").

JICA dispatched a mission to Bangladesh from January 14 to January 24, 2012 to develop the scope and implementation arrangements of the Preparatory Survey. After a series of discussions, the Japanese mission and the Bangladesh side (Economic Relations Division: ERD Ministry of Finance, Local Government Division: LGD Ministry of Local Government, Rural Development and Co-operatives, and CWASA) agreed on the scope and implementation arrangements of the Preparatory Survey as shown in the Minutes of Meeting on the Preparatory Survey on the Chittagong Water Supply Improvement Project dated January 22, 2012 (Supporting Report 1.1).

The Preparatory Survey on the Phase 2 Project commenced in May 2012 and the first field work by the Survey Team in Bangladesh was completed in July 20, 2012. Then, the second field work was conducted from August 27, 2012 to October 15, 2012. Final Report was completed in the middle of December with comments from Bangladesh side after the third field work conducted from November 9 to November 20, 2012. The major items covered by the report are as follows;

- Planning framework for the Phase 2 Project
- Selection of the Karnaphuli service area
- Outline design of distribution system,

- Preliminary facility plan,
- O&M Plan of facilities
- Construction plan of Phase 2 facilities
- Environmental and social considerations
- Implementation plan and cost estimates
- Financial analysis

Supporting report 1.2 presents M/Ms on the Preparatory Survey of the Chittagong Water Supply Improvement Project agreed upon between the Government of the Peoples ‘Republic of Bangladesh and Preparatory Survey Team at the four times of Steering Committee Meetings.

1.2 Objectives of the Preparatory Survey

The main objective of the Preparatory Survey is to provide information necessary for the evaluation of the feasibility of the proposed Phase 2 Project as a Japanese ODA loan project. Such information includes the outline of the project, project cost estimates, economic and financial viability of the project, project implementation schedule, manner of procurement and construction, organization for project implementation, operation and maintenance (O&M) arrangements, social and environmental considerations.

1.3 Survey Area and Design Year

The Preparatory Survey covers the jurisdiction area of Chittagong City Corporation (hereinafter referred to as “CCC”), as shown in the Location Map, as well as the surrounding area with regard to planning of the intake, water treatment plant, conveyance and transmission pipelines. The target year for the Project is set as the year 2030.

1.4 Scope of Work for the Preparatory Survey

The scope of the work for the Preparatory Survey is enumerated below.

(1) Basic Study

1) Collection and analysis of existing data and information on water supply sector in Bangladesh (including national Policy and Plan, etc.)
2) Collection and analysis of present conditions of the Survey Area through existing data, information and field survey;
    a) Natural Conditions (meteorology, hydrology, hydro-geology, etc.)
    b) Socio-economic conditions and trends (population, industries, land use, social infrastructure, economic conditions, etc.)
    c) Environmental conditions (environmental laws and regulations, public health, etc.)
3) Collection and analysis of present conditions of water supply in the Survey Area through existing data and field survey;
    a) Water demand and supply,
    b) Field survey,
        -Existing water supply facilities
        -Current conditions of non-revenue water
        -Water sources
    c) Water right and water quality,
    d) Willingness to pay and affordability for water supply service,
    e) On-going studies, plans and projects related to the Preparatory Survey (Karnaphuli Water Supply Project, Institutional Development Consultancy Service of CWASA, etc.), and

f) Evaluation of present water supply conditions and identification of problems

(2) Chittagong Water Supply Improvement Project (Phase 2 Project)

1) Planning of the Project

a) Review of existing surveys (population/demand projection)
b) Identification of priority supply area from Karnaphuli water treatment plant
c) Identification of Karnaphuli Service Area
d) Planning of Intake, raw water supply pipe and water treatment plant
e) Planning of transmission mains
f) Planning of primary distribution mains (zoning/ sectorization)
g) Planning of secondary and tertiary distribution mains (District Meter Area)

Note: Definitions of primary, secondary and tertiary distribution mains are referred to Chapter 6 Distribution System (page 6-17)

(3) Preliminary design of the Project

1) Topographic and route survey, geotechnical survey, and river cross-section survey, if necessary
2) Project scope and preliminary design of the facilities (intake, water treatment plant, transmission pipelines, service reservoirs, distribution network)
3) Development of operation and maintenance plan related to the facilities to be constructed under the Project
4) Preliminary cost estimation
5) Comparison of the estimated project cost with other similar projects, to verify the appropriateness of the project cost
6) Project implementation schedule and confirmation of necessary procedures for the approval of the project implementation (Environmental Impact Assessment (EIA), Development Project Proposal (DPP), land acquisition, etc.)
7) Procurement plan, method and contract packages of the Project
8) Financing plan of the Project
9) Economic and Financial analysis of the Project
10) Consideration of pro-poor components
11) Environmental and Social Assessment (preparation of Initial Environmental Examination (IEE), EIA, Environmental Monitoring Plan (EMP) and Resettlement Action Plan (RAP)
12) Recommendation on Terms of Reference (TOR) for consulting services (detailed design, construction supervision, etc.)
13) Project evaluation for the project implementation;
    -Technical evaluation
    -Economic and financial evaluation
    -Environmental and social evaluation
    -Institutional evaluation
14) Selection of key operation and effect indicators, setting up baseline and target data
15) Preparation of the institutional set-up for the Project implementation
16) Conclusions and recommendations

CHAPTER 2

GENERAL DESCRIPTION OF THE CHITTAGONG CITY AREA

CHAPTER 2 GENERAL DESCRIPTION OF THE CHITTAGONG CITY AREA

2.1 Natural Conditions

2.1.1 Topography

Chittagong City located in the south-eastern part of Bangladesh and facing the Bay of Bengal, is bordered to the south and east by the Karnaphuli River, the largest river in the south-eastern area of Bangladesh. The Karnaphuli Hydro Power Station is located about 50 km from Chittagong, along the Karnaphuli River.

The centre of the city is located near the river mouth utilized as a port. In the northwest, there are hilly areas with level from 60 m to 90 m. To the east of the hilly areas, flat plain is widely distributed and this is bordered by the Karnaphuli River.

2.1.2 Meteorology

Metrological observation in Bangladesh is conducted under the jurisdiction of the Bangladesh Meteorological Department. There is one meteorological observation station in Chittagong, R-306.

Chittagong City is located in the tropical zone. It is characterized by high temperature and heavy rainfall with often excessive humidity. There are three distinct seasons. The hot season lasts from March to May including some wet days. The monsoon season begins in June and usually continues until September, generally starting and ending with cyclones. Between November and February is the cold and dry season.

(1) Rainfall

Annual rainfall in Chittagong in each month in the years from 2002 to 2011 is shown in Table 2.1.1. During this period the annual average rainfall was 2,074 mm, with more than between 67% and 83% of the annual rainfall in each year occurring during the monsoon period between the months of June and September.

Table 2.1.1 Rainfall in Chittagong

Unit: mm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
2002	1	0	70	67	453	366	920	456	145	129	128	10	2745
2003	0	0	53	167	198	1209	372	260	210	234	0	66	2769
2004	0	0	5	145	250	593	902	170	548	206	0	0	2819
2005	0	0	67	158	242	259	129	381	406	101	0	1	1744
2006	0	0	0	0	598	244	637	268	438	-	0	0	2185
2007													0
2008	63	30	6	4	244	707	859	759	255	175	0	0	3102
2009	0	0	45	74	400	445	1414	277	300	17	-	0	2972
2010	0	9	50	50	282	916	245	392	86	301	52	22	2405
2011													
Average	6.4	3.9	29.6	66.5	266.7	473.9	547.8	296.3	238.8	116.3	18	9.9	2074.1

Source: Bangladesh Meteorological Department and previous reports

In the monsoon season (June to September) during the period from 1980 to 2010, total rainfall ranged from a low of 1,515 mm in 1980 to 3,224 mm in 1987 with an average of 2,578 mm. The total average rainfall in the monsoon season in each of the 10 year periods from 1980 to 1989, 1990 to 1999 and 2,000 to 2009 was 2,490 mm, 2,542 mm and 2,731 mm, respectively.

(2) Temperature

Figure 2.1.1 shows the average maximum and minimum and absolute maximum and minimum temperatures in each month.

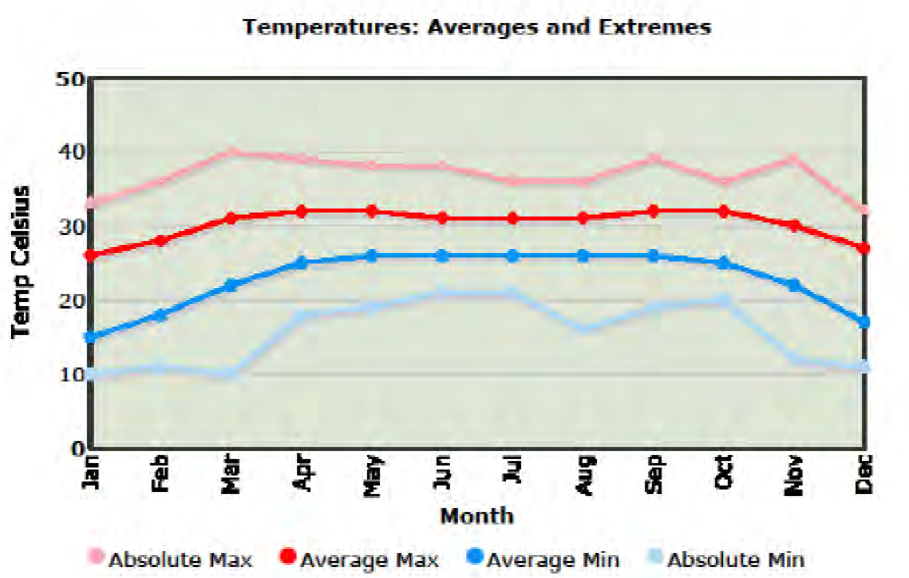


Figure 2.1.1 Monthly Temperatures in Chittagong – Averages and Extremes

The monthly average maximum and minimum temperatures in each month in the years from 2008 to 2010 are shown in Table 2.1.2.

Table 2.1.2 Temperature in Chittagong (2008 to 2010)

Unit: °C

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	Max	25.1	26.0	29.9	32.2	32.2	30.7	29.8	30.1	30.9	30.7	29.7	26.7
	Min	15.2	15.7	21.9	24.2	25.1	24.7	25.2	25.4	25.3	24.0	19.6	17.7
2009	Max	25.6	29.0	31.7	32.0	32.5	32.1	30.2	30.6	31.8	31.2	29.9	31.2
	Min	14.9	16.9	21.6	25.3	25.0	25.6	25.5	25.8	25.4	24.0	21.1	15.9
2010	Max	26.5	29.0	31.6	32.0	32.5	32.0	30.1	30.6	31.4	31.2	29.9	26.2
	Min	14.9	16.8	21.5	25.3	24.9	25.5	25.4	25.7	25.4	24.0	21.0	15.8
Average	**Max**	25.7	28.0	31.1	32.1	32.4	31.6	30.0	30.4	31.4	31.0	29.8	28.0
	Min	15.0	16.5	21.7	24.9	25.0	25.3	25.4	25.6	25.4	24.0	20.6	16.5

Source: Bangladesh Meteorological Department

(3) Relative Humidity

The monthly average relative humidity in each month in the years from 2008 to 2010 is shown in Table 2.1.3. The maximum humidity occurred during the monsoon season.

Table 2.1.3 Relative Humidity in Chittagong (2008 to 2010)

Unit: %

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	76	65	78	68	74	82	87	87	82	79	74	79
2009	74	65	69	76	75	80	85	78	82	78	72	74
2010	70	59	59	76	78	86	82	84	82	83	78	74
Average	73	63	69	73	76	83	85	83	82	80	75	76

Source: Bangladesh Meteorological Department

2.1.3 Hydrology

The Karnaphuli River originates from the eastern hilly areas and empties into the Bengal Bay passing the east-south rim of Chittagong City. The river, which is one of the main rivers in the south-east of Bangladesh, has a total length of about 58 km in main channel, originating from Kaptai Lake. The Halda River is one of the Karnaphuli River's tributaries and the confluence point between the Halda River and the Karnaphuli River is located about 17 km from the Karnaphuli River mouth. This river has a total length of about 98 km and runs from the hilly area near the national border between Bangladesh and India to north of Chittagong City. Kaptai Lake which has an area of 680 km^2 is located about 50 km north-east of Chittagong City and is the largest lake in the country. The lake was formed with the construction of the Kaptai Hydropower Dam in 1958, which discharges water to the Karnaphuli River.

Figure 2.1.2 shows the Karnaphuli river basin, including the Halda River and Kaptai Lake. Table 2.1.4 shows the number of days per year when the discharge from Kaptai Dam was low. In May 1995 the discharge from the dam was very low. In recent years there have been several months when the average discharge in the month or part of a month was low, for example in January 2007, December 2008, January 2009, April 2010 and May 2011 (all as shown in the table) and in April 2011, when the average discharge was 3.9 million m^3/d in a 20 day period.

Table 2.1.4 Number of Days per Year with Low Discharge

Year	Number of Days less than 5 million m^3/d	Number of Days less than 10 m^3/s (0.864 million m^3/d)	Notes
1991	1		
1992	1		
1993	3		
1994	18		
1995	32		
1996	2		
1997	10	5	
1998	4	0	
1999	3	0	
2000	N/A	0	
2001	N/A	0	
2002	N/A	1	
2003	N/A	0	
2004	N/A	0	
2005	N/A	0	
2006	N/A	0	
2007	N/A	2	average in month with lowest total 2.33 million m^3/d (January)
2008	N/A		average in month with lowest total 3.35 million m^3/d (December)
2009	N/A		average in month with lowest total 3.05 million m^3/d (January)
2010	N/A		average in month with lowest total 9.42 million m^3/d (April)
2011	6		all days occurred in May 2011, when average in month was 15.3 million m3/d and average in 13 day period when discharge at lowest was 4.9 million m^3/d

Notes: N/A Not available
Source: Kaptai Dam Management Office, except for number of days with discharge less than 10 m^3/s (information from KOICA Master Plan for Water Supply)

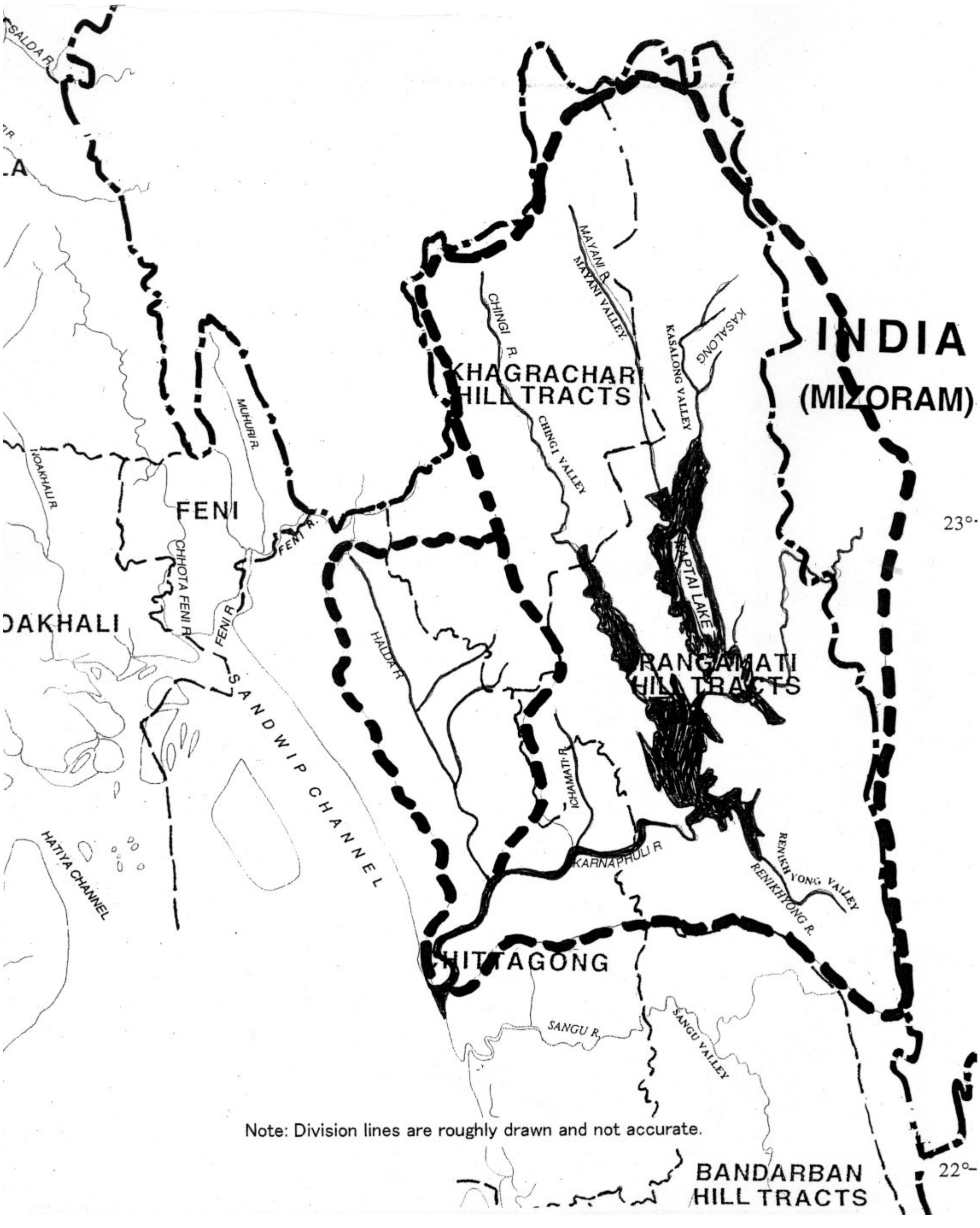


Figure 2.1.2 General Map of Karnaphuli River Basin

2.1.4 Geology

The hill formations in Chittagong comprise alternating layers of mudstones and sand formations in the Tertiary age. The thickness of both mudstones and sand formations is about 30 m, although it varies in places. The formations have an anticline structure extending from NNW to SSE with a steeper dip in the eastern wing along the eastern boundary between the hilly area and the alluvial area.

The alluvium plain consists of alternating layers of soft clay and sand. Based on the existing deep wells which are owned by CWASA, alluvial sediments have a thickness of more than 130 m.

2.2 Legislative Condition

2.2.1 Key Sector Issue

The water supply in the Bangladesh is not adequate at present in terms of quality, quantity and levels of service. The Government of the Republic of Bangladesh decided to improve water supply using surface water and reduce the use of groundwater, due to arsenic contamination and lowering of groundwater level.

The GOB established "The Sixth National Five-Year Development Plan (2011-2015)" with a special emphasis on providing a safe water supply to all people in an early stage. In the plan, the targets of service coverage for the urban and rural population in the year 2015 are established at 100% and 96.5%, respectively.

(1) National Sector Policies and Strategies

The government has adopted the following policies, which are relevant to the water supply sector:

- National Policy for Safe Water Supply and Sanitation (1998)
- National Water Policy (NWP) (1999)
- National Water Management Plan (NWMP) (2004)
- Sector Development Plan (SDP) (2011-2015)
- Partnership Framework among the Government of Bangladesh and Aisan Development Bank (ADB), DANIDA, the Government of Japan (GOJ), the Government of the Republic of Korea (ROK), and World Bank (WD)
- National Policy for Arsenic Mitigation (2004)

<u>National Policy for Safe Water Supply and Sanitation (1998)</u>

The NPSWSS states "the Government's goal is to ensure that all people have access to safe water and sanitation services at an affordable cost. The objectives of the NPSWSS are to improve the standard of public health and to ensure improved environment. For achieving these objectives, steps will be taken for:

1) facilitating access of all citizens to basic level of services in water supply and sanitation;
2) bringing about behavioural changes regarding use of water and sanitation;
3) reducing incidence of water borne diseases;
4) building capacity in local governments and communities to be effectively with problems relating to water supply and sanitation;
5) promoting sustainable water and sanitation services;
6) ensuring proper storage, management and use of surface water and preventing its contamina-

tion;

7) taking necessary measures for storage and use of rain water;
8) ensuring storm-water drainage in urban areas.

In relation to the institutional roles of WASAs outlined in the policy, the policy states:

a) Water Supply, Sewerage Authorities (WASAs) shall be responsible for sustainable water supply in the metropolitan areas where WASAs exist. In other urban areas the Paurasabhas (City Corporation) with the help of Department of Public Health Engineering (DPHE) shall be responsible for the service.
b) WASAs and the Paurasabhas shall be empowered to set tariffs, bylaws, appointment of staffs, etc. according to their needs and in accordance with the guideline laid down by the government.
c) WASAs and the Paurasabhas shall improve their operational efficiency including financial management. In the near future billing and collection targets will be 90% and 80%, respectively. Paurasabhas and WASAs will take actions to present the wastage of water. In addition they will take necessary steps to increase public awareness to prevent misuse of water. Paurasabhas will take appropriate measures to reduce unaccounted for water from 50% to 30%. Dhaka WASA and Chittagong WASA will also lower their unaccounted for water from the present level.

<u>National Water Policy (1999)</u>

The NWP aims to provide direction to all agencies working with the water sector, and institutions that relate to the water sector in one form or another for achievement of specified objectives, which are broadly:

1) To address issues related to the harnessing and development of all forms of surface water and ground water and management of these resources in an efficient and equitable manner
2) To ensure the availability of water to all elements of the society including the poor and the underprivileged, and to take into account the particular needs of women and children
3) To accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing
4) To bring institutional changes that will help decentralise the management of water resources and enhance the role of women in water management
5) To develop a legal and regulatory environment that will help the process of decentralisation, sound environmental management, and improve the investment climate for the private sector in water development and management
6) To develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement of the water management objectives through broad public participation.

According to Clause 4.3 of the NWP "in general, the priority for allocating water during critical periods in the water shortage zones will be in the following order: domestic and municipal uses, non-consumptive uses (e.g. navigation, fisheries and wild-life), sustenance of the river regime, and other consumptive and non-consumptive uses such as irrigation, industry, environment, salinity management, and recreation. The above order of priority could however be changed on specific socio-economic criteria of an area by local bodies through local consensus."

For economic and financial management, it is stated in Clause 4.14 of the NWP as an important principle, for the long-term, that public service agencies should be converted into financially autonomous entities, with effective authority to charge and collect fees.

National Water Management Plan (2004)

The NWMP was approved by the National Water Resources Council (NWRC) in 2004 and aims at implementing the NWMP within 25 years. It is expected to be reviewed and updated every five years.

In 2005, the government included the improvement of water supply and sanitation as part of its agenda for reducing poverty. As of today, there is no information on the updating of the plan.

Sector Development Plan (2011-2025) - Water Supply and Sanitation in Bangladesh

The first SDP-WSSB was prepared by LGD in 2000 to provide a 10-year plan for water supply and sanitation (WSS) sector in Bangladesh. Afterwards, the next SDP for a period of 15 years from 2011 was prepared by the Policy Support Unit of LGD. The objective of the SDP is to provide a framework for planning, implementing, coordinating and monitoring all activities in the WSS sector. As a strategic planning document, it addresses the emerging and the future challenging of the WSS sector and provides a road map for the development of the sector and corresponding sector investment plan.

Partnership Framework among the Government of Bangaldesh (GOB), and Asian Development Bank (ADB), DANIDA, the Government of Japan (GOJ), the Government of the Republic of Korea (ROK), and World Bank (WB)

GOB and major development partners signed a Partnership Framework for a coordinated approach to the existing and planned development partners' support to CWASA and for agreement with GOB on common policy issues. A policy action matrix is included in the framework, focused on, (i) strengthening CWASA's governance and organizational structure, (ii) improved financial management capacity of CWASA, and (iii) improved sustainable service delivery.

National Policy for Arsenic Mitigation (2004)

Complementing the NWP, the government adopted a National Policy for Arsenic Mitigation in 2004. The policy emphasizes public awareness, alternative safe water supply, proper diagnosis and management of patients, and capacity building. In terms of alternative supplies it gives "preference to surface water over groundwater".

In addition to the above, the draft Bangladesh Water Act 2012, which was approved by the cabinet in May 2012, is expected to be placed in parliament in the near future, as of November 2012. According to an article in The Star[1] there are concerns that the Act may limit people's basic right to safe water (under the provision of Clause 16 (2) and there are provisions that may encourage businesses to invest in the distribution of water in rural areas).

(2) Legislative Requirement

Access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection.

The national environmental legislation known as the Environmental Conservation Act, 1995, which is currently the main legislative document relating to environmental protection in Bangladesh and

[1] The Star, June 1, 2012 "Limiting the Right to Water"

was promulgated in 1995. In the Environment Conservation Rules, 1997, which are rules for the purposes of carrying out the above Act, standards for inland surface water and drinking are stipulated in Schedule 3, as shown in Tables 2.2.1 and 2.2.2.

Table 2.2.1 Standard for Inland Surface Water

Best Practice based classification	pH	BOD mg/L	DO mg/L	Total Coliform number/100
a. Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activity	6.5–8.5	3 or less	5 or more	200 or less
c. Source of drinking water for supply after conventional treatment	6.5–8.5	6 or less	6 or more	5000 or less
d. Water usable by fisheries	6.5–8.5	6 or less	5 or more	---
e. Water usable by various process and cooling industries	6.5–8.5	10 or less	5 or more	5000 or less
f. Water usable for irrigation	6.5–8.5	10 or less	5 or more	1000 or less

Notes: 1. In water used for pisiculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.
2. Electrical conductivity for irrigation water - 2250 μS/cm (at 25°C); Sodium less than 26%; boron less than 0.2%.
Source: Environment Conservation Rules, 1997

Table 2.2.2 Standard for Drinking Water

Parameter	Unit	Standards	Parameter	Unit	Standards
1. Aluminum	mg/L	0.2	26. Hardness (as $CaCO_3$)	mg/L	200 – 500
2. Ammonia (NH_3)	mg/L	0.5	27. Iron	mg/L	0.3 – 1.0
3. Arsenic	mg/L	0.05	28. Kjeldhl Nitrogen (total)	mg/L	1
4. Balium	mg/L	0.01	29. Lead	mg/L	0.05
5. Benzene	mg/L	0.01	30. Magnesium	mg/L	30 – 35
6. BOD_5 20°C	mg/L	0.2	31. Manganese	mg/L	0.1
7. Boron	mg/L	1.0	32. Mercury	mg/L	0.001
8. Cadmium	mg/L	0.005	31. Manganese	mg/L	0.1
9. Calcium	mg/L	75	32. Mercury	mg/L	0.001
10. Chloride	mg/L	150 – 600*	33. Nickel	mg/L	0.1
11. Chlorinated alkanes			34. Nitrate	mg/L	10
carbontetrachloride	mg/L	0.01	35. Nitrite	mg/L	<1
1.1 dichloroethylene	mg/L	0.001	36. Odor	mg/L	Odorless
1.2 dichloroethylene	mg/L	0.03	37. Oil and grease	mg/L	0.01
tetrachloroethylene	mg/L	0.03	38. pH	--	6.5 – 8.5
trichloroethylene	mg/L	0.09	39. Phenolic compounds	mg/L	0.002
12. Chlorinated phenols			40. Phosphate		6
pentachlorophenol	mg/L	0.03	41. Phosphorus	mg/L	0
2.4.6 trichlorophenol	mg/L	0.03	42. Potassium	mg/L	12
13. Chlorine (residual)	mg/L	0.2	43. Radioactive materials (gross alpha activity)	Bq/L	0.01
14. Chloroform	mg/L	0.09	44. Radioactive materials (gross beta activity)	Bq/L	0.1
15.Chromium (hexavalent)	mg/L	0.05	45. Selenium	mg/L	0.01
16. Chromium (total)	mg/L	0.05	46. Silver	mg/L	0.02
17. COD	mg/L	4.0	47. Sodium	mg/L	200
18. Coliform (faecal)	n/100mL	0	48. Suspended particulate matters	mg/L	10
19. Coliform (total)	n/100 mL	0	49. Sulfide	mg/L	0
20. Color	Hazen unit	15	50. Sulfate	mg/L	400
21. Copper	mg/L	1	51. Total dissolved solids	mg/L	1000
22. Cyanide	mg/L	0.1	52. Temperature	°C	20-30
23. Detergents	mg/L	0.2	53. Tin	mg/L	2
24. DO	mg/L	6	54. Turbidity	JTU	10
25. Fluoride	mg/L	1	55. Zinc	mg/L	5

Source: Environment Conservation Rules, 1997

(3) Environmental Requirement

In Bangladesh, the following Policy, Acts and Rules cover and facilitate all the activities regarding environment conservation mainly.

1) Environmental Policy, 1992
2) The Bangladesh Environment Conservation Act, 1995
3) Environment Conservation Rules, 1997

2.2.2 Water Resource for Water Supply System

The management of water resources has become a critical need in Bangladesh because of the growing demand for water and increasing conflict over its alternative uses. In Bangladesh water had been considered as a free gift of nature and access to water is recognised as a basic right. However procedural and fiscal measures are enforced to regulate its mobilisation and use. The Government of Bangladesh has formulated a National Water Policy. In accordance with Clause 4.3 of the NWP, "the ownership of water does not vest in an individual but in the State."

Furthermore "The Government reserves the right to allocate water to ensure equitable distribution, efficient development and use, and to address poverty. The Government can redirect its use during periods of droughts, floods, cyclones, and other natural and man-made disasters, such as contamination of groundwater aquifers that threaten public health and the ecological integrity. Allocation rules will be the formal mechanism for deciding who gets water, for what purpose(s), how much, at what time, for how long, and under what circumstances water use may be curtailed. Rules for water allocation will be developed for in-stream needs (ecological, water quality, salinity control, fisheries and navigation) during low flow periods; for off-stream withdrawal (irrigation, municipal and industrial, power), and for groundwater recharge and abstraction. Allocation for non-consumptive use (e.g. navigation) would imply ensuring minimum levels in water bodies used for that purpose."

2.2.3 Environmental and Social Considerations

(1) Statute Framework on Environment and Social Aspects

1) Relevant Policy, Strategy and Action Plan

Table 2.2.3 summarize relevant statutes including policy, Strategy and Action Plan on environmental and social aspects in Bangladesh.

Table 2.2.3 Relevant Policy, Strategy and Action Plan

Title	Year	Outline
National Environmental Policy (NEP)	1992	NEP was drawn up in1992 based on the IUCN concept of sustainable development, which was an outcome of the National Conservation Strategy. The objectives of NEP are to: ・ Maintain ecological balance and overall development through protection and improvement of the environment ・ Protect the country against natural disasters ・ Identify and regulate activities which pollute and degrade the environment ・ Ensure development that is environmentally sound for all sectors ・ Ensure sustainable, long-term, and environmentally sound use of all national resources ・ Actively remain associated with all international environmental initiatives to the maximum possible extent. For the water resources, the most relevant Policy clauses for FCD/I EAs are: ・ ensure environmentally sound utilization of all water resources. ・ ensure that water development activities and irrigation networks do not create adverse environmental impact.

Title	Year	Outline
		・ ensure that all steps taken for flood control be environmentally sound at the local, zonal and national levels. ・ ensure mitigation measures of adverse environmental impact of completed FCD/I projects ・ keep the rivers, canals, ponds, lakes, *haors*, and all other water bodies and water resources free from pollution. ・ ensure sustainable management of underground and surface water resources. ・ conduct EA before undertaking projects for water resources development and management. The Policy was supported by the 1992 NCS and following widespread and lengthy public consultations, by a recommended implementation strategy as part of the 1995 NEMAP.
National Forest Policy (NFP)	1994	NFP of 1994 is the amended and revised version of the NFP of 1977 in the light of the National Forestry Master Plan. The major target of the policy is to conserve the existing forest areas and bring about 20% of the country's land area under the forestation Program and increase the reserve forest land by 10% by the year 2015 through coordinated efforts of GO-Non Governmental Organisations (NGOs) and active participation of the people. Amendments of the existing laws (acts, rules and regulations) relating to the forestry sector and creation of new laws for sectoral activities have been recognized as important conditions for achieving the policy goals and objectives. The Forestry Policy also recognizes the importance of fulfilling the responsibilities and commitments under International Conventions, Treaties and Protocols.
National Water Policy (NWPo)	1999	NWPo of 1999 forms a comprehensive framework for ensuring activities in the water resources sector are fully environment friendly. Its many environmental concerns and specific demands recognize that most of the country's environmental resources are linked to water. Compliance with the Policy will ensure that the development and management of the nation's water resources include protection, restoration, preservation of natural habitats and their dependent bio-diversity, and water quality -with specific provisions for wetlands, mangrove and other forests, and endangered species. NWPo, also prescribes water resource management practices that avoid, or at least minimize environmental degradation. Specific provisions include; ・ Protection, restoration and enhancement of the water resources ・ Protection of water quality, including strengthening of the regulations concerning agrochemicals ・ and industrial effluent monitoring ・ Facilitation of potable water and sanitation provision ・ Provisions for fish and fisheries ・ Participation of local communities is a requirement for all water sector development as a subject to an environmental assessment procedure and for the planning and management process. NWPo, however, fails to address issues like consequences of trans-boundary water disputes and watershed management.
National Fisheries Policy	1999	National Fisheries Policy 1999, highlights the need to conserve fish breeding grounds and habitats, especially in the development of water management infrastructure such as FCD/I projects. It clearly points to a determination to prevent further drainage of standing water bodies for agricultural development, and to promote fisheries development in all water bodies. Beyond conservation, the policy emphasizes the need to expand fisheries areas and integrate rice, fish and shrimp cultivation. The policy proposes banning discharges of industrial waste, agro-chemicals and fish-farm chemicals into water bodies. Measures should be introduced to support shrimp culture, with co-ordination through national, divisional, district and than a level committees. Shrimp and fish culture should not be expanded into areas which damage coastal mangrove forests. Implicit in the Policy is the need to conserve fish migration routes which, in turn, implies the need to assess off-site impacts of interventions in the water resources sector.
National Policy for Safe Water Supply & Sanitation	1998	The objectives of the "National Policy for Safe Water Supply and Sanitation" are to improve the standard of public health and to ensure improved environment. For achieving these objectives, steps will be taken for: ・ Facilitating access of all citizens to basic level of services in water supply and sanitation ・ Bringing about behavioral changes regarding use of water and sanitation ・ Reducing incidence of water borne diseases ・ building capacity in local Governments and communities to deal more effectively with problems relating to water supply and sanitation ・ promoting sustainable water and sanitation services ・ ensuring proper storage, management and use of surface water and preventing its contamination ・ taking necessary measures for storage and use of rain water ・ ensuring storm-water drainage in urban areas
National Conservation Strategy (NCS)	1993	Bangladesh's endorsement of the World Conservation Strategy in 1980 was followed by its initiatives for developing a National Conservation Strategy. IUCN Bangladesh Country Office had been an active party to the process all through, which culminated in the preparation and subsequent submission of a draft NCS document with the Cabinet of in 1993. After about one decade of the submis-

Title	Year	Outline
		sion, the IUCN office successfully updated the Draft NCS document and forwarded to the Government for review and approval of the draft. The draft was approved in1993 and it is now to be presented in the National Level Workshop. The Final NCS Document will be modified in the light of feedback and comments to be received from the participants in the workshop.
National Environmental Management Action Plan (NEMAP)	1995	NEMAP, 1995, based on a nationwide consultation programme, was intended to develop the Environmental Policy and the National Conservation Strategy into an implementable strategy. NEMAP has the broad objectives of: ・ Identification of key environmental issues affecting Bangladesh; ・ Identification of actions necessary to halt or reduce the rate of environmental degradation; ・ Improvement of the natural and built environment; ・ Conservation of habitats and biodiversity; ・ Promotion of sustainable development; and ・ Improvement in the quality of life of the people. In addition, it identified the main national environmental issues, including those related to the water sector which EA (Environmental Assessment) practitioners should note. The main national concerns included flood damage, riverbank erosion, environmental degradation of water bodies, increased water pollution, shortage of irrigation water and drainage congestion; various specific regional concerns were also identified. A surprising omission, however, was specific mention of fisheries issues, but these may have been perceived as 'fish' rather than a 'water resources' concern. Arsenic contamination of groundwater used for potable water supply did not appear as an issue, as the threat had not then been identified.
Flood Action Plan (FAP)	1990	FAP an initiative to study the causes and nature of flood in Bangladesh and to prepare guidelines for controlling it. FAP included 29 different components of which 11 were regional, with some pilot projects, and the rest were supporting studies on issues like Environment, Fisheries, Geographic Information System, Socio-economic studies, Topographic Mapping, River Survey, Flood Modeling, Flood Proofing, Flood Response, etc. The aim of FAP is to set the foundation of a long-term programme for achieving a permanent and comprehensive solution to the flood problem.

Note: IUCN; International Union for Conservation of Nature and Natural Resources, FCD/I; Flood Control Drainage and Irrigation, EA; Environmental Assessment, NEMAP; National Environmental Management Action Plan, NCS; National Conservation Strategy

Source: JICA Study Team

2) Relevant Acts, Ordinance Rules

Table 2.2.4 summarizes relevant Acts, Ordinances and Rules on environmental and social aspects in Bangladesh.

Table 2.2.4 Relevant Act, Ordinance Rules

Title	Year	Outline
Bangladesh Forest Act	1927	The Act of 1927 provides for reserving forests over which the government has an acquired property right. This act has made many types of unauthorized uses or destruction of forest produce punishable. The Government may assign any village community its right to or over any land, which has constituted a reserved forest.
The Private Forest Ordinance	1959	The Private Forest Ordinance of 1959 provides for the conservation of private forests and for the forestation, in certain cases, of wastelands in Bangladesh.
East Bengal Protection and Fish Conservation Act	1950	The East-Bengal Protection and Fish Conservation Act of 1950, as amended by the Protection and Conservation of Fish (Amendment) Ordinance of 1982 and the Protection and Conservation of Fish (Amendment) Act of 1995, provides provisions for the protection and conservation of fish in inland waters of Bangladesh. This is relatively unspecific and simply provides a means by which the Government may introduce rules to protect those inland waters not in private ownership. This is framework legislation with rule making powers. Among others, some of these rules may: Prohibit the destruction of, or any attempt to destroy, fish by the poisoning of water or the depletion of fisheries by pollution, by trade effluent or otherwise.
The Embankment and Drainage Act	1952	An Act to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water
Antiquities Act	1968	Antiquity act (ACT No. XIV of 1968) was set by the Government in 1968 to the preservation and protection of antiquities in the country
Bangladesh Wild-	1973	The Bangladesh Wildlife (Preservation) Act of 1973 provides for the preservation, conservation and

Title	Year	Outline
life Act		management of wildlife in Bangladesh. The earlier laws on wildlife preservation, namely, the Elephant Preservation Act 1879, the Wild Bird and Animals Protection Act 1912, and the Rhinoceros Preservation Act 1932 have been repealed and their provisions have been suitably incorporated in this law. This Act encompasses a range of different activities including hunting and fishing although the provisions of greatest significance relate to the establishment of National Parks, Wildlife Sanctuaries and Game Reserves by MoEF. Such designations have enormous significance for the types of developments that may take place. An executive order issued in June 1998, in relation to the Bangladesh Wildlife Preservation Order of 1973 has imposed a ban for the next five years on hunting of any form of wildlife.
Protection and Conservation of Fish Rules	1985	These are a set of rules in line with the overall objectives of the Fish Act. Section 5 of the Rules requires that "No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters". Section 6 of the Rules states -"No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters".
Environmental Conservation Act (ECA 1995) Amended in 2000 & 2002 as well as by a gazette notification in 2009	1995	ECA 1995, the principal legislation for environment protection in Bangladesh, is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. A key provision in the Act is that No industrial unit or project shall be established or undertaken without obtaining an ECC from the DG of DoE in the manner prescribed by the Environmental Rules The main strategies of the Act can be summarized as: ・ Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas ・ Regulations in respect of vehicles emitting smoke harmful for the environment ・ Environmental clearance ・ Regulation of the industries and other development activities' discharge permits ・ Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes ・ Promulgation of a standard limit for discharging and emitting waste; and ・ Formulation and declaration of environmental guidelines. The following shows amendments of the Act ・ The amendment in 2000 of ECA focuses on: (1) ascertaining responsibility for Compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences. ・ The amendment in 2002 of ECA elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale and production of environmentally harmful items like polythene bags, (3) assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases. ・ The amendment in 2010 In addition, through a gazette notification date September 1, 2009, the High Court declared the 4 rivers surrounding Dhaka, namely Buriganga, Turag, Balu and Shitolakhkhya, as Ecologically Critical Areas, citing the ECA 1995, Section 5 (Declaration of ecologically critical area). Subsequently pollution creating activities that are detrimental to the water and aquatic life in those rivers has been declared forbidden.
Environmental Conservation Rules	1997	Promulgated under ECA of 1995, the Environment Conservation Rules of 1997 provides categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects. The rules set ; 1) National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc. 2) Requirements for and procedures to obtain environmental clearance 3) Requirements for IEE /EIA's according to categories of industrial and other development interventions
Urban open-fields, Garden and Natural Water-bodies Protection Act	2000	Those sites throughout urban areas should preserve their individual characters and should not be leased out or transferred to any other authority. Any encroachment to these areas will be strictly controlled.
Environmental Court Act	2000	By this act the Government shall establish one or more environment court in each Division and each environment court shall be constituted with one judge and, in consultation with the Supreme Court; the Government shall appoint an officer of the judicial service of the rank of Joint District Judge. An Environment Court shall be competent to impose penalty for offences under section 5A of this Act and under any other environmental law, to confiscate an equipment or part thereof, a transport used in the commission of such offence or an article or other thing involved with the offence, and to pass order or decree for compensation in appropriate cases.

Note: MoEF; Ministry of Environment and Forest

3) Multilateral Environmental Agreements in force in Bangladesh

Relevant international treaties, conventions and so on to which Bangladesh is a party are summarized in Table 2.2.5.

Table 2.2.5 International Conventions, Protocols and Treaties on Environment

No.	Title	Signed	Ratified/Accessed/ Accepted/Adaptation	Being Ratified
1.	International Plant Protection Convention (Rome, 1951)		1978	
2.	International Convention for the Prevention of Pollution of the Sea by Oil (London, 1954 (amended in 1962 and 1969.)		1981 (entry into force)	
3.	Plant Protection Agreement for the South East Asia and Pacific Region (as amended) (Rome, 1956)		1974 (AC) (entry into force)	
4.	Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water (Moscow, 1963)	1985		
5.	Treaty on Principles governing the Activities of States in the Exploration and use of outer Space Including the Moon and Other Celestial Bodies (London, Moscow, Washington, 1967)		1986 (AC)	
6.	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Brussels, 1969)		1982 (entry into force)	
7.	Convention on Wetlands of International Importance especially as Water-fowl Habitat (Ramsar, 1971) ("Ramsar Convention")		1992 (ratified)	
8.	Convention on the Prohibition of the Development, Production and Stock-piling of Bacteriological (Biological) and Toxic Weapons, and on their Destruction (London, Moscow, Washington, 1972.)		1985	
9.	Convention Concerning the Protection of the World Cultural and natural Heritage (Paris, 1972)		1983 (Accepted), (ratified)	
10.	Convention on International Trade in Endangered Species of Wild Fauna and flora (Washington, 1973) ("CITES Convention")	1981	1982	
11.	United Nations Convention on the Law of the Sea (Montego Bay, 1982)		1982	
12.	Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985)		1990 (AC), (entry into force)	
13.	Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal 1987)		1990 (AC), (entry into force)	
13a.	London Amendment to the Montreal Protocol on substances that Deplete the Ozone Layer (London, 1990)		1994 (AC), (entry into force)	
13b.	Copenhagen Amendment to the Montreal protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992		2000 (AT), 2001 (Entry into force)	
13c.	Montreal Amendment of the Montreal Protocol on Substances that De-plete the Ozone Layer, Montreal, 1997		2001 (Accepted), (Entry into force)	
14.	Convention on Early Notification of a Nuclear Accident (Vienna, 1986)		1988(entry into force)	
15.	Convention on Assistance in Case of a Nuclear Accident of Radiological Emergency (Vienna, 1986)		1988(ratified &entry into force)	
16.	Agreement on the Network of Aquaculture Centres in Asia and the Pacific (Bangkok, 1988)		1990(ratified)	
17.	Basel Convention on the Control of Transboundary Movements of Haz-ardous Wastes and Their Disposal (Basel, 1989)		1993 (AC)	
18.	International Convention on Oil Pollution Preparedness, Response and Cooperation (London,1990)	1990		*
19.	United Nations Framework Convention on Climate Change, (New York, 1992)	1992	1994	
20.	Convention on Biological Diversity, (Rio De Janeiro,1992)	1992	1994	
21.	International Convention to Combat Desertification, (Paris 1994)	1994	1996(ratified &entry into force)	
22.	Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, (Geneva, 1976)		1979 (AC) (entry into force)	
23.	Agreement Relating to the Implementation of Part XI of the United Na-tions Convention on the Law of the Sea of 10 December 1982 (New York, 1994)	1996		

No.	Title	Signed	Ratified/Accessed/ Accepted/Adaptation	Being Ratified
24.	Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (New York, 1995)	1995		
25.	Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (Paris, 1993)	1993		
26.	United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (Paris, 1994)	1994	1996	
27.	Convention on Nuclear Safety (Vienna, 1994)	1995	1995 (AT)	
28.	Cartagena protocol on Biosafety to the Convention on Biological Diversity	2000	2004 (AC)	
29.	Convention on persistent Organic Pollutants, Stockholm	2001	2007 (AC)	
30.	Kyoto protocol to the United Nations Framework Convention on Climate Change		2001 (AC), 1997 (AD)	

*Note: AC: Accession/Accessed, AD: Adaptation/Adapted, AT: Accepted, *; In the process of ratification*
Source: DoE

(2) Environmental Conservation Rules 1997 and Environmental Clearance System

As specified in Clause 7 of the Environmental Conservation Rules 1997, all new industries and projects must apply for a Site Clearance Certificate (SCC) and/or an Environmental Clearance Certificate (ECC). For the purpose of the issuance of ECC, the industries and projects are classified according to their sites and potential impact on the environment into the four (4) categories as shown in Table 2.2.6. Details can be found in the Rules, especially, Schedule 1 attached in the Rules provides the Category classification of most common industries, in which "Water Distribution Line (Laying /Relaying/Extension) and "Water Treatment Plant" projects are classified as "Red" Category.

Table 2.2.6 Four Categories of Industries and Issuance of SCC and/or ECC

Category	Issuing of SCC and/or ECC	Time Period from receipt of application	
		SCC	ECC
1. Green	An ECC shall be issued to all existing and proposed industrial units and projects	-	~ 3 w. days
2. Amber-A	For industrial units and projects firstly a SCC and thereafter an ECC shall be issued	~ 15 w. days	~ 7 w. days
3. Amber -B	For industrial units and projects firstly a SCC and thereafter an ECC shall be issued	~ 30 w. days	~ 15 w. days
4. Red	For industrial units and projects firstly a SCC and thereafter an ECC shall be issued	~ 30 w. days	~ 30 w. days

Note: SCC; Site Clearance Certificate, ECC; Environmental Clearance Certificate, ~ ; within, w. days; wording days
Source; Environmental Conservation Rules 1997, MoEF, SRO No, 118-Law/2008, Environmental Conservation Law, 1995, 2008, MoEF,

Provided that the Director General (DG) of DoE may, without issuing a SCC at the first instance, directly issue ECC if he, on the application of an industrial unit or project, considers it appropriate to issue such certificate to the industrial unit or project.

1) Application for SCC and/or ECC

The entrepreneur of the concerned industrial unit or project shall apply to the concerned Divisional Officer of DoE using Form-3 of the ECR, along with appropriate fees as specified in Schedule-13. The necessary documents to be attached with an application for SCC and/or ECC by the each category are summarized in Table 2.2.7.

Table 2.2.7 Necessary Documents Applied for ECC by Category

Category	Necessary Documents
1. Green	i. General information about the industrial unit or project ii. Exact description of the raw materials and the manufactured product an iii. NOC from the local authority
2. Amber -A	i. General information about the industrial unit or project ii. Exact description of the raw materials and the manufactured product iii. NOC from the local authority iv. Process flow diagram v. Layout Plan (showing location of ETP) vi. Effluent discharge arrangement vii. Outlines of the plan for relocation, rehabilitation (if applicable); viii. Other necessary information (if applicable)
3. Amber- B	i. F/S report of the industrial unit or project (applicable only for proposed industrial unit or project) ii. (ii) IEE Report of the industrial unit or project, and also the process flow diagram, Layout Plan (showing location of Effluent Treatment Plant), design of ETP of the unit or project (these are applicable only for a proposed industrial unit or project) iii. EMP report for the industrial unit or project, and also the Process Flow Diagram, Layout Plan (showing location of Effluent Treatment Plant), design of ETP and information about the effectiveness of the ETP of the unit or project, (these are applicable only for an existing industrial unit or project) iv. NOC from the local authority; v. Emergency plan relating adverse environmental impact and plan for mitigation of the effect of pollution vi. Outline of the relocation, rehabilitation plan (where applicable) vii. Other necessary information (where applicable)
4. Red	i. F/S report of the industrial unit or project (applicable only for proposed industrial unit or project) ii. IEE report relating to the industrial unit or project, and also the TOR for the EIA of the unit or the project and its Process Flow Diagram or EIA report prepared on the basis of TOR previously approved by the Department of Environment, along with the Layout Plan (showing location of ETP), Process Flow Diagram, design and time schedule of the Effluent Treatment Plant of the unit or project, (these are applicable only for a proposed industrial unit or project) iii. EMP Report for the industrial unit or project, and also the Process Flow Diagram, Layout Plan (showing location of ETP), design and information about the effectiveness of ETP of the unit or project (these are applicable only for an existing industrial unit or project) iv. NOC from the local authority v. Emergency plan relating adverse environmental impact and plan for mitigation of the effect of pollution; vi. Outline of relocation, rehabilitation plan (where applicable) vii. Other necessary information (where applicable)

Note: NOC; No Objection Certificate, ETP; Effluent Treatment Plant, F/S; Feasibility Study, IEE; Initial Environmental Examination, TOR; Terms of Reference, EIA; Environmental Impact Assessment, EMP; Environmental Management Plan

Source: Environmental Conservation Rules 1997, MoEF

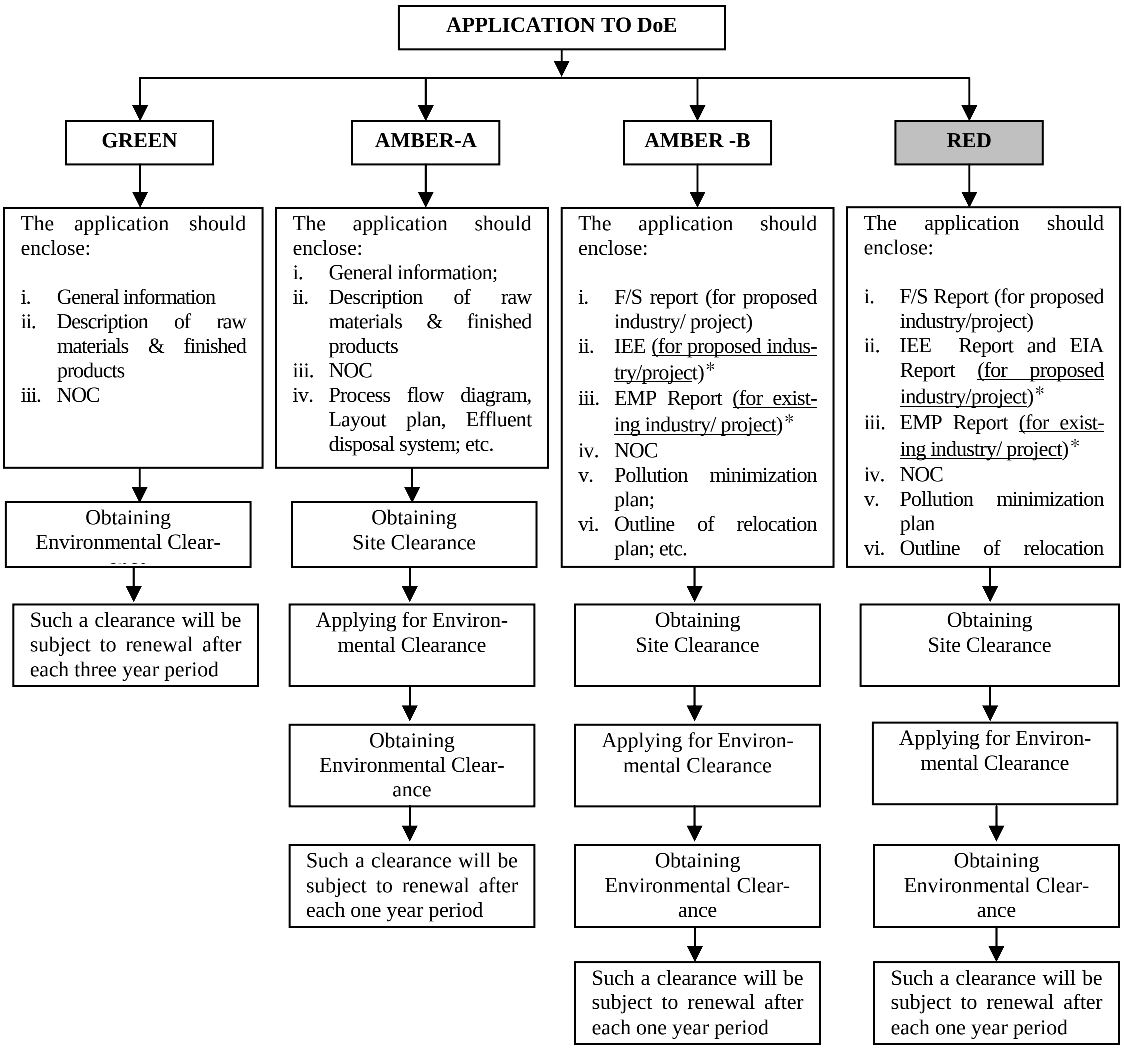
2) Actions may/shall be taken by Applicant after Issuing of SCC

Upon receiving a Site Clearance Certificate (SCC) from DoE, the entrepreneur (applicant):

a) may undertake activities for land and infrastructure developments
b) may install machinery including an Effluent Treatment Plant (ETP) (applicable for industrial units or projects of Amber-A and Amber-B Category only)
c) shall apply for an ECC upon completion of the activities specified in a. and b. above, and without the ECC shall not have gas line connection, and shall not start trial production in the industrial unit, and in other cases shall not operate the project (applicable for Amber-A and Amber-B Category industrial units or projects only)
d) shall submit, for approval of the Department, the EIA report prepared on the basis of program outlined in the IEE Report along with time schedule and the ETP design (applicable only for Red Category industrial units or projects)

3) Flow Chart of Environmental Clearance Procedure

Figure 2.2.1 shows the flow chart of the environmental clearance procedures for industrial projects.



NOC ; No Objection Certificate, usually obtained from local government, F/S; Feasibility Study, IEE; Initial Environmental Examination, TOR; Terms of Reference, EIA; Environmental Impact Assessment, EMP; Environmental Management Plan,
** ; See 3) Environmental Assessment Process in WARPO Guidelines*
Source; EIA Guidelines for Industry 1997, DoE, MoEF

Figure 2.2.1 Flowchart of Environmental Clearance Procedure

4) Validity period of ECC

Table 2.2.8 shows the period of validity of an ECC and its renewal period.

Table 2.2.8 Validity Period of ECC

Category	Validity period from ECC issuance Date	Renewal Period (days before expiry of its validity period)
1. Green	Three (3) years	at least thirty (30) days
2. Amber-A	One (1) year	at least thirty (30) days
3. Amber -B	One (1) year	at least thirty (30) days
4. Red	One (1) year	at least thirty (30) days

Source; Environmental Conservation Rules 1997, MoEF

(3) Environmental Assessment Procedures in Bangladesh

The Environmental Assessment (EA) system and its procedures are dealt with in the framework of the Environmental Clearance system mentioned in (2) above.

1) Guidelines

Relevant official entities including DoE and local bodies have published a set of environmental guidelines and manuals for conducting environmental assessment and management of different types of projects including water supply and management as shown in Table 2.2.9.

Table 2.2.9 Environmental Guidelines on Environmental Assessment & Management

Title	Year	Outline
Guidelines for Environmental Assessment of Small-scale Projects	1994	The purpose of this guideline is to enable the local level engineers (Thana Engineers) and other technical staff to better appreciate the environmental issues related to small-scale (less than 1000 ha benefited area) selected infrastructure development and equip them to carry out environmental impact assessment and incorporate the environmental protection parameters in the project preparation process. The guidelines are planned to enable the Thana Engineers to analyse the adverse environmental consequences of projects and adopt appropriate measures to eliminate, reduce to acceptable levels or offset such adverse consequences through proper planning and design and thus to optimize overall socio-economic benefits. The ultimate purpose of the guidelines is to strengthen and guide the initiatives of LGED to ensure planned development of physical infrastructure facilities taking environmental and social dimensions into consideration at the local level. The guidelines constitute simple procedures and formats to guide Initial IEE and EIA of proposed projects and draw up plans for environmental management. The guidelines may also be used to conduct IEE and EIA of ongoing and implemented projects to identify potential negative impacts and to design environmental protection measures and appropriate monitoring programmes.
Guidelines for Project Assessment (GPA)	1994	Developed by FPCO in 1994, GPA aims to ensure that all project components are assessed in a similar manner and to permit MCA techniques to be used when comparing proposed project or component alternatives.
Manual on EIA for large-scale projects	1995	Under FAP, a manual on EIA was prepared in 1995 (ISPAN, 1995) so that all FAP regional plans and projects are subject to a comprehensive and uniform EIA. The goal of all environmental assessments is to protect the environment by ensuring that only environmentally sound projects are designed and implemented. In EIA, positive and negative impacts are identified and either project designs are altered or mitigation measures are developed to lessen or alleviate negative ones. Public participation is central to the process and should take place at all stages of an EIA. The EIA involves an integrated assessment of the impacts of a project or plan on both natural and human environments. It focuses on linkages among the physical-chemical, biological, social and economic components of the environment.
EIA Guidelines for Industries	1997	The Guidelines sets out the procedures for environmental clearance of projects by DoE, as required by the Environmental Conservation Rules (DoE, 1997). Although intended primarily for the industrial sector, the procedures also apply to FCD/I projects. Namely, the guidelines covers significant water sector interventions, including flood control embankments, polders, dykes, water supply and sewage treatment, as well as roads and bridges. All these water sector interventions fall under the ‘Red’ category, with the exception of bridges less than 100 m long, and feeder and local roads. This requires the most stringent EIA process to be followed for proposed project construction, re-construction and extension. The responsibility for following the envi-

Title	Year	Outline
		ronmental assessment procedure lies with the project proponent or developer. The procedures are different, depending upon the categorization of the proposed intervention. The two most stringent classes, Orange/Amber B and Red, are required to have an IEE, with an EMP. The red classification requires an additional full EIA to be undertaken. Once DoE approves these documents, then a SCC is issued - provided the developer has obtained an NOC from the local authority.
EIA Guidelines for the Water Resources Sector	1992	The environmental component of the FAP-16, drew up a set of EIA Guidelines, which were approved by the MoEF and DoE for use in the water resources sector; and they were adopted by FPCO and WARPO in 1992. In addition to the water resources EIA Guidelines, FAP 16 drafted a manual in 1995 for carrying out EIA. The manual was intended to assist people not familiar with EIA work, and to give more detail on the use of the Guidelines for a wide range of water sector projects. Under SEMP, the DoE has recently started drafting 18 sets of sectorial EIA Guidelines. In 2003, WARPO in collaboration with DoE modified the guidelines as “Guidelines for Environmental Assessment of Water Management (Flood control, Drainage and Irrigation) Projects (as shown in the following column)
Guidelines for People’s Participation in Water Management (GPP)	2000	GPP was finalized jointly by the Ministry of Water Resources (MOWR) and the Ministry of Local Government Division (LGD) also provide insight into people’s participation in small scale water resources development projects (GPP, 2000) .
Guidelines on Participatory Water Management	2001	The guidelines were prepared by Bangladesh Water Development Board (BWDB) of LGED in 2001 which sets out the procedures for people’s participation.
Guidelines for Environmental Assessment of Water Management (Flood Control, Drainage and Irrigation) Projects	2003	These Guidelines for Environmental Assessment are an update of the “EIA Guidelines for the Water Resources Sector” for assessment of FAP projects by FPCO in 1992 under the FAP 16 activities. The "Guidelines for Environmental Assessment of Water Management Projects (FCD/I)" was prepared on December, 2001 and approved by MoEF in 2003. The Guidelines cover EA - a process that covers two key activities of IEE and EIA at the planning level. All agencies involved in the planning, implementation, operation and maintenance and monitoring of FCD/I projects should use these Guidelines to assist in drawing up a TOR for environmental studies, in monitoring the studies and in evaluating the resulting EA reports.
Sectorial Guidelines for Environmental Management		These guidelines covering 18 sectors which have potentially great impacts on the environment (DoE, under the Sustainable Environmental Management Programme (SEMP), in preparation

Note: LGED; Local Government Engineering Department, EA; Environmental Assessment, EIA; Environmental Impact Assessment, IEE; Initial Environmental Examination, EMP; Environmental Management Plan, FCD/I; Flood Control Drainage and Irrigation, FAP; Flood Action Plan, FPCO; Flood Plan Co-ordination Organization, MCA; Multi-criteria Assessment, ISPAN; Irrigation Support Project for Asia and the Near East, WARPO; Water Resources Planning Organization, TOR; Terms of Reference

Source; State of Environment Bangladesh 2001, MoEF, DoE,
Guidelines for Environmental Assessment of Water Management (Flood control, Drainage and Irrigation) Projects 2005 WARPO
Integrating Environmental Considerations into the Economic Decision-Making Process, ESCAP

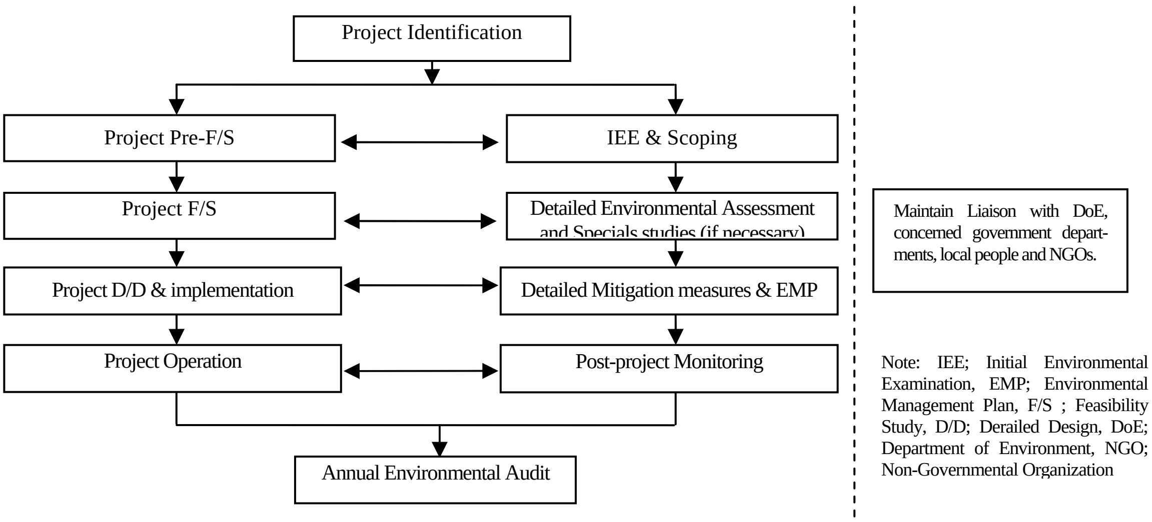
Of the above the “EIA Guidelines for Industries” and “Guidelines for Environmental Assessment of Water Management (Flood control, Drainage and Irrigation) Projects” will initially be made.

2) Environmental Impact Assessment (EIA) Process

In Bangladesh, according to the EIA Guidelines for Industry 1997 DoE, the EIA Process can be summarized as follows;

- The primary responsibility for carrying out an EIA study of any project lies with the project proponent. The proponent may get the study done using in-house expertise, a project consulting agency or an independent environmental consulting agency having requisite qualification to perform the task.
- EIA should be carried out in tiers and as indicated in Figure 2.2.2. It will be seen from this figure that the EIA procedure should be initiated simultaneously with the project planning and the level of efforts required for various tiers of EIA should be commensurate with the project development, throughout the stages of its identification to implementation. Thus the environmental planning should be centered and integrated with the project.

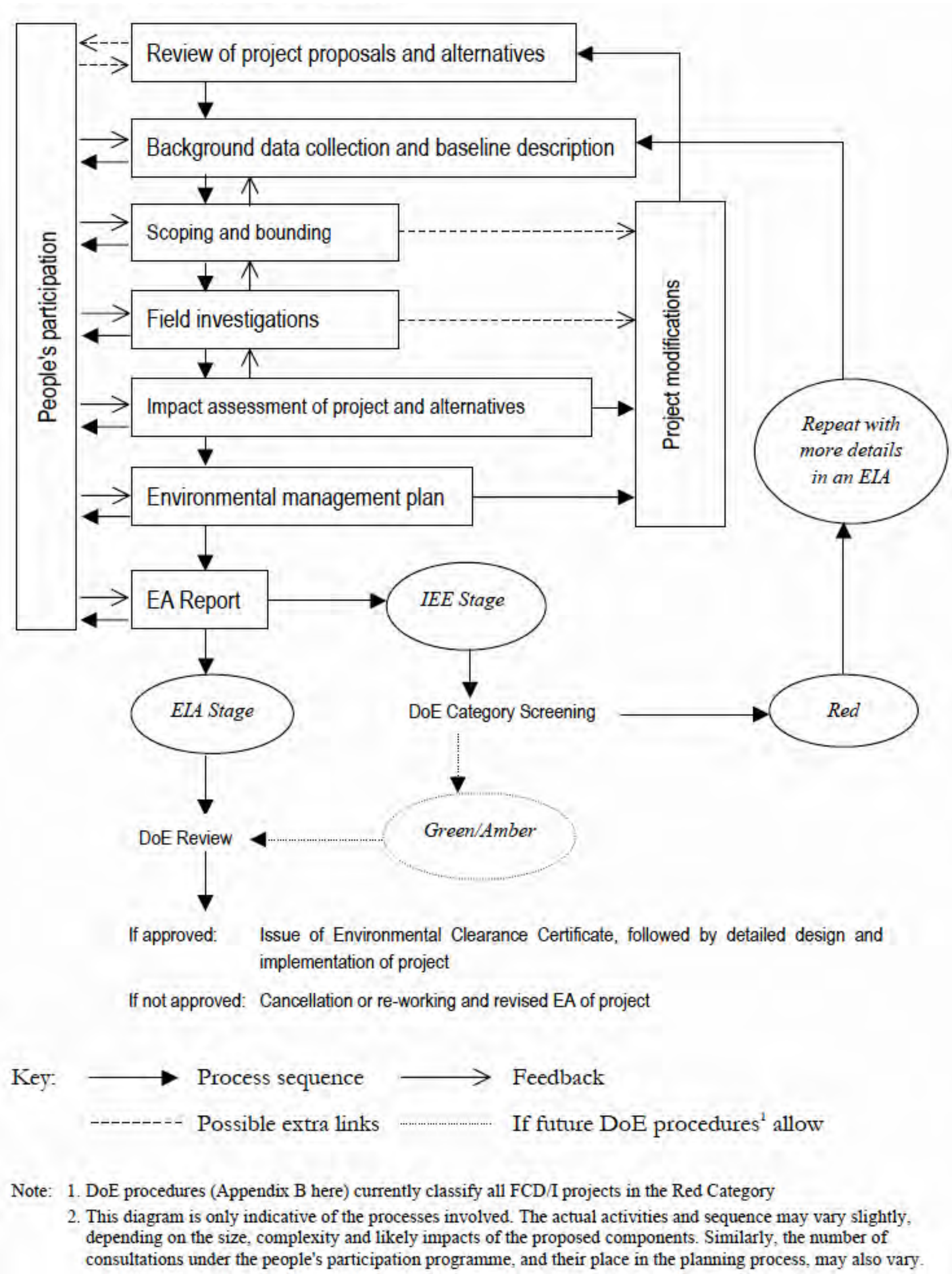
- The TOR for EIA study has been indicated in the form of structures of an IEE report and EIA report, respectively. These will normally be found meeting the study requirement in most of the EIA studies.
- The important stages in the development of an EIA study are:
  - Screening / scoping
  - Identification of significant environmental issues and how these will be resolved
  - Adequacy of imitative measures and an Environmental Management Plan (EMP)
- At this stage, interaction among the DoE, concerned other Governmental Departments/Authorities, NGOs and the people likely to be affected may be establish, in order to formulate views and suggesting and consider them while preparing further proposals for development of the project and environment planning.
- Review of an EIA report in the responsibility of DoE wherein the review exercise will be carried out either through the staff of DoE and /or an Environmental Clearance Committee (ECCo) to be appointed by the Government. Namely the EIA will be reviewed by the respective Divisional office of DoE whereby the review report will be submitted for consideration by DG (Director General) at DoE for the entire industrial project, which require IEE/EIA (Refer to Figure 2.2.2). Then the Environmental Clearance Committee (ECCo) will call the proponent to give presentation about the project objective, strategy, remedial action, findings and etc. The office of the DG will make final decision which will be communicated to respective Divisional office, who in turn, will communicate to the entrepreneur.
- Finally, DoE will issue environmental clearance to a project, or reject it, or call for some more information/studies before clearance in accorded. The environmental clearance may be subject to such conditions as may be considered necessary from the point of view of environmentally should implementation and operations of the project.
- Environmental Assessment (IEE & EIA) Process in WARPO Guidelines



Source; EIA Guidelines for Industries 1997 DoE

Figure 2.2.2 Project Planning, It's Implementation and EIA Process

In addition, the Guidelines for Environmental Assessment of Water Management (FCD/I) Projects 2005 WARPO, which basically follows the EIA Guidelines for Industries 1997 DoE, depicts a process for Environmental Assessment (EA) including IEE and EIA that employs a people's participation oriented approach as shown in Figure 2.2.3.



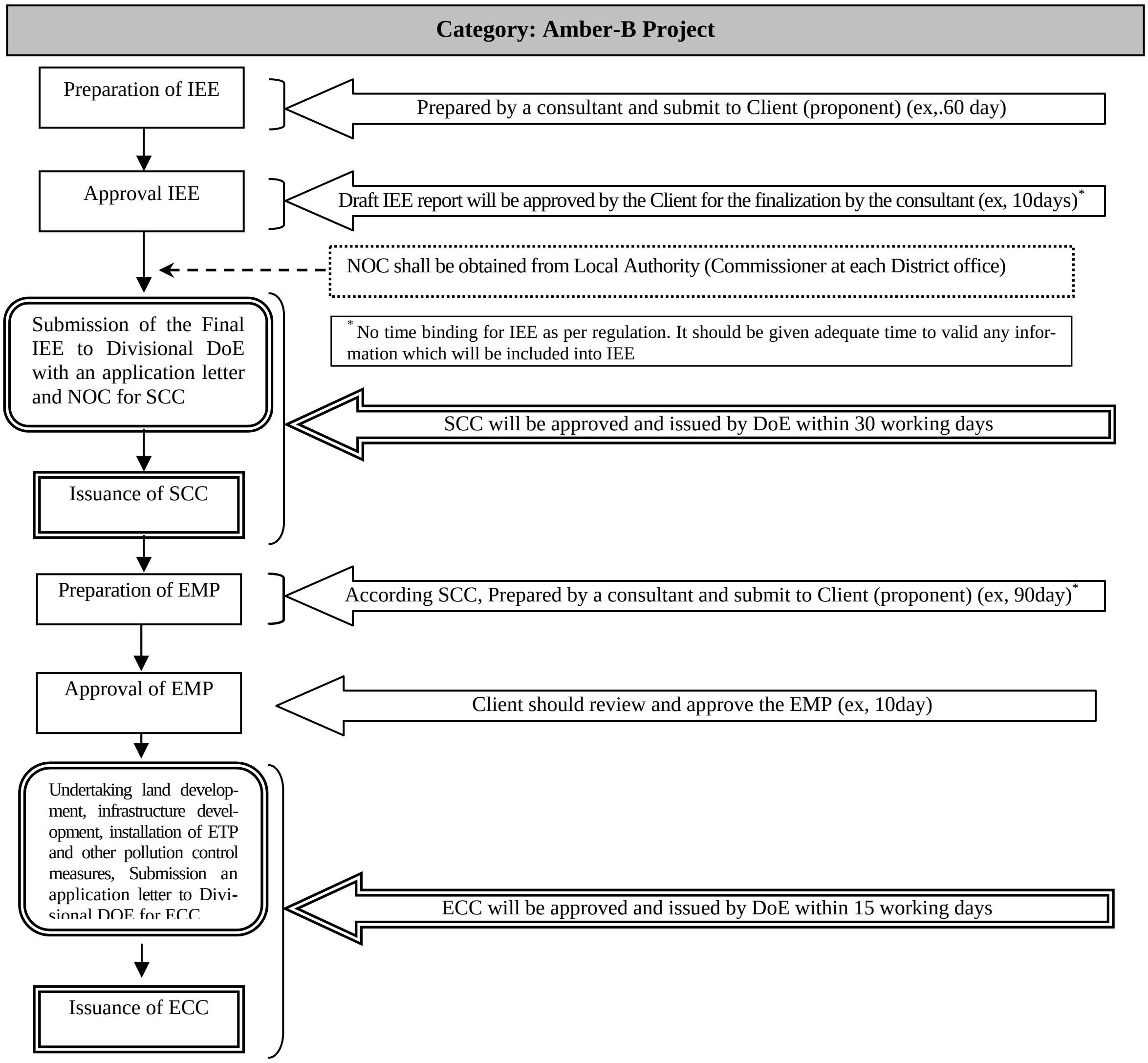
Source; Guidelines for Environmental Assessment of Water Management (FCD/I) Projects 2005 WARPO

Figure 2.2.3 Key Steps in the Environmental Assessment for FCD/I Projects

The Guidelines of WARPO mentions that the DoE procedures currently classify all FCD/I projects in the "Red" Category. In addition, the Guidelines of WARPO basically employs the "Flow Chart of Environmental Clearance Procedure" shown in Figure 2.2.1. However, the requirements of WARPO vary from those of the DoE 1997, in requiring an IEE, EIA and EMP for proposed, as well as existing industry/ projects (asterisk and underlined explanation in Figure 2.2.1) which are omitted in the WARPO Guidelines. As well, the "Guidelines" notes that automatic application of the Red Category procedures and regular renewal of the Certificates is not appropriate for all FCD/I projects, especially small interventions with minimal impacts. Unless/until the procedures are formally revised, the DoE should be consulted for guidance on individual projects.

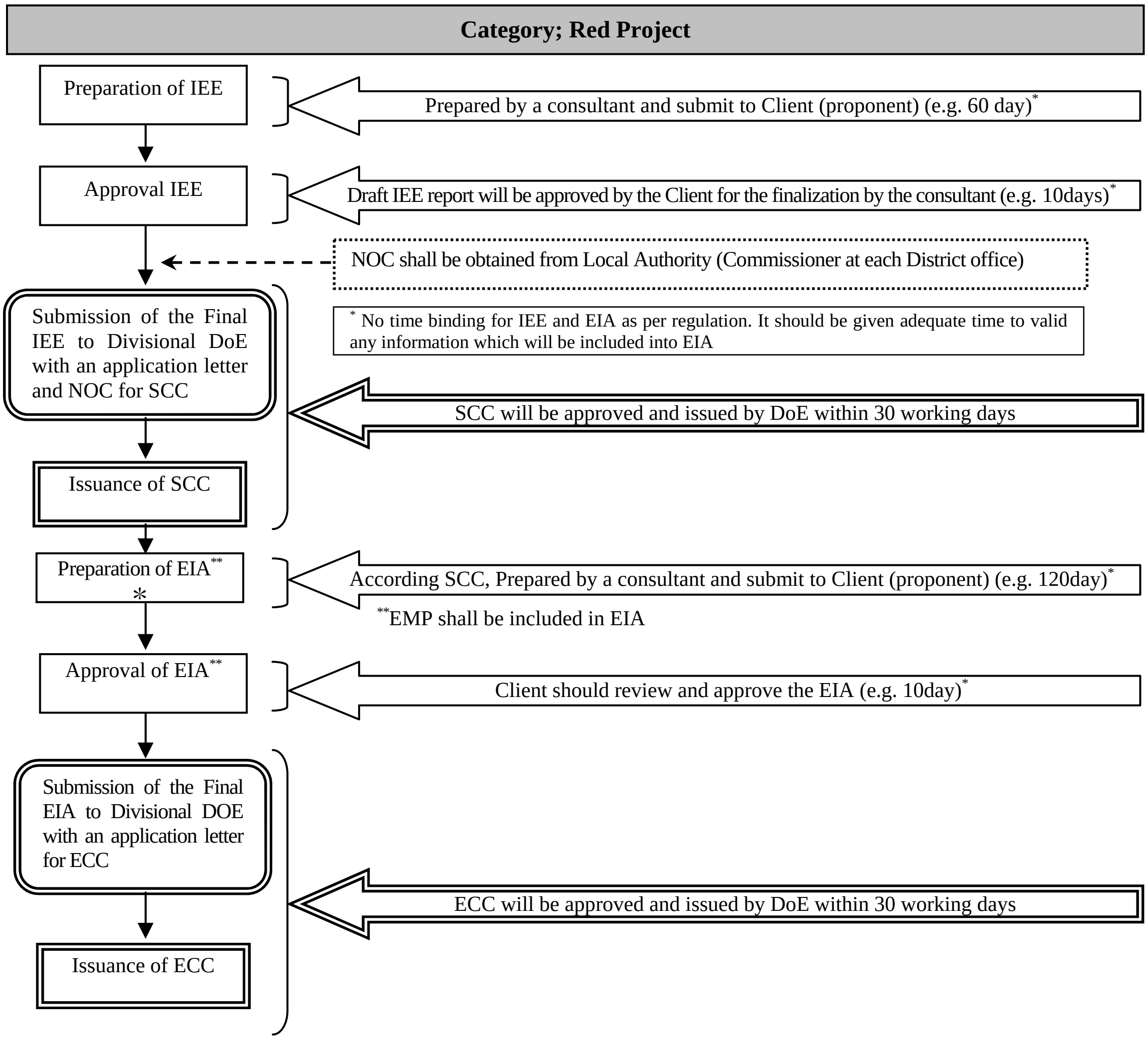
a) Sequence between Environmental Clearance system and Environmental Assessment Procedures

As mentioned above, the Environmental Assessment (EA) system and its procedures are dealt with in the framework of the Environmental Clearance system. Figures 2.2.4 and 2.2.5 show sequence between the "Environmental Clearance system" and "Environmental Assessment Procedures" in case of Amber-B and Red Projects.



IEE; Initial Environmental Examination, NOC; No Objection Certificate, EMP; Environmental Management Plan, SCC; Site Clearance Certificate, ECC; Environmental Clearance Certificate, ETP: Effluent Treatment Plant
Source: JICA Study Team

Figure 2.2.4 Environmental Clearance & Environmental Assessment in Amber-B Category



IEE; Initial Environmental Examination, EIA; Environmental Impact Assessment, NOC; No Objection Certificate, EMP; Environmental Management Plan, SCC; Site Clearance Certificate, ECC; Environmental Clearance Certificate
Source: JICA Study Team

Figure 2.2.5 Environmental Clearance & Environmental Assessment in Red Category

b) Public Participation

The "EIA Guidelines for Industries" mentions the public participation as follows;

- ***Public Participation;*** Since the general public is the ultimate recipient of the economic benefits and environmental damages, an EIA study involved in the public as part of the decision making process development. To achieve effective public participation, it is necessary to communicate with as many people as possible, as early as possible, and through as many different ways possible. This requires pre-planning, resources, identification of target groups and a variety of techniques for effective communication. Some of the techniques which could be adopted are:

- Radio and Television	- Sample polls	- Public Hearings (consultations)
- News releases	- Lobbying	- Information van
- News Letters	- Workshops	- Citizens advisory committee
- Advertisements	- Public Meetings	

In addition, "Guidelines for Environmental Assessment of Water Management (Flood control, Drainage and Irrigation) Projects" notes as follows:

- ***People's Participation during IEEs;*** People's participation at the IEE stage involves four steps:

  - Wide and effective dissemination of information on potential interventions
  - Local-level meetings and discussions, identifying problems and developing a problem-solving process
  - Inventory of problems/ constraints and potentials
  - Assessment and reconnaissance of social, agricultural, fishery, livestock and environmental issues

- ***People's Participation during EIAs;*** During EIAs, the participation should be more detailed, involving:

  - Identification of all stakeholders - individuals, communities and government and nongovernmental agencies at all levels from the project site to regional and central agencies
  - Application of field methods to ensure full participation, including social assessment by surveys and participatory rapid rural appraisal
  - Assessment of the capacity of local stakeholder to participate effectively and implementation of measures to ensure the latter (e.g. by involvement of NGOs to help voice local concerns)
  - Identification of support of, and opposition to, the proposed project and enhancement/mitigation measures.

However, "Public Hearing" (to disclose a draft or summary EIA report to public for asking comments upon it, which usually seen in other countries) is not identified in the EIA procedures in Bangladesh.

c) JICA Guidelines for Environmental and Social Considerations (April, 2010)

Based on the JICA's policy on the environmental and social consideration for Japanese loan projects, CWASA shall refer to the JICA Guidelines for Environmental and Social Considerations, dated March 19, 2010.

(4) Environmental Management System in Bangladesh, Chittagong and CWASA

1) Department of Environment

Under the Ministry of Environment and Forest (MoEF), the DoE is the practical official entity for managing the environment and evaluating IEE and EIA reports to be submitted. The headquarters of the DoE is located in Dhaka and organized into nine main functional areas, each of which is headed by a Director, under the overall management of the Director General. The functional areas are: (i) Environmental Clearance, (ii) Law, (iii) Administration and Human Resources Development, (iv) Climate Change (v) Planning, (vi) Air Quality Management (vii) Information Technology, (viii) Monitoring and Enforcement and (ix) Natural Resources Management.

2) Divisional and District Level

There are six Divisional Offices (Barisal, Bogra, Chittagong, Dhaka, Khulna and Sylhet) that carry out enforcement activities including overall management of the environment supported by the laboratory analysis. Twenty newly created District Offices have yet to be started in full operation.

In case of approval of EIA, after submission, it is initially checked and verified at divisional level. Subsequently the EIA report is sent to a committee, called the "Environmental Clearance Committee (ECCo)", which is formed by the Director General (DG) of DoE and which reviews the EIA report in detail and makes a recommendation to the Deputy Director of the DoE for rejection or approval of the EIA. The decision is sent to divisional officials to issue an approval or rejection letter, usually with conditions. Once the mitigation measures are in place as recommended in the EIA report, the proponent applies for ECC to the relevant Divisional DoE office. After field inspection by the DoE officials, the DoE will send an ECC application with their recommendations to ECCo in Dhaka office. ECCo makes a recommendation on the application to the DG for his decision. After the DG's approval, the divisional officer issues ECC. In addition, environmental monitoring in EIA and /or IEE, each Divisional Office including Chittagong follows the direction of the DoE, Head Office.

3) CWASA

In CWASA there is no department, division or section for environmental and social considerations.

2.3 Socio-Economy Conditions

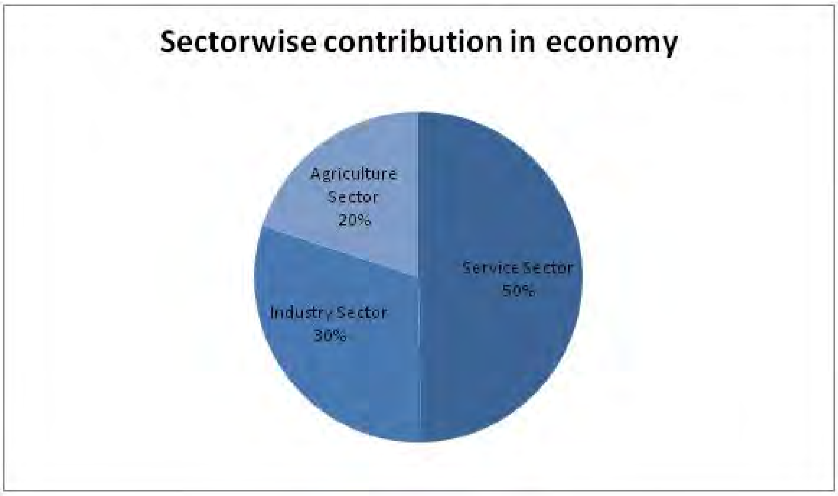
2.3.1 General

(1) Bangladesh

Bangladesh's Gross Domestic Product (GDP) at constant prices has grown at a rate of about 6.1 % per year over the past four years (6.43 %, 6.19 %, 5.74 % and 6.07% in each of the years 2006 to 2007, 2007 to 2008, 2008 to 2009 and 2009 to 2010), respectively, with the provisional GDP increase for the year 2010 to 2011 being 6.66 %[2]. GDP per capita was US$ 775 at current prices in 2010-2011.[3]

The sector wise contribution to the economy in 2010-2011 is shown in Figure 2.3.1. In this period the service sector accounts for 50 % of the GDP, which is similar to the years 1980-1981, 1990-1991 and 2000-2001, when the contribution ranged from about 49 % to 50%. In the period from 1980-1981 to 2010-2011 the contribution from agriculture decreased from approximately 33 % to 20 %, with their being a corresponding increase in the contribution from industry in the above period (17 % to 30 %) and a progressive increase in the contribution from industry in each of the above years.[4]

[2] Bangladesh Bureau of Statistics
[3] Board of Investment, Prime Minister's Office
[4] Bangladesh Economic Review 2010



Source: Bangladesh Economic Review 2010

Figure 2.3.1 Sector-wise Contribution in Economy

Bangladesh produces large quantities of agricultural goods including rice and jute. Although wheat production has increased in recent y ears (from 2004-2005 to 2009-2010); the country is generally self-sufficient in rice production. Bangladesh's growth of its agro industries is due to its rich deltaic fertile land, enabling multiple harvests.

Bangladesh's industrial base remains positive, including its vast human resource base, rich agricultural land, relatively abundant water, and substantial reserves of natural gas, with two natural sea ports in Chittagong and Mongla. In addition Bangladesh is one of eight member countries in an emerging economic hub group, South Asia Association for Regional Cooperation (SAARC) and functions as a geographical linking with the Association of South-East Asian Nations (ASEAN).

The 2011 Human Development Report[5] prepared by the United Nations Development Programme (UNDP) includes information on the Human Development Index (HDI). This index is a composite statistic, which is used to rank countries by level of "human development" and distinguish "very high human development", "high human development", "medium human development", and "low human development" countries. The HDI is a comparative measure of life expectancy, literacy, education and standards of living for countries worldwide.

Bangladesh's HDI value for 2011 is 0.500, which is in the low human development category. Overall Bangladesh was ranked 146th out of 187 countries and territories in 2011, with a lower score than the index for South Asia. Table 2.3.1 shows HDI indicators as well as HDI for selected countries and groups in 2011.

[5] Human Development Report 2011, United Nations Development Programme

Table 2.3.1 Bangladesh's HDI Indicators 2011 Relative to Selected Countries and Groups

Country/Group	HDI Score	HDI Rank	Life expectancy at birth	Expected years of schooling[1]	Mean years of schooling[2]	GNI per capita (2005 PPP$)
Bangladesh	0.500	146	68.9	8.1	4.8	1,529
India	0.547	134	65.4	10.3	4.4	3,468
Nepal	0.458	157	68.8	8.8	3.2	1,160
Pakistan	0.504	145	65.4	6.9	4.9	2,550
Sri Lanka	0.691	97	74.9	12.7	8.2	4,943
South Asia	0.548	-	65.9	9.8	4.6	3,435
Medium HDI	0.630	-	69.7	11.2	6.3	5,276
Low HDI	0.456	-	58.7	8.3	4.2	1,585

Notes: 1. Total number of years of schooling a child of school-entrance age can expect to receive if prevailing patterns of age-specific enrolment rates stay the same throughout the child's life.
2. Average number of years of education received in a life-time by people aged 25 years and over.
Source: UNDP Development Report 2011

Between 1980 and 2011 Bangladesh's HDI value increased from 0.303 to 0.500, an increase of approximately 65%, with an annual average increase of about 1.6%. Table 2.3.2 shows Bangladesh's progress in each of the HDI indicators as well as HDI between 1980 and 2011, compared to that in South Asia and low human development (LHD) groups. In the above period the HDI index in Bangladesh has increased faster than in the LHD group.

Table 2.3.2 Trends in Bangladesh's HDI compared to South Asia and Low Human Development (LHD) (1980-2011)

Year	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (2005 PPP$)	HDI Value		
	Bangladesh					South Asia	LHD
1980	55.2	4.4	2.0	584	0.303	0.356	0.316
1985	56.9	4.5	2.4	646	0.324	0.389	0.334
1990	59.5	5.0	2.9	690	0.352	0.418	0.347
1995	62.1	6.0	3.3	784	0.388	0.444	0.363
2000	64.7	7.0	3.7	905	0.422	0.468	0.383
2005	66.9	8.0	4.2	1,120	0.462	0.510	0.422
2010	68.6	8.1	4.8	1,459	0.496	0.545	0.453
2011	68.9	8.1	4.8	1,529	0.500	0.548	0.456

Source: UNDP Development Report 2011

In the period from 1980 to 2011 per capital GNI increased by about 160%, with life expectancy at birth increasing by 13.7 years, expected years of schooling by 3.7 years and mean years of schooling by 2.8 years.

The Gender Inequality Index (GII), which is included in the UNDP Human Development Report reflects gender-based inequalities in three dimensions – reproductive health, empowerment, and economic activity. GII shows the loss in human development due to inequality between female and male achievements in the three GII dimensions.

Bangladesh has a GII value of 0.550, ranking it 112th out of 146 countries in the 2011 index, with the details of some of the parameters for Bangladesh and selected groups and countries shown in Table 2.3.3. Bangladesh was ranked above both India and Pakistan, but lower than Sri Lanka in 2011, as it was for the HDI. In addition, its score is better than the average scores for South Asia and countries with a low HDI, but significantly worse than the average score for countries with a medium HDI.

Table 2.3.3 Gender Inequality Index (GII)

Country /Group	GII value	GII rank	Maternal mortality ratio[1]	Adolescent fertility rate[2]	Female seats in parliament (%)[3]	Population with at least secondary education (%)[4]		Labor force participation rate (%)[5]	
						Female	Male	Female	Male
Bangladesh	0.550	112	340	78.9	18.6	30.8	39.3	58.7	82.5
India	0.617	129	230	86.3	10.7	26.6	50.4	32.8	81.1
Pakistan	0.573	115	260	31.6	21.0	23.5	46.8	21.7	84.9
Nepal									
Sri Lanka	0.419	74	39	23.6	5.3	56.0	57.6	34.2	75.1
South Asia	0.601	-	252	77.4	12.5	27.3	49.2	34.6	81.2
Medium HDI	0.475	-	135	50.1	17.3	41.2	57.7	51.1	80.0
Low HDI	0.606	-	532	98.2	18.2	18.7	32.4	54.6	82.7

Notes: 1. Ratio of number of maternal deaths to the number of live births in a given year, expressed per100,000 live births
2. Number of births to women ages 15-19 per 1,000 women ages 15-19.
3. Proportion of seats held by women in a lower or single house or senate, expressed as percentage of total seats.
4. Percentage of the population ages 25 and older that have reached secondary education.
5. Proportion of a country's working-age population that engages in the labor market, either by working or actively looking for work, expressed as a percentage of the working-age population.
Source: UNDP Development Report 2011

According to Bangladesh at a Glance[6] 32% of the population of Bangladesh was below the poverty line in 2010. This is similar to the figure of 31.5% for the incidence of poverty using the upper poverty line, which has been estimated using the Head Count Rate, in the Household Income and Expenditure Survey (HIES) 2010. Using the lower poverty line the incidence of poverty reduces to 17.6% in the above survey.

(2) Chittagong

In the HIES 2010 urban poverty in Chittagong was estimated at 11.8% using the upper poverty line, compared to the national average of 21.3% and 18.0% in Dhaka, with urban poverty in Chittagong being lower than in all other divisions. Urban poverty in Chittagong, based on the upper poverty line, reduced significantly compared to other divisions in the period between 2005 and 2010 (27.8%) and has also reduced significantly since 2000, when it was 55.9%. Using the lower poverty line urban poverty in Chittagong in 2010 was estimated at 4.0%, second only to Dhaka at 3.8% and a significant reduction from 8.1% in 2005.

Rural poverty in Chittagong in the HIES 2010 was estimated at 31.0% using the upper poverty line, compared to the national average of 35.2%, with rural poverty in Chittagong being lower than in all other divisions, except for in Rajshahi (new) and Sylhet where it was 30.0% and 30.5% respectively.

2.3.2 Public Hygiene

(1) General

Bangladesh has made significant progress in health outcomes since its independence. Reduction of infant and child mortality rates has been significant. For example the under-five mortality rate declined from 151 deaths per thousand live births in 1991 to 48 in 2010. During the same period the infant mortality rate reduced from 94 deaths per thousand live births to 38, which is lower than the figure of 52 for South Asia.

An overview of the current health profiles of Bangladesh is presented in the Health Bulletin 2011,

6 World Bank

prepared by the Directorate General of Health Services (DGHS), Ministry of Health & Family Welfare (MOHFW).

Water-borne diseases or diseases associated with unsafe water, poor sanitation, and poor food handling practices include among others, diarrhoea, dysentery, malaria, and dengue. Diarrhoea was the most common cause of admissions to both upazalia health complexes and district and general hospitals, accounting for about 15 % and 9% of admissions respectively. Data of children who attended out-patient and emergency departments of Integrated Management of Childhood Illness (IMCI)[7] facilities shows that diarrhoea is the most common specific cause (excluding very severe disease, which is non-specific) of admissions for children aged 0-28 days and 29-59 days, accounting for between 18 and 19% of admissions. For age groups 2-12 months and 1-5 years the percentage of admissions due to diarrhoea reduced to about 13% for each age group, with pneumonia being the most common cause of admission for both age groups.

National data indicates that for upazalia health complexes diarrhoea was either the most or second most common cause of admission for each age group from 0-28 days to over 50. Where it was the second most common, in the younger age groups pneumonia was the most common, whereas in the older age groups assault was the most common. The situation was similar for district level hospitals, although in some age groups diarrhoea was ranked third, with peptic ulcers being a common cause of admission age groups 25-49 years and over 50.

Bacillary dysentery and dysentery each account for between 2 and 3 % of admissions in upazalia health complexes and district level hospitals, although neither are reported amongst the top ten causes of admissions. This does not appear to be consistent with the summary information on the top ten causes of admissions, which shows that some diseases in the top ten account for less than 2 % of the total. This may be due to categorization used in the summary information.

Diarrhoea/dysentery caused 7% of deaths of children in the age group 5-14 years in upazalia health complexes, but was not in the top causes of mortality in other age groups or for any age groups in district and general hospitals.

(2) Chittagong Division

The reported number of cases and deaths from diarrhoea, as well as the fatality rate in Chittagong Division in recent years is shown in Table 2.3.4.

Table 2.3.4 Incidence of Diarrhoea in Chittagong Division

Year	Number of incidences reported	Number of deaths reported	Fatality rate (No per '1000 people)
2001	-	-	0.05
2002	-	-	0.06
2003	379,276	265	0.07
2004	432,829	277	0.06
2005	405,446	162	0.04
2006	363,710	84	0.02
2007	446,965	148	0.03
2008	410,195	123	0.03
2009	366,092	79	0.02
2010	367,072	95	0.026

Source: Director, Disease Control, Directorate General of Health Services (DGHS), as reported in Health Situation of Bangladesh (published November 2011)

Integrated Management of Childhood Illness (IMCI) is a strategy as well as a program developed in mid-1990s by WHO, UNICEF and other partners to unify existing vertical child health programs (e.g., Control of Diarrheal Diseases and Acute Respiratory Infections). IMCI addresses morbidities which are responsible for almost 75% of under-5 deaths. MOHFW of Bangladesh introduced IMCI in 2002.

The number of reported incidences of diarrhoea has been relatively stable over the period from 2003 to 2010; however the number of deaths generally decreased year on year, although the number of deaths in 2006 was much lower than in the preceding years and the following two years.

The historical trend for the number of deaths per 1000 people is similar in Chittagong to the national trend and that in other divisions.

With regard to children treated at IMCI facilities, Chittagong accounted for 17.1% of diarrhoea cases, but only 14% of all admissions.

There have been no reported incidences of dengue fever in Chittagong Division since 2005, when there were two cases and the last reported death was in 2003.

(3) Chittagong City

Chittagong City has a number of hospitals (including specialist hospitals) and medical institutions which provide health care services. The public and some of the private hospital in the city are shown in Table 2.3.5.

Table 2.3.5 Hospitals in Chittagong City

Type	Name	Number of Functional Beds
Public	Chittagong Medical College Hospital	1010
Public	Infectious Diseases Hospital	20
Public	Chittagong General Hospital	150
Public	Chest Diseases Hospital	150
	Diabetic Hospital	
	Mother and Children Hospital	
	Police Hospital	
Private	Chittagong Medical Centre	
Private	Royal Hospital	
Private	Chittagong Metropolitan Hospital	
Private	Chittagong Eye Hospital	
Private	Chittagong Poly Clinic	
Private	Nebadita Hospital	
Private	Agrabad Shishu Hospital	
Private	Panasia Hospital	
Private	Holy Crescent Hospital	
Private	Holy Family Hospital	
Private	Surgiscope Hospital	
Private	Centre Point Hospital	
Private	National Hospital	

Source: Health Bulletin 2011 (Government Hospitals)

2.3.3 Sanitation and Sewerage

(1) Drainage System

Urban drainage is a major issue in most cities of Bangladesh due to their low-lying topography, their location next to rivers and the short, but very intensive, monsoon season. Chittagong is no exception in this regard.

There are currently 22 major canals and a network of about 100 secondary and tertiary canals in Chittagong. These are operated and maintained by CCC, who undertook to dredge 145 drains in

2008, including the removal of illegal encroachments, following major floods in 2007.

A Storm water Drainage and Flood Control Master Plan, for which CDA was the Client, was prepared in 1994 to cover the period from 1995 to 2015. The World Bank financed Chittagong Water Supply Improvement and Sanitation Project includes a subcomponent for updating of drainage master plans, identification of priority investments and design of priority investments. It is expected that the assessment activities done under the above will include recommendations for the priority rehabilitation of some existing storm water canals that could provide limited but immediate improvements to the storm water drainage system in Chittagong.[8]

(2) Sewerage

There are essentially no waterborne sewerage systems in Chittagong and a significant portion of wastewater is discharged untreated to ponds, channels and drains and then to the sea via the Karnaphuli River. Storm drains/canals act as combined sewers. According to the Sewerage Master Plan[9], the only sewerage system which was planned and constructed as a sewerage system is a 1.8 km long culvert along Sheikh Mujib Road; however it is not known if this culvert has ever been used for conveyance of sewerage only.

Chittagong City Corporation, which is responsible for sanitation has developed various slum sanitation improvement programs with the support of NGOs and as a result 90% of the open latrines have been converted to septic latrines.[10]

(3) Solid Waste Management (SWM)

SWM in Chittagong, and in many other Bangladeshi cities, is hampered by the absence of adequate national or local legislation relating to municipal SWM and the treatment and disposal of hazardous waste. In particular, there are no mandatory regulations or performance standards for city corporations (e.g. CCC) to establish and manage an effective SWM system; nor are there any sanctions to prevent littering and indiscriminate dumping.

CCC is responsible for collection and disposal of household waste and more than 95% of such waste is collected and dumped.[11]

The Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011 proposes that the two existing landfills are relocated from the southern part of the city to the north due to the wind speed and direction.

2.3.4 Commerce and Industry

Chittagong has traditionally been a major centre for trade and commerce and is the second centre of commerce and industry in Bangladesh after Dhaka. The manufacturing industry started to develop in the 1950's when the Nasirabad Industrial Area was constructed. Subsequently industrial areas were developed at Kalurghat and Fouzderhat. The first heavy industrial development in the city was in the 1960's when an oil refinery, cement clinker plant and a steel mill were constructed on the

8 Project Appraisal Document on a Proposed Credit to the People's Republic of Bangladesh for a Chittagong Water Supply and Sanitation Improvement Project
9 Part of the 'Preparation of Master Plan for Water Supply and Wastewater Management of the Detailed Planning Area of Chittagong, Bangladesh, financed by Korea International Cooperation Agency
10 Project Appraisal Document on a Proposed Credit to the People's Republic of Bangladesh for a Chittagong Water Supply and Sanitation Improvement Project
11 Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011

Patenga Peninsula.

About 30% industrial products of the country come from Chittagong district alone, most of which come from the city area. The major industrial estates developed by the Government including by Chittagong City Corporation (CCC), Chittagong Development Authority (CDA), Bangladesh Small and Cottage Industries Corporation (BSCIC) and the public Works Department (PWD) are shown in Table 2.3.6

Chittagong City owns some very prestigious industrial enterprises, with Chittagong Oil Refinery, Lubricating Grease Industry, Dockyard are the most important ones. Besides these there are jute, textile, leather, cigarette, edible oil, soap, glass, salt, fertilizer, garment and gas industries, etc.

Table 2.3.6 Major Industrial Estates developed by the Government

Name of Estate	Organization	Area (hectares)	No. of plots	Year of Development
Kalurghat	CDA	81	58	1961-63
Mohra	CDA	31	31	1962-63
Fouzderhat/Sagarika	CDA	132	78	1961-62 1969-70
Sholashahar (light industry)	CDA	17	37	1960-61
Nasirabad	PWD	155	396	1950-51
Sagarika	CCC	6	10	-
Chandgaon FIDC Road	CCC	5	3	1968
Fauzdarhat	BCSIC	13	159	1963
Sholashahar	BCSIC	6	66	1963
Kalurghat (old)	BCSIC	5	71	1963
Kalurghat (extension)	BCSIC	13	255	1982-83
Patiya	BCSIC	4	79	1981
Patenga	Central Government			
Fauzdarhat	Central Government			
Kumira	Central Government			
CEPZ (Halishahar)	CDA	183	502	Approx. 1983
Patenga	KEPZ	90	254	Approx. 2006

Source: Detailed Area Plan for Chittagong Metropolitan Master Plan and Bangladesh Export Processing Zones Authority

As of May 2012, about US $940 million has been invested in Chittagong EPZ since 1983-1984, with the maximum in any year being US$ 126.46 million in 2007-2008[12]. Investment decreased significantly in the following two years but recovered to about US$ 85 million in 2010-2011 and US$ 83 million in 2011-2012 up to May 2012. Total exports from the EPZ up to May 2012 are US$ 14,867 million, with a maximum of about US$ 1,690 million in the current year (up to May 2012 only). Exports have increased every year (year on year), except for between 1986-1987 and 1987-88 and between 2000-2001 and 2001-2002, when there were small percentage decreases. In 2011-2012 (as of May 2012), approximately 171,000 local people were employed in the EPZ, the maximum in any year.

With regard to Karnaphuli EPZ, about US$ 212 million has been invested since 2006-2007, with a maximum of US $ 76.91 million in the current year (up to May 2012). Investment in the current year is similar to that in the Chittagong EPZ. Total exports from the EPZ up to May 2012 are about US$ 463 million, with a maximum of about US$ 220 million in the current year (up to May 2012 only), which is a significant increase from almost US$ 10 million in 2007-2008. In 2011-2012 (as

[12] Bangladesh Export Processing Zones Authority (BEPZA) – including subsequent information regarding Chittagong and Karnaphuli EPZs

of May 2012), approximately 25,000 local people were employed in the EPZ, the maximum in any year.

In addition, a Korean company, Youngone Corporation, has established a special Korean Export Processing Zone (KEPZ) in the city. This is built on a land area of nearly 1,000 hectares and is expected to attract foreign direct investment worth $1 billion.[13] Permitted industries at the KEPZ are as follows:

- Electrical and Electronics items
- Software development, IT and R&D types industries
- Scientific instruments and precision tools
- Jewellery industries and cutting
- Engineering products and equipment
- Leather products and shoes, bags, jackets etc.
- Sports goods and toy manufacturing, footwear
- Backward linkage industries for textile
- Pharmaceutical products
- Gas based industries, Petrochemical products
- Agro-based industries, organic fertilizer production, garden and farm equipment manufacturing
- Ceramic industries
- Agro construction materials
- Port related services and business, ship chandler items

Hi-Tech projects for electrical/electronic equipment and components, assembly plants for cars and its components, software development, large scale chemical/petrochemical industries are encouraged at the above KEPZ.

Chittagong port which has recently attained international attained international standards in terms of competence indicators handles about 92 % of the country's imports and exports[14]. The main imports at the port include cement clinker, sugar, salt, fertilizer, general cargo, iron materials, chemicals, coal and edible oil, with the main exports including ready-made garments, knitwear, jute and jute products, hides and skins, tea, naphtha, molasses and frozen foods. In 2009-2010 cement clinker amounted to 26% (in terms of tonnes) of total imports, followed by poles in bulk (12%) and foodgrain (10%). In the previous five years cement clinker was the main import in each year.

Table 2.3.7 summarises the cargo handled by the port in the years from 2006 to 2011.

Table 2.3.7 Cargo Handled at Chittagong Port

Year	Imports	Exports	Inland	Inland Container Depot	Total	Import and Export Annual Growth	Total Annual Growth
	(Tonnes)					%	
2006	23,936,103	3,089,550	2,633,565	480,349	30,139,567		1.93
2007	24,236,261	3,392,974	2,677,509	492,644	30,799,388	2.23	2.19
2008	24,492,707	3,704,862	2,518,564	434,628	31,150,761	2.06	1.14
2009	30,886,680	3,957,894	2,830,025	494,525	38,169,124	23.57	22.53
2010	36,670,356	4,512,439	3,730,829	483,039	45,396,663	18.19	18.94
2011	38,266,480	4,873,562	5,577,114	556,781	49,273,937	4.75	8.54

Source: Chittagong Port Authority

[13] Export Processing Zone Exclusive for Korea, The Korea Times, 25 March 2009
[14] Budget Speech 2012-2013

There are plans for expansion of the port. However issues that currently constrain expansion include that 500 acres of Chittagong Port Authority land is leased out and the intention of expanding the port downstream of Karnaphuli Fertilizer Company Limited may not be implementable because of the government's plan to construct a 1,300MW coal fired power station in that area.

According to the Statistical Yearbook, 2010 about 57% of the population older than 15 is active in Chittagong, with about 83% of males and 31% of females being economically active, as of 2005-2006, based on a total population of 5.063 million.

There is no recent information on the employment structure in Chittagong. A Census of Non-farm Economic Activities (CNFEA) was published in 1986 (BBS, 1986) from which a detailed breakdown of the employment structure of Chittagong city is presented in Table 2.3.8.

Table 2.3.8 Employment Structure in Chittagong

Sector	No. of Jobs City	No. of Jobs Statistical Metropolitan Area (SMA)	Sources
Manufacturing	161,000	201,000	CNFEA (1986)
Wholesale, retail and trade	121,000	133,000	CNFEA (1986)
Financial, insurance, and business services	27,000	28,000	CNFEA (1986)
Community, social, & personnel services	48,000	56,000	CNFEA (1986)
Public administration, defence & police	20,000		Team
Utilities	3,000		Team
Agriculture	8,000		Pop. Census (1991)
Transport (incl. 80,000 Informal)	120,000		Transport Team (Residual)
Rest of informal, floating jobs	152,000		
Total	660,000		(Derived)

Source: Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011

The most recent estimate of the breakdown of manufacturing jobs is given in Table 2.3.9

Table 2.3.9 Estimated Breakdown of Manufacturing Jobs in Chittagong

Sector	Manufacturing Jobs (%)	No. of Jobs City	No. of Jobs SMA
Food, beverages, and tobacco	9	20,000	17,000
Textiles and garments	57	92,000	114,000
Wood and wooden products	7	5,000	11,000
Paper, printing, and publishing	2	4,000	5,000
Chemical, rubber, and plastics	4	7,000	9,000
Metallic mineral products	4	6,000	7,000
Basic metallic industries	5	8,000	10,000
Metal products, machinery, & equipment	12	19,000	24,000
Other manufacturing	2	3,000	4,000
Total	100	164,000	201,000

Source: Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011

It should be noted that the information in the above two tables is virtually identical to that included in the SAPROF.

2.3.5 The Electricity Power Supply Situation in Bangladesh

(1) Situation

As of May 2012, installed capacity is 8,099 MW, with natural gas being by far the biggest source of power contributing about 67 % of capacity, followed by furnace oil, about 21 %, with diesel, coal and hydropower also being used.[15] The maximum demand to date in 2012 was 6,066 MW.

The above installed capacity is higher than stated in the Budget Speech 2012-2013, as follows "The demand for electricity in the country now stands at 7,518 MW and we are producing 6,066 MW". According to the above speech 3,300 MW has been added to the national grid from January 2009 to April 2012.

(2) Power Supply in Chittagong

In Chittagong, there are two electricity boards which are REB (Rural Electrification Board) and PDB (Power Development Board). REB is responsible for rural areas and PDB mainly covers the city area. Power supply interruption is chronic problem in the city.

(3) Electricity Charges

The electricity tariff applied by PDB varies depending upon the category of user, with their being a minimum charge for most categories, as well as demand and service charges. The tariff for the main categories is shown in Table 2.3.10.

The electricity tariff applied by REB varies depending upon the category of user, with their being a minimum charge for most categories, as well as demand and service charges. The tariff for the main categories is shown in Table 2.3.11.

[15] Bangladesh Power Development Board

Table 2.3.10 PDB Tariff

Consumer Category	Range	Rate /kWh	Charges		
			Demand	Service	Minimum
Domestic Category - A	000-100 kWh 101-400 kWh 401 & above for all units in kWh	Tk. 3.05 Tk. 4.29 Tk. 7.89	Tk. 12 /kW sanctioned load	Tk. 6 /month for single phase & Tk. 27 /month for 3-phase	Tk. 100 / month
Agricultural Pumping Category - B	Flat	Tk. 2.26	Tk. 35 /kW /month for sanctioned load above 30 kW	1-phase Tk. 5/ month 3-phase Tk.25 / month	Tk. 125 /H. P. /month during season
Small Industry Category - C	Flat Off peak Peak	Tk. 6.02 Tk.5.16 Tk. 7.33	Tk. 37 /kW per month	Tk. 63.00 /month	Not applicable
Non-Residential Category – D		Tk. 3.92	Tk. 10 / kW of sanctioned load	1-phase Tk. 5/ month 3-phase Tk.25.00 / month	Tk. 100
Commercial Category - E	Flat Off peak Peak	Tk. 7.79 Tk. 6.25 Tk. 10.25	Tk. 22 /kW /month for sanctioned load above 40 kW	Tk. 6 / month for single phase & Tk 27 /month for 3-phase	Tk. 125 /kW of sanctioned load /month
Medium Voltage 11 kV General Category - F	Flat Off peak Peak	Tk. 5.90 Tk. 5.16 Tk. 8.08	Tk. 45 /kW of sanctioned load per month	Tk. 400.00 /month	Tk. 80 /kW of sanctioned load but not less than Tk. 8000 /month
Extra High Voltage Category - G1	DESA-132kV DESA-33kV	Tk. 2.34 Tk. 2.39	Tk. 40 /kW of sanctioned load	Not applicable	Tk. 80 /kW of sanctioned load
Extra High Voltage 132 kV General Category - G2	Flat Off peak Peak	Tk. 5.33 Tk. 4.82 Tk. 7.51	Tk. 35 /kW of sanctioned load	Tk. 80 /kW of sanctioned load	Tk. 60 /kW of connected load
High Voltage 33 kV General Category - H	Flat Off peak Peak	Tk. 5.61 Tk. 5.08 Tk. 7.91	Tk. 35 /kW of sanctioned load per month	Tk. 400 /month	Tk. 80 /kW of connected load
Category - I1	REB 1)132kV 2)33kV -Economically unsolvent -Economically Margin -Economically solvent	Tk. 2.34 Tk. 2.05 Tk. 2.05 Tk. 2.39	Not applicable	Tk. 400	Not applicable
Category - I2	DESCO -132kV -33kV	Tk. 2.34 Tk. 2.39	Not applicable	Tk. 400	Not applicable
Category - I3	WZPDCL -132kV -33kV	Tk. 2.34 Tk. 2.39	Not applicable	Tk. 400	Not applicable
Category - I4	Distribution of BPDB -132kV -33kV	Tk. 2.34 Tk. 2.39	Not applicable	Tk. 400	Not applicable
Category - I5	Distribution Company in Future -132kV -33kV	Tk. 2.34 Tk. 2.39	Not applicable	Tk. 400	Not applicable
Street lights and pumps Category – J		Tk. 5.61	Tk. 37 /kW of sanctioned load	Tk. 205	Not applicable

Note: Category I is High Voltage Bulk Supply for Rural Electrification of Board/ Palli Biddyut Samiti
Source: PDB

Table 2.3.11 REB Tariff (PBS-2, Chittagong)

Consumer Category	**Range/Step**	**Tariff Rate** (Tk./kWh)	**Demand Charge** (Tk/kW/mo.)	**Service Charge** (Tk/month)	**Minimum Charge**
Class-A : Residential (House or Bari)	0-75 kWh	3.80	15.00	10.00	65.00
	76-200 kWh	4.63			
	201-300 kWh	4.79			
	301-400 kWh	7.16			
	401-600 kWh	7.48			
	Above 600 kWh	9.38			
Class-B : Pumps used in Agri-culture	Flat Rate for any consumption (kWh)	3.60	40.00 (Applicable for demand above 30kW)	30.00	10/HP
Class-C : Small Industry	Flat Rate	6.95	15.00/kW upto 25kW, 40.00/kW above 25kW	70.00	1-Phase =DC+SC 3-Phase=45.00/kW
	Off-Peak Hour	5.96			
	Peak Hour	8.47			
Class-D : Official/Commercial	Flat Rate	9.00	25.00	1-Ph.=10.00 3-Ph.=30.00	1-Ph. =95.00/kW 3-Ph.=130.00/kW
	Off-Peak Hour	7.22			
	Peak Hour	11.85			
Class-E : Medium Voltage (11KV) -General Use	Flat Rate	6.81	45.00/kW	400.00	Tk55.000/kVA
	Off-Peak Hour	5.96			
	Peak Hour	9.33			
Class-F : High Voltage-33KV General Use/WTP	Flat Rate	6.48	40.00/kW	450.00	80.00/kW
	Off-Peak Hour	5.87			
	Peak Hour	9.14			
Class-G : Street Light	Flat rate for any consumption (kWh)	6.48	15.00	-	389.00/light
Class-H : Charitable Institution (School, Madrasha, Mosque, Hospital etc		4.53	-	-	-

Source: PBS-2 (Polly Bidduth Samity-2, Chittagong)

2.4 Land Use

2.4.1 Existing and Future Land Use

The Detailed Area Plan for Chittagong Metropolitan Master Plan (2nd Edition, September 2011) includes existing land use and development plan proposals for the CCC area and areas outside the CCC area, covering a total area of 691 sq.km. In the DAP, the CCC area has been subdivided into six zones, termed as Detailed Planning Zones (DPZs), taking into account the urban, geo physical and development character and ward boundary. There are a further six DPZs outside the CCC area. For each DPZ development proposals, including future land use plans have been prepared. Table2.4.1 shows the reference number and general location of the DPZs. Existing land use in the DPZs 01 to 06 is shown in Table 2.4.2.

Table 2.4.1 Detailed Planning Zones

Type	Name
Within CCC Area	
DPZ 01	Patenga – Halishahar
DPZ 02	Agrabad – Kattali
DPZ 03	Sadarghat – Chawk bazaar
DPZ 04	Bakalia- Chandagon
DPZ 05	Lalkhan bazaar – Pahartali
DPZ 06	Panchlaish – Baizid
Outside CCC area	
DPZ 07	Silimpur – Kumira
DPZ 08	Hathazari – Raozan
DPZ 09	Kulgaon – Halda
DPZ 10	Madunaghat – CUET
DPZ 11	Boalkhali – Patiya
DPZ 12	Anwara - Karnaphuli

Source: Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011

Table 2.4.2 Existing Land Use

Unit: acre

Type of Use/Area	DPZ01	DPZ02	DPZ03	DPZ04	DPZ05	DPZ06	Total
Agriculture & Fisheries	1,725.36	725	2	925	11	2,026	5,414
Commercial Activity	42.23	52	336.61	282	141	72	926
Education & Research	65.36	55	46.71	46	48	18	279
Hilly land	-	-	595.01	-	2,296	2,636	5,527
Manufacturing & Processing	1,325.25	1,825	31.24	540	344	157	4,222
Miscellaneous	42.65	43	25.24	399	49	68	627
Mixed Use	4.29	4	251.78	676	80	19	1,035
Open/Community Space	36.60	33	41.42	149	48	15	323
Residential	3,023.04	3,326	838.24	1,015	1,635	1,287	11,124
Restricted (port, airport, defence)	1,273.36	773	41.85	-	142	1,426	3,656
Service Facilities	13.61	14	50.21	29	50	-	157
Transport & Community	625.36	725	356.08	479	405	358	2,948
Vacant Land	1,645.28	945	66.85	1982	393	792	5,824
Water Body (khals, ponds, marshy land	1,125.25	809	629.61	1,628	255	727	5,174
Coastal Char	1,756.36	756					2,512
Office Use			13.16	44	17		74
Total	**12,704**	**10,085**	**3,326**	**8,195**	**5,914**	**9,601**	**49,825**

Source: Detailed Area Plan for Chittagong Metropolitan Master Plan, 2nd Edition 2011, based upon Land use survey 2006-2007

Residential land accounts for approximately 22% of the total area in DPZ01 to DPZO6, ranging from 12% in DPZO4 to 33% of DPZ02.

2.5 Water Supply Sector Institutional Arrangement in Chittagong

2.5.1 General

A large number of government entities are in charge of various aspect of the water sector in Bangladesh. The National Water Management Plan (NWMP) lists not less than 14 ministries involves in the sector. Among them the Ministry of Local Government, Rural Development and Cooperatives (LGRD&C) is in charge of water supply in rural areas and cities.

2.5.2 Chittagong Water Supply and Sewerage Authority (CWASA)

Chittagong Water Supply and Sewerage Authority (CWASA) is responsible for providing water, sewerage and storm water drainage services in Chittagong.

2.5.3 Chittagong City Corporation (CCC)

Chittagong City Corporation (CCC), which is a local government autonomous body under the Ministry of Local Government, Rural Development and Cooperatives (LGRD&C), descended from Chittagong Municipality. Chittagong Municipality was established in 1863 and renamed as Chittagong Paura-Shava in 1977, then upgraded to a Municipal Corporation in 1982 and finally renamed as Chittagong City Corporation in 1990.

2.5.4 Chittagong Development Authority (CDA)

Chittagong Development Authority (CDA), which is the statutory planning and development authority for the Chittagong Metropolitan Area (CMA), was created in 1959 under the provisions of the CDA Ordinance 1959, and was established by Bangladesh Government in order to ensure the planned and systematic growth of the city. CDA was established to provide development improvement and expansion of the town of Chittagong and certain areas in its vicinity, with its major roles being development control, promotion and permission.

The major functions of CDA are:

- Preparation of master plan for Chittagong city and the area in the vicinity and its continuous review;
- Preparation of short term and long-term development programs for improvement and expansion of Chittagong city. This includes construction of new roads, widening and improvement of major city roads, construction of shopping complexes, development of industrial and residential estates and commercial plots and other necessary urban developments;
- Exercising planning control over the structure plan as per the provisions of CDA Ordinance and Government approved Master Plan;
- Development control within the preview of Bangladesh Building Construction Acts, 1952 and its subsequent revisions.

2.5.5 Department of Public Health Engineering (DPHE)

The Department of Public Health Engineering (DPHE), a national agency under the Ministry of Local Government, Rural Development and Co-operatives (MLGRD&C), is responsible for assisting municipalities and communities in the development and operation of water supply and sanitation infrastructure throughout the country except in Dhaka including Narayanganj, Chittagong, Rajshahi and Khulna where WASAs operate. DPHE’s mandate also includes providing advisory services in framing policy and actions plans for water supply and sanitation.

2.5.6 Department of Environment (DOE)

Refer to Section 2.2.3.

CHAPTER 3

EXISTING WATER SUPPLY AND ON-GOING WATER SUPPLY PROJECT

CHAPTER 3 EXISTING WATER SUPPLY AND ON-GOING WATER SUPPLY PROJECTS

3.1 Existing Water Supply System and Facilities

3.1.1 Existing Water Supply Services in Chittagong City

The area covered by the CCC is about 155 square kilometres and consists of 41 wards. The area falls in the jurisdiction of CWASA for water supply services according to the city's ordinances.

The current water sources of CWASA are surface water, which is used at Mohara Water Treatment Plant (WTP) (approximately 91,000 m^3/d capacity) and ground water, which is treated at Kalurghat Iron Removal Plant (68,000 m^3/d capacity), supplemented by many tube wells (60,000 m^3/d). The total production capacity of 219,000m^3/d caters for about 47% of the present demand in the CCC area.

The existing water supply network comprises 564 kilometres of transmission and distribution pipelines consisting of various materials (mainly Ductile Iron (DI), Asbestos Cement (AC) and polyvinyl chloride (PVC)). The network directly serves about 45,000 households out of an estimated number of households of more than 600,000 in the CCC area and hydrants (689 units). The overall service area is managed in two Maintenance and Operation Divisions (MOD), namely MOD-I and MOD-II, which are each further divided into two sub-areas. Figure 3.1.1 shows the existing water supply system and served area.

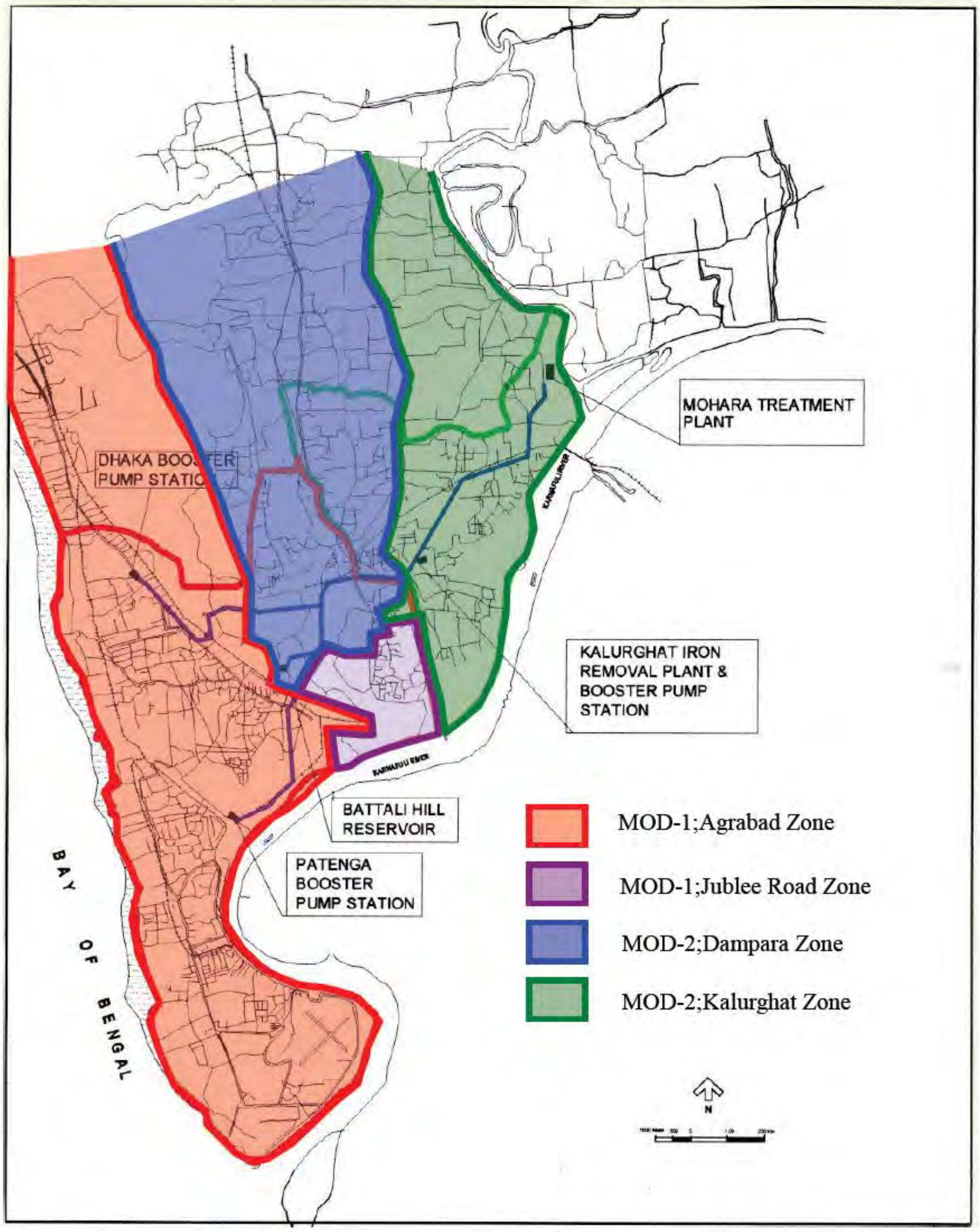


Figure 3.1.1 Existing Water Supply System and Served Area

3.1.2 Outline of Existing Water Supply Systems in Chittagong City

(1) Kalurghat Water Supply System

The Kalurghat System was constructed in 1977 under the International Development Association (IDA) financed First Chittagong Water Supply and Sanitation Project and subsequently added to in the Second Chittagong Water Supply Project. It was planned to cover the central area of the city by direct pumping from the Kalurghat Iron Removal Plant (IRP) with the provision of Booster Pump Stations (BPSs) and a balancing tank, i.e. old Battali Hill Reservoir. However, water has never been supplied to Battali Hill Reservoir because the reservoir is not watertight, due to structural failure. Therefore, water is directly supplied from the BPSs by pumps.

(2) Mohara Water Supply System

In 1988, the Second Chittagong Water Supply Project was completed with financing by the IDA. In the project, Mohara WTP, ADC Hill Reservoir, Patenga BPS, and Dhaka Trunk Road BPS were constructed, and pipelines connecting those facilities and old Battali Hill Reservoir[1] were also installed. Mohara WTP was constructed to supplement the water from the Kalurghat Water Supply System. In the original plan, the transmission line from Mohara WTP was designed to transmit water to two reservoirs, i.e., old Battali Hill Reservoir and ADC Hill Reservoir, and two booster pump stations, i.e., Dhaka Trunk Road BPS and Patenga BPS. However, water has not been supplied to either reservoir from this source and at present ADC Hill Reservoir is ~~s~~supplied from nearby tube wells. There are two branch pipelines in the Mohara system extending to the Nashirabad Industrial Area, and one pipeline is used as an interconnection pipe with the Kalurghat system.

(3) Operation of the Existing Water Supply System

Four interconnection pipes are installed between the Kalurghat and Mohara system. The valves installed between the two systems are usually open partially in order to relieve water shortages in the Kalurghat system. Consequently, Kalurghat IRP and Mohara WTP jointly serve an integrated water service area. However, the service area has suffered from chronic water supply interruptions due to a shortage of water production capacity.

The interconnections between the two systems force pump operation at lower pressure and larger supply amount from Mohara WTP. At Mohara WTP, two distribution pumps are operated in the daytime, while three pumps are operated during the night-time to supply water to higher elevation and distant areas. However the expected improvement in water supply interruptions has not occurred as of today.

Water pressure is still insufficient to reach both Battali Hill and ADC Hill Reservoirs. As these reservoirs are not used effectively, the whole system cannot cope with the peak water demand in the existing service area. During peak demand hours, water pressure is low in most of the service area and the area where there is disruption to the water supply service increases.

3.1.3 Major Water Supply Facilities in Existing Water Supply System

3.1.3.1 Mohara Water Treatment Plant

(1) Treatment Facilities

The existing Mohara WTP (production capacity of 91,000 m^3/d) treats surface water from the Halda River and is the first phase out of a planned two phases in the master plan. The High Rate Clarifier – Rapid Sand Filter treatment method is adopted in treatment process. A schematic diagram of the treatment process is shown in Figure 3.1.2.

[1] The pipeline connecting the transmission line with Battali Hill reservoir was also arranged for use as a “floating type reservoir”.

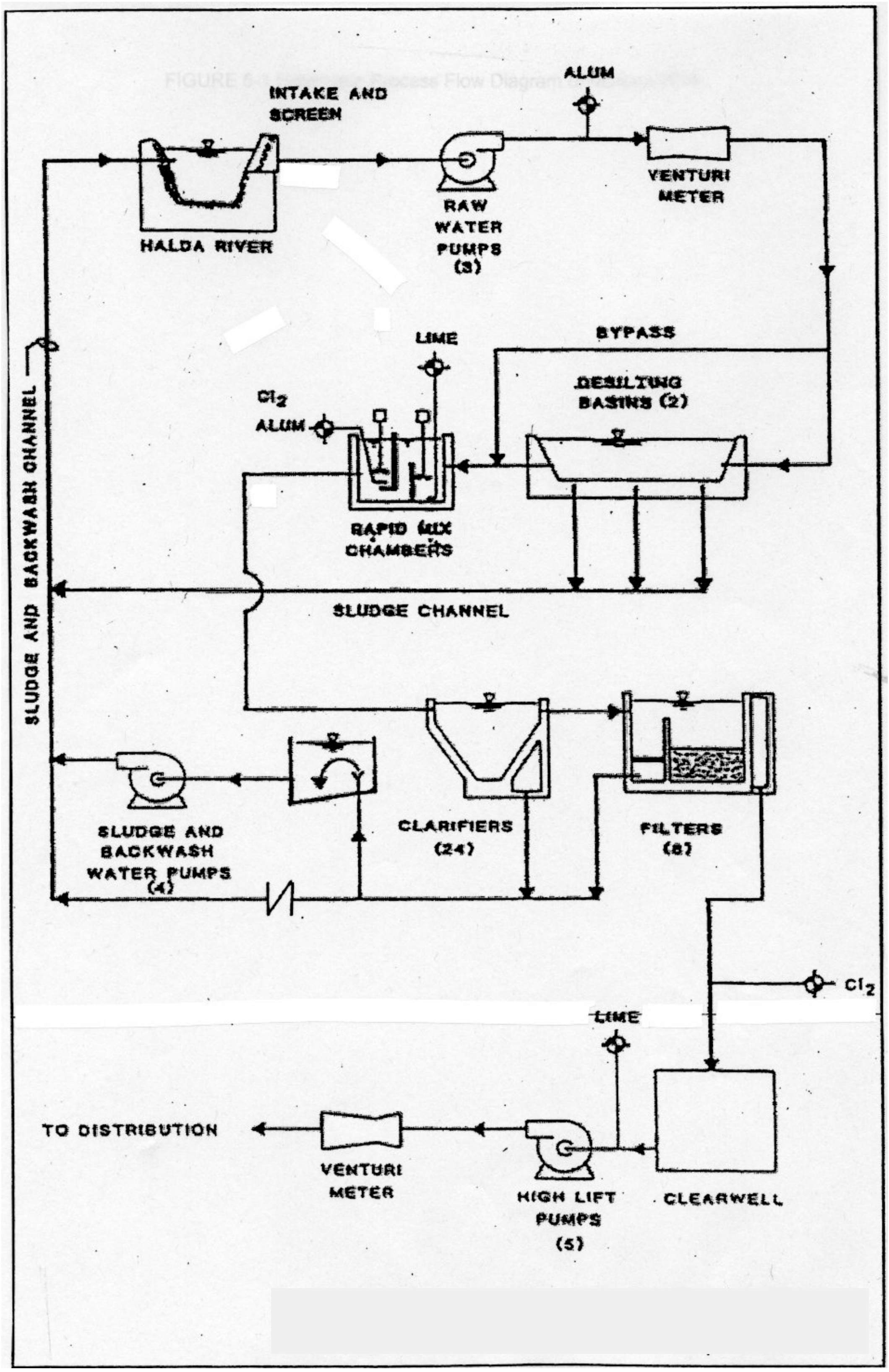


Figure 3.1.2 Treatment Process of Mohara WTP

Replacement of some mechanical and electrical equipment at the plant, provision of a standby generator and other works including installation of valves to facilitate operation and maintenance, has recently been completed, with financing by Japanese Government (Mohara and Kalurghat Water Treatment Plants Rehabilitation Project).

The plant consists of intake pumps (raw water pumps), desilting basins, flash mixers, clarifiers, filters, clear water reservoirs, transmission pumps (high-lift Pumps), a wastewater drainage facility, an administration building and a chemical storage building. The design raw water turbidity is 350 NTU. Two desilting basins are installed in order to reduce the load to the clarifiers and filters. All mechanical equipment including intake pumps, flash mixers, transmission pumps and drainage pumps is operated manually.

Land for expansion of the treatment facilities is available within the site area, although the area available is limited. The outline of the facilities is summarized in Table 3.1.1

Table 3.1.1 Outline of Facilities at Mohara WTP

Facilities	Dimension	Capacity/Notes
Intake Pump	47 m^3/min x 14 m x 160kW x 3 units 40m^3/min x 12.7m x 132kW x 2 units	new pumps recently installed old pumps; planned to be replaced in the future
Desilting Basin	25.29 m x 134.11 m x 1.98 m x 2 units	90,900 m^3/d
Rapid Mixing Chamber	2.29 m x 2.28 m x 1.45 m x 1 unit	for Lime
	2.29 m x 2.28 m x 1.00 m x 1 unit	for Alum
Clarifier	7.62 m x 7.62 m x 24 units	90,900 m^3/d
Filter	(2.44 m x 9.14 m x 2) x 8 units	90,900 m^3/d
Clear Water Reservoir	30.28 m x 39.27 m x Effective Depth 2.88m	Total Depth 4.57m
Transmission Pump	16 m^3/min x 83 m x 350 kW x 5 units	16m^3/min x 81 m (Punp recently replaced)

(2) Treatment Efficiency

The result of water quality analysis in 2010 is summarized in Table 3.1.2. During this year the turbidity of the raw water ranged from 20 NTU to 500 NTU, with the maximum turbidity being lower than the maximum of 830 NTU referred to in the SAPROF report. In the period from May to September turbidity ranged from 80 NTU to 500 NTU, with the maximum turbidity in the months of January, February and December being 70 NTU.

Turbidity of the treated water ranged from 0.5 NTU to 1.20 NTU, meeting the Bangladesh Drinking Water Standard (BDWS: 10 NTU) and WHO guideline (5 NTU). The maximum concentration of manganese in the treated water was 0.12 mg/l. which are slightly higher than the BDWS and WHO guideline of 0.1 mg/l. However, the concentration of the manganese ranged from 0.05 mg/l to 0.12 mg/l, showing an improvement compared to the period between February and August 2000, when it ranged from 0.10 mg/l to 0.16 mg/l.

In 2010 all other parameters complied with the BDWS, with the exception of copper in one month (1.08 mg/l compared to 1.00 mg/l in the BWDS).

Table 3.1.2 Results of Water Quality Analysis at Mohara WTP

No.	Parameter	Unit	Mohara WTP				BDWS	WHO DWG
			Dry Season		Rainy Season			
			Raw Water*	Treated Water*	Raw Water**	Treated Water**		
1	Water Temp.	^0C	28°C	25°C	29°C	28°C	-	
2	Conductivity	µS/cm	246	215.60	219	220.30	-	-
3	pH	-	7.01	7.12	7.23	7.18	6.5 ~8.5	6.5 ~8.5
4	Turbidity	NTU	70	0.96	500	0.90	10	5
5	T-Alkalinity	mg/litre	67	67	63	63	-	
6	Ca Hardness	mg/litre						
7	T-Hardness	mg/litre	55	50	130	130	500	250~500
8	NH_3-N(NH_3)	mg/litre	0.20	0.19	0.28	0.18	0.50	0.5
9	NO_3-N(NO_3)	mg/litre	3.0	3.2	2.0	1.8	44	10
10	PO_4	mg/litre	0.32	0.58	0.32	-	6	6
11	SO_4	mg/litre	20	20	17	18	-	400
12	Chloride	mg/litre	26	26	28	15	600	600
13	Resi. Chlorine	mg/litre	-		-	-	0.2	
14	T-Fe	mg/litre	0.28	0.32	0.60	0.55	1	0.1~1.0
15	Mn	mg/litre		0.07		0.10	0.1	0.5
16	SS	mg/litre					10	
17	TDS	mg/litre	124	108	210	95	1,000	1,000
18	DO	mg/litre	9.5		7.1		6	
19	BOD	mg/litre	1.3		1.4		0.2	
20	COD	mg/litre	23		20		4	
21	Fecal Bacteria							0
22	As	mg/litre		0.003		0.004	0.05	0.01
23	Cd	mg/litre		0.002		0.003	0.005	0.005
24	Cr	mg/litre		0.003		0.002	0.05	0.05
25	Cu	mg/litre		0.08		1.08	1	1
26	Pb	mg/litre		ND		ND	0.05	0.05
27	Hg	mg/litre					0.001	0.001
28	Zn	mg/litre		0.15		0.15	5	5
29	Cn	mg/litre					0.1	0.07
30	F	mg/litre		0.40		0.53	1	1.5

Sampling Date: * January, 2010 & ** June, 2010
BWDS: Bangladesh Drinking Water Standard (July 1991), ND: not detectable
WHO DWG: Guidelines for Drinking Water Quality (WHO, 2003)

(3) Detail of the Existing Facilities

1) Intake Facility

The intake facility consists of an intake mouth and intake pumps, with the intake mouth constructed at the riverbank and pumps installed in the pump house. River water is pumped after screening to the desilting basins, which are located 300 m from the pump house. During three months of the year from January to March, when turbidity of the raw water is low, water is directly pumped to the rapid mixing chamber to carry out cleaning of the desilting basins

2) Desilting Basin

The two desilting basins are used in order to reduce the load to the clarifiers and filters.

Pre-coagulation by alum is carried out at the inlet to the basins when turbidity exceeds 300 NTU for a period of 3 to 4 months in a year. During operation, sediment is removed every day by opening valves installed on four discharge pipes from the bottom of each basin. During the period from January to March when raw water is directly sent to the rapid mixing chamber settled silt in the basins is dried and removed manually.

3) Rapid Mixing Chamber

The rapid mixing chamber comprises two units of flash mixers installed in series, with lime and alum dosed upstream of each mixer, separately. When raw water is pumped directly to the rapid mixing basins, the water level rises above the designed water level (which is 0.55m below the top of the chamber).

4) Clarifier

Twenty four units of pyramid-type high rate sludge blanket type clarifiers are provided. The inlet pipe to each clarifier is 300 mm diameter at the centre of the clarifier. To retain the slurry interface at a stable level, there is a sludge pocket inside each clarifier and slurry is drained by manually operating a valve. Excess sludge is also drained by manual operation of valves installed on sludge drain pipes. The nature of the floc is basically good and sedimentation occurs even in inlet channel of clarifiers.

5) Filter

There are eight self-backwashing type filters with surface washing equipment. The continuous filtration time ranges from 30 to 40 hours and backwashing is conducted when the filter water depth reaches the critical design depth, 3.66 m at maximum. Currently the backwashing period is eight minutes, with five minutes of surface-washing commencing three minutes after the start of backwashing. Backwashing is carried out manually by judgment of the operators.

6) Clearwater Reservoir

A chlorination channel is installed at the beginning of the clear water reservoir. The reservoir is divided into two tanks, each with a capacity of 3,360 m^3, with a total retention time of 1.8 hours. Although the nominal retention time is 3 hours, which would require a capacity of 11,280 m^3, the actual retention time is considered to be practicable taking into account of the centre level of the suction pipes of the transmission pumps.

7) Wastewater Discharge Facilities

Wastewater generated at the treatment plant is discharged to the Halda River via a wastewater drain basin. When the water level in the river is low, wastewater can be directly discharged to the river by gravity. If the water level in the river is high, a flap gate which is installed on the effluent pipe is closed and wastewater flows into a wastewater drain basin. Wastewater stored in the basin is drained and discharged to the river by a slurry pump automatically operated by water level switch.

The basin receives wastewater generated in the plant from the following:

- Sludge which is drained from the bottom of the desilting basins
- Slurry which is drained from the slurry blanket and sludge which is drained from the bottom of the clarifiers
- Backwashing wastewater from the filters

8) Chemical Dosage Facilities

Alum as coagulant and lime as pH adjustment agent are dosed to the raw water. The dosing rates are determined based on turbidity, pH and the results of jar tests. Chemical dosing facilities for alum and lime are provided. The design turbidity is 350 NTU.

Post-chlorination is conducted for disinfection and pre-chlorination is also carried out from time to time to remove algae and/or insects.

9) Transmission Pump (High-Lift Pumps)

Five units of transmission pumps including one standby unit are installed in the pump house. The four duty pumps have sufficient capacity when all are operated to transfer the total production capacity to Battali Hill reservoir. However, at present, pumps are operated in low head and large discharge operation to cope with the increased water demand and restrictions caused by the connection with the Kalurghat System.

3.1.3.2 Kalurghat Iron Removal Plant (KIRP) and Booster Pump Station

(1) Treatment Facilities

Kalurghat IRP and BPS have nominal capacity of 45,500 m^3/d. Ground water containing high concentration of iron is pumped to the IRP from 41 tube wells, the majority of which are scattered in the MOD II area (only two wells are in the MOD I area). Table 3.1.3 summarizes water quality examination results on concerned wells as the sources of KIRP.

Aeration towers, sedimentation basins and filters are installed in the plant for iron removal. Groundwater is aerated by gravity sprinkling aeration towers for oxidization of iron and to disperse the volatile component, such as CO_2. Lime is dosed at the inlet of a sedimentation basin to raise pH. Although a chlorine injection facility is provided at the aerators, it is not used at present. Oxidized iron is removed in sedimentation basins and rapid sand filters. Treated water flows into a clear water reservoir and is directly distributed by pumps.

Additional filters with a capacity of 22,000 m^3/d located adjacent to the southern edge of the clear water reservoir were constructed in 1987 under the Second Chittagong Water Supply Project. The filters designed to reduce the load on the existing filters as an alternative to increasing the capacity of the IRP treat water without the need for sedimentation. The total treatment capacity of the IRP with the addition of the filters is 68,000 m^3/d.

Table 3.1.3 Results of Water Quality Analysis of Existing Deep Wells for Kalurghat Plant

No.	Name of TW	Sampling date	Water Quality								
			pH	Turbid-ity (NTU)	Cl (mg/l)	T-Fe (mg/l)	T-hardness (mg/l)	Alkalinity (mg/l)	Mn (mg/l)	No3 (mg/l)	TDS (mg/l)
1	No.1 TW	Jan,01,2011	6.72	22	20	6.7	95	112	0.5	1.2	135
2	No.2 TW	Jan,08,2011	6.68	18	20	5.6	92	110	0.4	1.0	130
3	No.3 TW	Jan,15,2011	6.92	32	22	7.2	90	115	0.6	0.80	128
4	No.4 TW	Jan,20,2011	6.81	22	18	6.9	85	112	0.8	0.90	137
5	No.5 TW	Jan,28,2011	6.80	26	22	5.2	86	140	0.5	0.8	160
6	No.6 TW	Feb,02,2011	6.84	30	20	5.2	65	98	1.0	1.20	138
7	No.7 TW	Feb,07,2011	7.08	12	18	8.2	125	130	1.8	1.20	112
8	No.8 TW	Feb,12,2011	7.80	16	22	5.2	72	112	0.8	1.0	135
9	No.9 TW	Feb,18,2011	6.84	20	30	1.5	78	110	0.4	1.0	138
10	No.10 TW	Mar,01,2011	7.12	10	32	5.4	110	95	0.6	1.3	158
11	No.11 TW	Mar,07,2011	7.32	12	15	2.2	86	92	0.4	1.2	108
12	No.12 TW	Mar,13,2011	7.48	19	22	6.2	62	94	0.3	0.8	102
13	No.13 TW	Mar,19,2011	7.23	20	25	4.2	72	86	0.4	2.10	132
14	No.14 TW	Mar,27,2011	6.82	12	15	7.8	92	140	0.9	1.50	158
15	No.15 TW	Apr,03,2011	6.68	36	35	15.0	110	120	1.2	1.30	162
16	No.16 TW	Apr,08,2011	-	-	-	-	-	-	-	-	-
17	No.17 TW	Apr,13,2011	6.68	25	45	6.8	92	112	0.4	0.8	240
18	No.18 TW	Apr,18,2011	-	-	-	-	-	-	-	-	-
19	No.19 TW	Apr, 25,2011	7.48	16	23	4.1	78	90	0.6	0.7	145
20	No.20 TW	May,01,2011	7.68	16	22	9.20	95	135	1.2	0.8	142
21	No.21 TW	May,08,2011	-	-	-	-	-	-	-	-	-
22	No.22 TW	May,12,2011	6.52	22	16	7.8	100	120	0.8	0.5	160
23	No.23 TW	May,18,2011	-	-	-	-	-	-	-	-	-
24	No.24 TW	May,24,2011	6.82	25	15	5.80	86	112	0.9	0.6	142
25	No.25 TW	Jun,01,2011	7.49	17	22	4.15	79	93	0.65	0.68	142
26	No.26 TW	Jun,08,2011	7.70	18	23	9.18	93	132	1.18	0.78	140
27	No.27 TW		-	-	-	-	-	-	-	-	-
28	No.28 TW	Jun,18,2011	6.55	21	17	7.82	101	11	0.84	0.49	161
29	No.29 TW		-	-	-	-	-	-	-	-	-
30	No.30 TW	Jul,23,2011	6.85	24	16	5.83	84	110	0.88	0.55	140
31	No.32 TW		-	-	-	-	-	-	-	-	-
32	No.33 TW	Jul,30,2011	6.84	30	20	5.2	65	98	1.0	1.20	138
33	No.34 TW	Aug,05,2011	7.01	10	16	8.1	120	128	1.78	1.18	110
34	No.35TW	Aug,13,2011	-	-	-	-	-	-	-	-	-
35	No.36 TW	Aug,19,2011	6.98	11	17	8.18	118	128	1.79	1.18	110
36	No.37 TW	Sep,01,2011	-	-	-	-	-	-	-	-	-
37	No.38TW	Sep,15,2011	-	-	-	-	-	-	-	-	-
38	No.39TW	Oct,15,2011	-	-	-	-	-	-	-	-	-
39	Kopolock-2 TW	Nov,01,2011	6.78	20	32	6.20	90	112	0.9	1.2	162
40	Fulkoli TW	Nov,15,2011	-	-	-	-	-	-	-	-	-
41	Saiyed shah TW	Dec,06,2011	6.72	28	35	8.2	92	135	1.5	1.2	172
Average (Kalurghat No.1-41)						6.52		109.72	0.86		
Max. (Kalurghat No.1-41)						15		140	1.80		
Min. (Kalurghat No.1-41)						1.5		11.0	0.3		
Water Drinking Standard			6.5~8.5	10	<600	<1.0	<500	-	<0.1	<1.0	<1,000

The newer filters have a blower so as to scour filter media by air during backwashing. The older filters do not have air or surface washing equipment and have been operated with insufficient washing operation resulting in early clogging of filter layers. Table 3.1.4 presents an outline of the IRP.

Table 3.1.4 Outline of Kalurghat Plant

Facilities	Dimensions	Capacity/Notes
Aeration tower	3.35 m x13.2 m x 4.44 mH x 2 units	22,700 m^3/d/unit
Sedimentation Basin	(46.38～34.16 m) x (79.19～68.52m) x 3.05 mD x 2 units	22,700 m^3/d/unit
Old Filter	4.88 m x 6.71 m x 8 units	45,500 m^3/d
New Filter	8.23 m x 13.30 m x 4 units	22,700 m^3/d
Clearwater Reservoir	29.87 m x 98.45 m x 2.87 m x 1 unit 22m x 135m x 6m x 1 unit	Nominal Volume: 9,100 m^3 Capacity 17,820 m^3
Distribution Pump	18 m^3/min x72 m x 315 kW x 4 unit	New pumps recently installed
	14.2 m^3/min x 63.4 m x 250 kW x 1 unit	Old pump, planned to be removed
	9.1 m^3/min x63.4 m x 200 kW x 1 unit	Old pump, planned to be removed
	12 m^3/min x 71.9 m x 200 kW x 2 units	Old pump, planned to be replaced

(2) Present Status of Iron Removal

In the original design, injection of chlorine and lime into the aeration tower was planned. However, it cannot be used for iron removal efficiently because chlorine is dispersed into the air. At present, only lime dosing is executed at the inlet of the sedimentation basins. Chlorine injection for iron removal purpose is not practiced and oxidization is carried out by the aeration tower only.

Table 3.1.5presents updated water quality examination results (May 26, 2011). The total iron of treated water in the clear water reservoir was 0.87 mg/L, less than WHO standard value of 1 mg/L.

Table 3.1.5 Iron Removal Status in Kalurghat Iron Removal Plant

Sampling No.	Iron (mg/l)	Sampling Point	WHO limit
No. 1	6.80	Aeration tower	0.1~1.0
No. 2	2.90	Before Aerator	
No. 3	2.85	After Aerator	
No. 4	2.78	Upstream of Sedimentation Basin	
No. 5	2.70	Middle of Sedimentation Basin	
No. 6	2.73	Downstream of Sedimentation Basin	
No. 7	2.73	Transmission Channel to Filter	
No. 8	1.18	After Old Filter	
No. 9	0.56	After New Filter	
No. 10	0.87	Clear Well	

Note: Sampling Date: 26-05-2011

As chlorine is injected at the inlet channel between the old filter and the clear water reservoir, oxidized iron might be settled in this reservoir. There is only one clear water reservoir and as there is no bypass line to the distribution pumps, the reservoir has never been cleaned. There is a possibility of re-elusion of settled iron to the treated water, which is stored in the reservoir.

(3) Booster Pumps

Pumps which are installed in the booster pump station (BPS) are utilized as distribution pumps. When four pumps are operated, the reservoir becomes empty within five or six hours, so the pumps must be stopped to allow the water level in the reservoir to recover. Because of this the pumps are operated intermittently, five to six hours during daytime and nine hours at night-time.

3.1.3.3 Other Water Sources

Thirty two tube wells under MOD-I are operated as of May 2012, as shown in Table 3.1.6. The production capacities of the wells have been gradually decreasing due to clogging of the well screens.

Table 3.1.6 Production Amount of Tube Wells under MOD-I

No.	Pump Name	Pump Type	Horse Power	Production Capacity (m^3/hour)
1	Love lane	Submersible	60	149.82
2	Jubilee road	Submersible	40~55	99.88
3	Collegiate	Submersible	75	149.82
4	Agrabad-1	Submersible	10	22.70
5	Agrabad-2	Submersible	12.5	49.94
6	Agrabad-3	Submersible	25	49.94
7	Halishahar-2	Submersible	15	36.32
8	Firojsha-1	Submersible	41	99.88
9	Firojsha-2	Submersible	41	49.94
10	Firojsha-3	Submersible	41	99.88
11	Halishahar-1	Submersible	25	49.94
12	Goalpara	Submersible	60	99.88
13	Policeline	Submersible	25	49.94
14	Ice Factory	Submersible	25	49.94
15	Jail road	Submersible	30	74.91
16	Bakulia	Submersible	33	83.99
17	Bahutala	Submersible	33	49.94
18	H-L block	Submersible	25	49.94
19	CGS colony	Submersible	25	49.94
20	MOD-I office	Submersible	25	49.94
21	Sadarghat	Submersible	41	99.88
22	Haji camp	Submersible	25	49.94
23	Dulalabad	Submersible	25	49.94
24	Rongipara	Submersible	13.5	29.96
25	Uttara	Submersible	25	49.94
26	Fire service	Submersible	25	49.94
27	Basundara	Submersible	25	49.94
28	Hazi para	Submersible	25	49.94
29	Al-Nahian	Submersible	41	99.88
30	Bisha colony	Submersible	41	99.88
31	CSD	Submersible	41	99.88
32	Moharipara	Submersible	25	49.94

Note: Data collected from Monthly Performance Report- operation (water) under MOD-I, Reporting month, May, 2012

There are also two tube wells under MOD-I as of May, 2012, operated to supplement the capacity of the wells supplying Kalurghat IRP (refer to Table 3.1.7).

Table 3.1.7 Production Amount of Tube Wells for KIRP

No.	Pump Name	Pump Type	Horse Power	Production capacity (m^3/hour)
1	Fulkali	Submersible	62	149.82
2	Saiyedshah	Submersible	62	149.82

Note: Data collected from Monthly Performance Report- operation (water) under MOD-I, Reporting month, May, 2012

There are thirty nine tube wells under MOD-II that are operated as of May, 2012, as shown in Table3.1.8. The water from these wells is pumped to Kalurghat IRP. The production capacities of the wells have been gradually decreasing due to clogging of the well screens.

Table 3.1.8 Production Amount of Tube Wells under MOD-II (1)

No.	Pump Name	Pump Type	Horse Power	Production capacity (m^3/hour)
1	Kalurghat-1	Turbine	60	75
2	Kalurghat-2	Turbine	60	60
3	Kalurghat-3	Submersible	72	65
4	Kalurghat-4	Turbine	80	100
5	Kalurghat-5	Turbine	60	85
6	Kalurghat-6	Turbine	60	80
7	Kalurghat-7	Turbine	80	70
8	Kalurghat-8	Submersible	72	100
9	Kalurghat-9	Turbine	50	76
10	Kalurghat-10	Turbine	80	120
11	Kalurghat-11	Submersible	72	90
12	Kalurghat-12	Turbine	60	120
13	Kalurghat-13	Submersible	72	40
14	Kalurghat-14	Submersible	72	154
15	Kalurghat-15	Turbine	80	60
16	Kalurghat-16	Turbine	75	40
17	Kalurghat-17	Submersible	52	50
18	Kalurghat-18	Turbine	60	70
19	Kalurghat-19	Submersible	25	17
20	Kalurghat-20	Turbine	60	70
21	Kalurghat-21	Submersible	72	60
22	Kalurghat-22	Submersible	52	43
23	Kalurghat-23	Turbine	60	90
24	Kalurghat-24	Turbine	75	34
25	Kalurghat-25	Submersible	52	50
26	Kalurghat-26	Submersible	41	80
27	Kalurghat-27	Turbine	60	15
28	Kalurghat-28	Turbine	75	160
29	Kalurghat-29	Submersible	72	154
30	Kalurghat-30	Submersible	72	150
31	Kalurghat-32	Turbine	75	70
32	Kalurghat-33	Turbine	60	76
33	Kalurghat-34	Turbine	60	40
34	Kalurghat-35	Submersible	72	90
35	Kalurghat-36	Submersible	72	70
36	Kalurghat-37	Submersible	72	110
37	Kalurghat-38	Submersible	52	72
38	Kalurghat-39	Submersible	52	120
39	Kolphlock-2	Submersible	72	156

Note: Data collected from Monthly Performance Report- operation (water) under MOD-II, Reporting month, May, 2012

There are also fourteen tube wells under MOD-II that are operated to provide water directly to the consumers as of May, 2012 (refer to Table 3.1.9).

Table 3.1.9 Production Amount of Tube Wells under MOD-II (2)

No.	Pump Name	Pump Type	Horse Power	Production capacity (m^3/hour)
1	Almas	Submersible	72	50
2	Mehedibag	Submersible	18	11
3	Ambagan	Submersible	25	13

No.	Pump Name	Pump Type	Horse Power	Production capacity (m^3/hour)
4	Khulshi	Submersible	25	11
5	Jalalabad	Submersible	25	21
6	Polytechnical	Submersible	25	7
7	Hilview	Submersible	18	20
8	Momenbag	Submersible	62	66
9	Shersha	Submersible	25	44
10	Bayzid	Submersible	25	17
11	Roufabad	Submersible	25	42
12	Garibullah	Submersible	25	32
13	MOD-2 pump	Submersible	41	80
14	Parsival Hill	Submersible	25	50

Note: Data collected from Monthly Performance Report- operation (water) under MOD-II, Reporting month, May, 2012

3.1.3.4 Existing Water Distribution System

(1) Existing Pipeline

The major transmission and distribution pipelines in the city were installed from 1966 to 1979 under the First Chittagong Water Supply and Sanitation Project. In this project AC pipe were used, with DI pipes being used in the Second Water Supply Project. For smaller size pipes with diameter less than or equal to 300 mm, PVC pipe have been used more recently. The total length of the existing pipelines is estimated at about 564 km, with the pipe length and materials by diameter shown in Table 3.1.10. However, the location of the pipes is difficult to identify due to lack of as-built drawings, as confirmed by the Project for Advancing Non Revenue Water Initiative (PANI).

Table 3.1.10 Length of Pipelines

Diameter (mm)	Length (m)				
	Ductile Iron (DI)	Asbestos (AC)	PVC	Other (MS pipe)	Total
100	0	8,720	261,526	33	270,279
150	0	18,920	64,180	0	83,100
200	0	17,720	67,258	12	84,990
300	5,523	46,959	6,280	0	58,762
450	5,123	23,894	0	0	29,017
600	11,108	13,024	0	0	24.132
750	1,910	0	0	0	1,910
900	10,325	0	0	0	10,325
1200	1,570	0	0	0	1,570
Total	35,559	129,237	399,244	45	564,085

Source: Inventory and Valuation of Fixed Assets CWASA

Table 3.1.11 shows the existing pipe length by pipe material and installed year (the part of pipes within limited information available).

Table 3.1.11 Pipe Length by Pipe Materials and Installed Year

Pipe Material	Length (m): Installed Year					
	Total	Before 1970	1971-80	1981 –90	1991 –2000	2001 -
PVC	150,600	17,500	100,900	11,700	20,500	
AC	128,000	51,200	70,100	6,700	0	
DI	129,900			129,900		

Source: Inventory and Valuation of Fixed Assets CWASA

(2) Area Served by Existing Distribution System

The location of the main pipelines as well as treatment plants and other major facilities is shown in Figure 3.1.3. The two systems i.e., the Kalurghat system and the Mohara system have an integrated water supply network without division into small service blocks. Even in the case of the existence of a small-scale elevated tank, the distribution volume is controlled by open-close operation of supply valve, without any systematic schedule. At present, under the considerable shortage of water supply capacity, intermittent water supply by valve operation is executed as daily practice or upon end users' request.

In the North Halishahar and Rampur areas, located in south of the Dhaka Trunk Road BPS, people suffer chronic water shortages which has been exacerbated by rapid population growth in the area. As Friday is a non-working day in the CEPZ, which is one of the largest consumers served by Patenga BPS, water is sent to the above two areas from Patenga BPS from Thursday night to Friday night by shifted valve operation. Such "intermittent water supply" is practiced with the provision of ground storage tanks by families, who typically have a storage tank with a capacity of 10 m^3 or more each in their premises.

(3) Kalurghat System

The distribution trunk main from Kalurghat IRP, diameter of 600 mm, is connected to Battali Hill reservoir (capacity approximately 13,600 m^3), which is the largest reservoir in the water supply system. As this reservoir was designed as a floating tank, a single connection pipe with a diameter of 600 mm was used for both the inlet and outlet pipes. From this distribution trunk main, two semi-trunk mains each with a diameter of 450 mm are extended to Dhaka Trunk Road BPS and Patenga BPS. However, currently treated water at Kalurghat IRP is directly supplied by pumps without utilizing Battali Hill reservoir because of the low working pressure.

A pipe with a diameter of 450 mm from Kalurghat IRP is connected to the transmission pipe from Mohara WTP, which has a diameter of 900 mm. Thus, Mohara system together with Kalurghat system directly distributes water without using existing reservoirs. Interconnection pipes between the two systems were installed without a systematic hydraulic study for the distribution being carried out. Intermittent pump operation has been forced due to insufficient capacity of the existing clear water reservoir (as stated previously) and limited water production by the wells.

(4) Mohara System

The Mohara system was designed to transmit treated water to Battali Hill reservoir, ADC Hill reservoir, Dhaka Trunk Road BPS and Patenga BPS.

Presently, Mohara WTP supplies treated water by high lift pumps without using Battali Hill reservoir. During daytime, two units of pumps are operated while three units are operated in night-time, from 11:00 or 12:00 pm to 8:00 am. To cope with the fluctuation of distribution flow, such irregular plant operation has been forced with continuous monitoring of water level in the clear water reservoir at the WTP. In addition, as distribution is carried out without a reservoir the peak demand cannot be met.

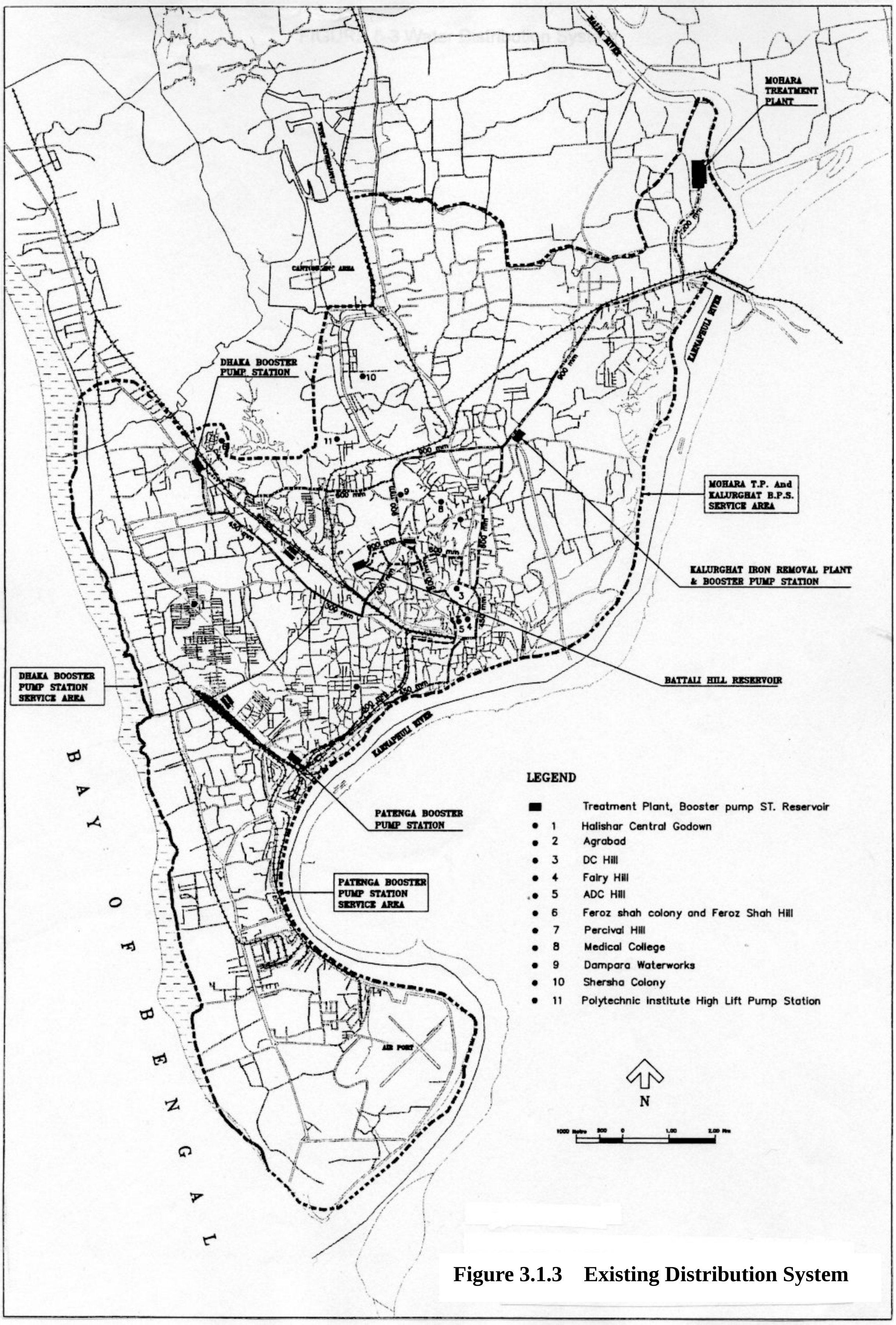


Figure 3.1.3 Existing Distribution System

With the exception of some locations, the service area of the Mohara and the Kalurghat systems is generally flat with an elevation of about 5 m. Since water supply capacity is limited, the areas located at the end of distribution pipelines or fringe parts of the service area cannot receive sufficient volume and water supply interruption occurs frequently during the period when areas near the WTP are receiving sufficient water.

(5) Small-scale Water Supply Systems

Besides the Mohara and the Kalurghat systems, several small-scale water supply systems are also utilized. The water source of the systems is groundwater. The typical system consists of a well source and a ground reservoir or an elevated tank and water is delivered by gravity. Most of them were constructed during the age of East Pakistan and no drawings of the facilities are available. Most of the groundwater from the existing wells contains high iron.

(6) Reservoirs and Booster Pump Stations

Among the existing reservoirs (excluding those at WTP and IRP), Battali Hill Reservoir has the largest storage capacity of about 13,600 m^3, followed by ADC Hill Reservoir having 4,546 m^3. Other reservoirs are small, namely; Agrabad elevated tank with 568 m^3, and other elevated tanks and ground reservoirs with a volume of 454 m^3 or less. The storage capacity and water level of each reservoir and elevated tank are shown in Table 3.1.12.

Table 3.1.12 Reservoirs and Elevated Tanks

Reservoir / Name		Capacity m^3	Water Level		Remarks
			HWL(m)	LWL(m)	
1	Mohara WTP	11,364	4.9	2.75	in use
2	Kalurghat IRP & BPS	9,092	3.32	0.0	in use
3	Halishahar Central Godown				
3-1	Tank 1 RC Elevated Tank	455	29.3	24.7	in use
3-2	Tank 2 RC Ground Reservoir	227	10.0	NA	in use
4	Agrabad RC Elevated Tank	568	25.3	21.9	in use
5	DC Hill RC Elevated Tank	455	48.8	43.9	in use
6	Fairy Hill				
6-1	Tank 1 RC Elevated Tank	455	40.5	36.0	not in use
6-2	Tank 2 SS Elevated Tank	796	36.1	28.8	no tank
7	ADC Hill Ground Tank	4,546	38.1	33.5	in use
8	Ferojshah Hill	227	46.0	NA	in use
9	Ferojshah Colony	45	15.0	NA	in use
10	Battali Hill	13,638	51.5	42.7	not in use
11	Percival Hill	455	42.7	38.1	in use
12	Medical College				
12-1	Water Tower RC Elevated Tank	45	25.0	NA	in use
12-2	Reservoir RC Ground Reservoir	455	43.6	40.2	in use
13	Dampara Waterworks RC Round Reservoir	455	15.0	NA	in use
14	Sherahah Collony RC Ground Reservoir	68	NA	NA	not in use
15	Parada Comer RC Ground Reservoir	68	NA	NA	in use
16	Polytechnic Institute High Lift Pimp Station	455	NA	NA	not in use
	Total	**46,142**			

There are two existing booster pump stations, namely; Dhaka Trunk Road BPS and Patenga BPS, having in-line boost pumping structure without a receiving tank.

3.2 On-going and Planned Water Supply Studies and Projects

Many studies for the improvement of water supply in Chittagong city have conducted through international technical assistance (JICA, JBIC and KOICA). Master plan for Water Supply and Wastewater Management of the Detailed Planned Area of Chittagong was prepared by KOICA in 2009 (utmost recent water supply study covering entire Chittagong city beyond CCC area). The following are on-going projects as of today.

3.2.1 Karnaphuli Water Supply Project (Phase 1)

A. Physical Works

(1) Purpose of the Project

To improve living standard of urban dwellers and investment climate in Chittagong City by developing water supply facilities and institutional capacity of CWASA.

(2) Scope of the work for the Project and Construction Packages

The water intake is located near the Godown Bridge, Rangunia on the right bank of the Karnaphuli River. The treatment plant will be constructed in Pomra along the Roads and Highways Department (RHD) main road. Treated water will be pumped to the Nashirabad reservoir through a 1,200mm diameter transmission pipeline. It is planned that Nashirabad reservoir would distribute water to Khulshi, Fatehabad, Nashirabad and Salimpur service blocks through an elevated tank with a capacity of 2,200 m^3. A part of the water will be pumped further to Battali Hill reservoir. Battali Hill reservoir is planned to distribute water to Kotowari, Halishahar, Agrabad and Madar-Bari service blocks.

The following are three construction packages.

1) Contract No. KWSP-C-1: Intake Facility and Water Treatment Plant

- Intake Facility: Civil/Architectural Works for 300,000 m^3/day
  Mechanical/Electrical Works for 150,000 m^3/day
- Water Treatment Plant: Production Capacity 143,000 m^3/day

2) Contract No. KWSP-C-2: Transmission and Distribution Pipelines

- Conveyance pipeline (1,200mm x 3.6 km)
- Transmission pipelines (1000/1200mm x 29.9 km) including Bridge crossing of Pipeline over Halda River
- Distribution pipelines (300-1,200mm x 42.8 km)

3) Contract No. KWSP-C-3: Nashirabad Reservoir(26,300 m^3), Battali Hill Reservoir (8,500m^3), and transmission/ distribution pumps
- Nashirabad Elevated Tank: capacity 2,200m^3
- Battali Hill Reservoir: capacity 8,500m^3
- Khulshi Booster Pump Station: rehabilitation work

Table 3.2.1 presents planned schedule for the construction packages. The outline of the Karnaphuli Water Supply System is shown in Figure 3.2.1.

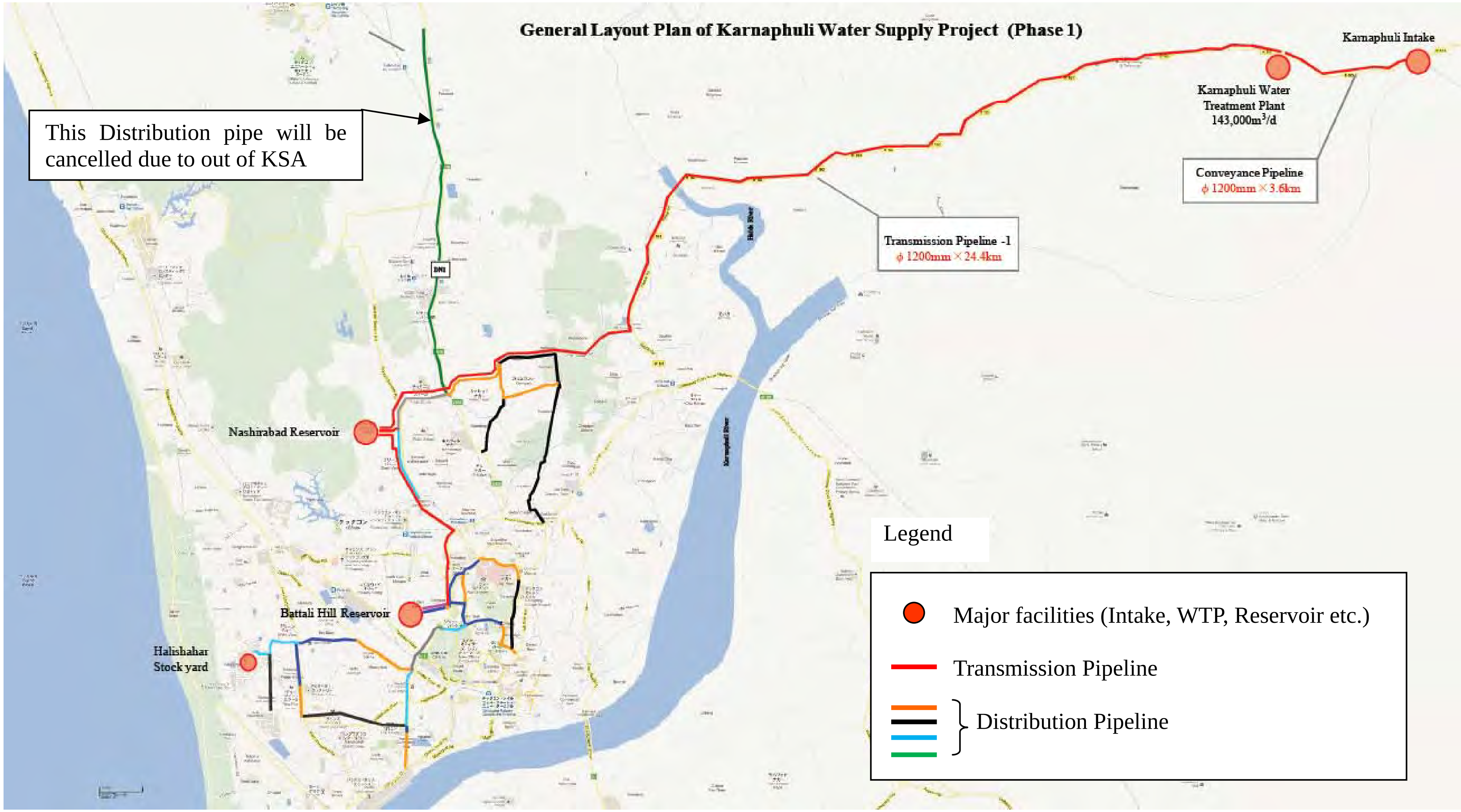


Figure 3.2.1 Outline of Karnaphuli Water Supply Project

Table 3.2.1 Construction Schedule by Package

Description	Package 1 (KWSP-C-1)	Package 2 (KWSP-C-2)	Package 3 (KWSP-C-3)
Contractual Commencement Date	11/20/2011	04/18/2012	02/09/2011
Contractual Completion Date	05/19/2014	10//04/2014	08/08/2013

(3) Status of the Project

Present progress status of the three packages is summarized as follows as of end of November 2012:

1) C-1 package: physical progress is reported at 11%
2) C-2 Package: physical progress is reported at 7%.
3) C-3 package: physical progress is reported at 61%.

With reference to the delay of C-2 Package, the following is relevant information.

At present work is on-going only in the CCC area, where trial pits are being carried out and pipe installation was scheduled to start in July, 2012. However, there was an objection from RHD, Ministry of Communication regarding laying 34 km of conveyance and transmission mains along the stretch from Madunaghat to the entrance to Chittagong University of Engineering and Technology and to the intake structure.

The RHD prefers that the Contractor lays the pipes outside the existing road surface. This is different from the original plan (and Contract), which is to install pipes under the road. Various problems will arise if the alignment is changed as per RHD’s preference, such as (i) need for survey and design of the pipeline for revised alignment of pipeline, (ii) relocation of households would be required, (iii) the removal of hundreds of old and young trees would be required, (iv) demolition of stores, businesses, etc. Negotiations between CWASA and RHD had been continued for more than 3 months. The permission on the pipe laying was obtained on October 3, 2012. Then, the contractor started construction work in the middle of October, 2012.

B. Institutional Works

JICA extended technical assistance for the development of the institutional capacity of CWASA (Institutional Development Consultancy Services (IDCS)) as follows:

(1) Purpose of the IDCS

The purpose of the IDCS is to strategically improve CWASA’s medium and long term management capacity to ensure the operational sustainability of CWASA in the post-implementation period of the Karnaphuli Water Supply Project.

(2) Scope of Services in the IDCS

The Consulting services consist of (1) business plan, (2) organizational restructuring, (3) legal and regulation, (4) water supply for slum dwellers, and (5) computerization of accounting system.

1) Business Plan

a) Assist CWASA to review the existing “Investment Plan” that includes new water production and distribution facilities that may be financed by donors and the GOB.

b) Assist CWASA to prepare an appropriate tariff structure including step tariff. This should take into account of customer's willingness to pay, affordability to pay and cost recovery of capital investment in a reasonable period.
c) Assist CWASA to prepare a "Revenue and Expenditure Plan" that considers tariff setting, water demand, billing and collection, NRW in the revenue, as well as operation and maintenance cost, number of staff, etc.
d) Assist CWASA to prepare a "Loan Repayment Plan" that considers the conditions of Subsidy Loan Agreements between CWASA and GOB, such as interest rate and repayment period.
e) Assist CWASA to prepare an integrated "Financial Model" of CWASA under the new organizational structure. The Investment Plan, the Revenue and Expenditure Plan and the Loan Repayment Plan prepared by the International Consultant (Business Plan) should be incorporated into the Financial Model.
f) Assist CWASA to prepare an initial 5-year Rolling Business Plan that should include the financial viability of CWASA by using the "Financial Model" prepared by the national Specialists (Business Plan) as well as the financial statement of CWASA.
g) Assist CWASA to update the Business Plan on an annual basis by the end of FY. The first two year's updates should take into account the other activities in the long-term action plans

2) Organizational Restructuring

a) Assist CWASA to create a "Transitional Plan" and implement the Plan
b) On- the- job Training

3) Legal and Regulation

a) Assist CWASA to review current acts, ordinances and regulations and propose new acts, ordinances and regulations.

4) Water Supply for Slum Dwellers

a) Assist CWASA to formulate schemes to provide water for the urban poor
b) Review lessons learned from the experience in other organizations

5) Computerization of Accounting System

a) Mobilization of the accounting and billing systems
b) On- the –Job training

(3) Status of the services

The assistance work for the institutional improvement of CWASA is on-schedule as of July, 2012. The Consultants inputs as of October, 2012 are reported at 71% of the scheduled. Supporting Report 3.3 shows the road map for the implementation of the services.

3.2.2 Project for Advancing NRW Reduction Initiative (PANI)

(1) Purpose of the project and scope of work

The purpose of the project is to provide CWASA staff with technology transfer for the improvement of capacity building with reference to the reduction of NRW. The area covered by PANI is limited to four pilot areas/zones, as shown in Figure 3.2.2, for which a redeveloped pipeline network MAP using

(Geographical Information Systems) GIS Mapping and high resolution satellite image was prepared, as referred to in the major activities below. Project activities also included house-to-house surveys to verify the functional status of water meters. The following are specific goal of the project.

1) Completion of Baseline Survey, Customer, Water Meter, Water Consumption & Billing
2) Installation of NRW Reduction Task Force, Meter Replacement/Installation, Monitoring
3) Transfer of Ownership of Service Connection & Water Meter
4) Renovation of Water Meter Testing Laboratory & Meter Storage Warehouse.
5) Installation of NRW Reduction Task Force, Meter Replacement/Installation, Monitoring
6) Installation of GIS Operation Group, Development and Operationalize Various Database

To achieve the goal, the major activities are:

a) Organize NRW Reduction Management & Action Teams,
b) Develop NRW reduction long term and annual work plan,
c) Implement pilot project for on the job training of NRW reduction work,
d) Redevelop GIS Map and information on distribution networks.

(2) Present status of the project

1) Redevelopment of distribution network drawings in use of GIS Mapping and high Resolution Satellite image in model area.
2) Field verifications survey to identify pipelines
3) Underground utilities survey (Test excavation)
4) House to House survey to verify functional status of water meter

(3) Issues and Problems on the on-going works

1) Absence of Reliable drawings of distribution net work
2) No updated record of drawings
3) Absence of accurate topographic map in Chittagong City.
4) Inappropriate customer data management due to absence of map

Figure 3.2.2 Location of PANI Area

5) No updated information of water meters installed at customers

Table 3.2.2 shows one of the outputs of the study for reduction of NRW in pilot areas.

Table 3.2.2 Experience on the Reduction of NRW in Provision/Replacement of Water Meter

Pilot Area	No of Connec-tions	Served Popula-tion	Survey Date		No. of Work-ing Meters	(1) Water quantity supplied (m^3)	(2) Water Con-sumption (m^3)	NRW (%): (2)/(1)
Khulshi	172	1049	Before	2011.1	72	1474	659	55%
			After	2011.2	129	1086	776	29%
				2012.5	152	2756	2230	19%
Chandgaon-A	201	1226	After	2011.10	191	3957	3390	14%
				2011.2	199	1626	1403	13%
Chandgaon-B	304	1854	After	2012.2	302	1951	1700	12%
Agrabad	234	1427	After	2012.4	229	1079	891	17%
Halishahar	128	781	After	2012.4	84	N A	N.A	-

Note: Data collected from PANI on 03-07-2012

3.2.3 Chittagong Water Supply Improvement and Sanitation Projects (financed by the World Bank)

Financing Agreement between GOB and International Development Association (IDA) was made for the Project on July 26, 2010. Then, the Subsidiary Loan Agreement was made between GOB and CWASA on October 19, 2010.

The project is targeted at infrastructure investments for increasing production of safe water by CWASA, coupled with the rehabilitation and expansion of its water distribution network to increase access to safe water within its service area. The project will also support the comprehensive institutional development of CWASA. In parallel, the clarification of institutional mandates for sewerage and drainage in Chittagong, and identification and design of priority investments will be supported. The Project consists of two major components as follows:

- Water Supply and Sanitation
- Sewerage and Drainage- US$ 9.5 Million including contingencies.

Note: Information source is Project Appraisal Documents, May 27, 2010.

Proposed works include the following:

(1) Construction of Madunaghat Water Treatment Plant, production capacity 90,000 m^3/d.

(2) Development of Transmission and Distribution System and Other Works

1) Madunaghat WTP to Nashirabad Reservoir (45,000m^3/d); 12.00km long pipeline, 900mm diameter.
2) Madunaghat WTP to Kalurghat Booster Pump station (45,000m^3/d); 9.00km long pipeline, 900mm diameter.
3) Kalurghat Booster Pump station to Patenga Booster Pump station (25,000 m^3/d); 13.00km long pipeline, 750mm diameter.

4) Rehabilitation of Kalurghat and Patenga BPSs

(3) Development of Drainage and Sanitation System

(4) Rehabilitation of existing CWASA distribution facilities

1) Distribution network in North Mohara Service block (20,000m^3/d, 80 km long with 10,000 connections)
2) Distribution network in South Mohara Service block (25,000 m^3/d, 50 km long with 15,000 connections)
3) Extension of water supply and sanitation services expanding to urban slums (phase-1)

The Government of Bangladesh agreed to lend to CWASA the amount in Taka equivalent to SDR 112,500,000 (equivalent to US$ 170,010,000). The Government opens a Subsidiary Loan Account on its books in the name of CWASA. CWASA shall pay to the Government interest on Principal of the Subsidiary Loan outstanding from time to time, at the 5% per annum. The execution of the agreement was scheduled to start on June 30, 2011 to complete June 30, 2030.

The EIA report for the project has been approved by the DoE and selection of Consultants is in progress for package (1).

3.2.4 Emergency Water Supply Project financed by GOB

CWASA has been undertaking Emergency Water Supply Project financed by GOB from January, 2010 to complete on June, 2013. The project was designed to construct 30 deep wells in CCC area to produce a total of 20,000m^3/d.

3.3 Organization and Activities of CWASA

3.3.1 Historical Background and Legal Status of CWASA

Chittagong Water Supply and Sewerage Authority (CWASA) was first established in 1963 under the East Pakistan Water Supply and Sewerage Ordinance 1963 for the purpose of providing water supply, sewerage and storm water services to the city of Chittagong.

The name of the Ordinance was changed to the Water Supply and Sewerage Authority Ordinance in 1984 after the independence of Bangladesh. The Water Supply and Sewerage Authority Act (WASA Act 1996) enacted in 1996 repealed the previous Ordinance and provided for the establishment of Water Supply and Sewerage Authorities to provide water supply, sewerage and drainage services to the cities and towns in Bangladesh.

The WASA Act 1996 prescribes that the Government shall establish an Authority that carries out water supply and sewerage services with an autonomous corporate management in local areas by notification in the official Gazette.

Whereas the Dhaka Water Supply and Sewerage Authority (WASA) was reorganized to an autonomous corporate soon after the WASA Act 1996 came in force, CWASA remained in direct control of the Ministry of Local Government, Rural Development and Cooperatives (MLGRD&C) until 2008.

CWASA has been vested to reorganize to an autonomous corporate with the Gazette issued in May 2008. Under the WASA Act, the CWASA's equity is fully owned by the Government, and the CWASA's Management Board is organized with the Board Members appointed by the Government.

13 Board Members was officially appointed by LGRD&C at the date of 31st July 2012, and the first Board Meeting was held on 1st September 2012.

The first Board Meeting determined to remain the present Managing Director and three Deputy Managing Directors in office, and the Government is in process of approval on the appointed Managing Director and Deputy Managing Directors.

As such, CWASA's management has started a new era.

3.3.2 Organization and Staffing of CWASA

Figure 3.3.1 shows the current organization of CWASA and the numbers of personnel presently sanctioned by the MLGRD&C and actually positioned. The Managing Director executes the management of CWASA under the policy determined by the Management Board.

The current organization, as shown in the organization chart, broadly comprises three departments, namely Engineering, Finance and Administration, and each department has a Deputy Managing Director in charge.

A. Engineering Department

The Engineering Department has a Chief Engineer under the Deputy Management Director (Engineering) to manage this department.

It comprises three circles named Treatment & Production Circle, Maintenance, Operation & Distribution Circle, and Planning & Construction Circle, each organized as follows:

(1) Treatment & Production Circle:

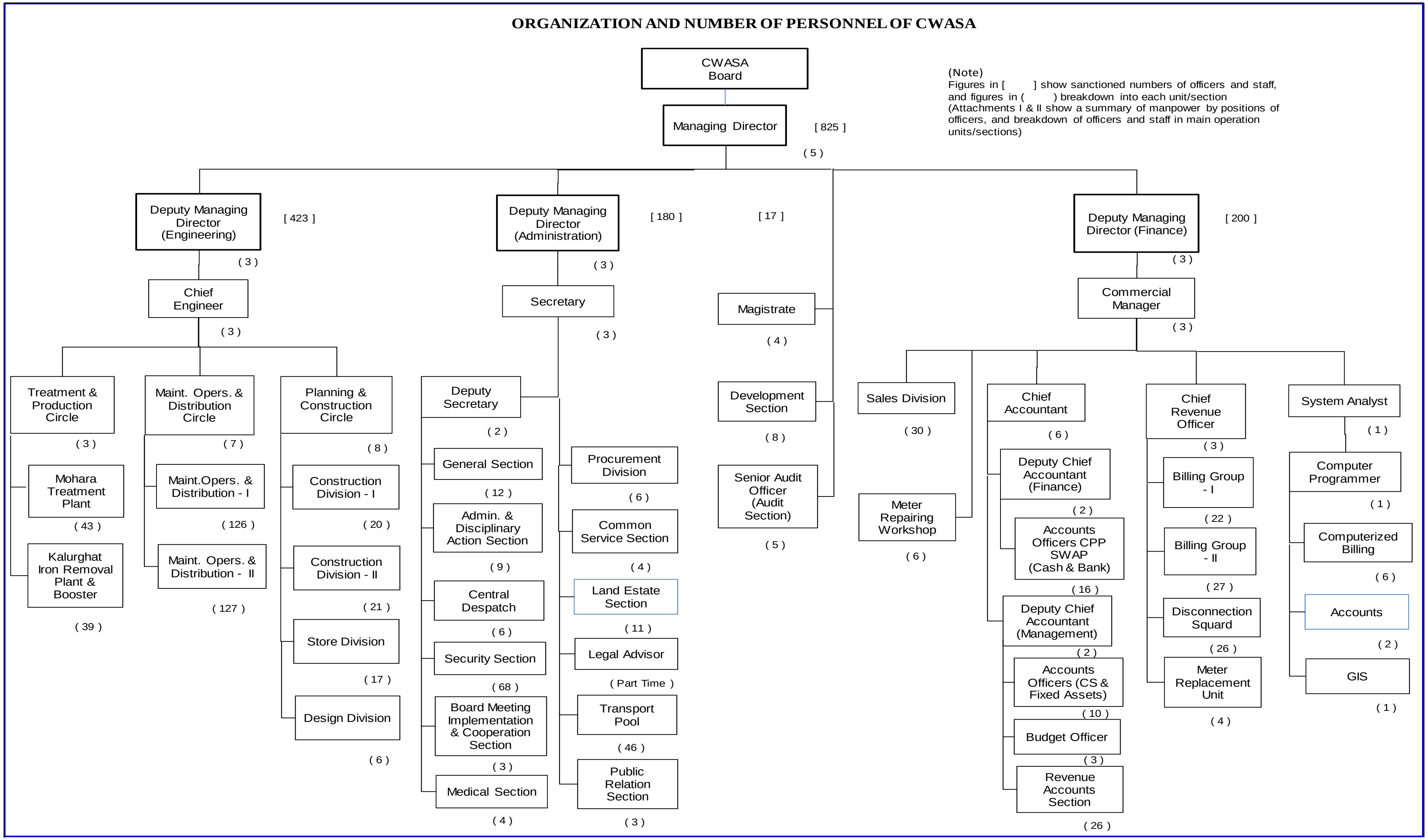
The Treatment & Production Circle is headed by a Superintendent Engineer and has two operational units; Mohara Water Treatment Plant (WTP) Unit, and Kalurghat Iron Removal Plant Unit.

(2) Maintenance, Operation and Distribution Circle:

The Maintenance, Operation and Distribution Circle are headed by a Superintendent Engineer and consist of two divisions named Maintenance, Operation and Distribution – I and Maintenance, Operation and Distribution – II.

(3) Planning & Construction Circle:

The Planning & Construction Circle consists of four Divisions; Construction Division – I, Construction Division – II, Store Division, and Design Division. The Planning and Construction Circle is headed by a Superintendent Engineer. He carries out duties for Planning by himself while supervising overall works of this Circle. The current organization of the Engineering Department is organized for the operation and maintenance of the existing water production and distribution facilities; Mohara WTP, Kalurghat IRP, Booster Stations, Deep Tube Wells, and water distribution pipelines/ network systems. The reorganization and enhancement of the Engineering Department should be immediately implemented to meet the requirements for efficient operation and maintenance of new large-scale water treatment plants, water transmission/distribution pipelines and network which will be put in operation with the completion of the on-going Karnaphuli Water Supply Project and other projects to be implemented in the near future.



Source: CWASA

Figure 3.3.1 Organization and Number of Personnel of CWASA

Table 3.3.1 Breakdown of Manpower Sanctioned and Actually Positioned for Main Operation Units (1)

MOHARA WTP			KALURGAT IRP AND BOOSTER STATION			MAINT. OPERS. AND DISTRIBUTION - I			MAINT. OPERS. AND DISTRIBUTION - II		
POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS	
	Actual	Sanctioned		Actual	Sanctioned		Actual	Sanctioned		Actual	Sanctioned
Executive Engr.	1	1	Executive Engr.	1	1	Executive Engr.	1	1	Executive Engr.	1	1
Assist. Engr.	2	3	Assist. Engr.	1	2	Assist. Engr.	2	2	Assist. Engr.	3	1
Sub-assist. Engr.	4	5	Sub-assist. Engr.	4	3	Sub-assist. Engr.	2	3	Supdt. Water Works	0	1
Chemist	1	1	Foreman	0	1	UDA	1	2	Sub-assist. Engr.	3	3
UDA	1	1	Overseer	0	2	LDA-Cum-Typist	2	5	UDA	1	2
LDA-Cum-Typist	0	1	LDA-Cum-Typist	1	2	Pipeline Supervisor	2	3	LDA-Cum-Typist	2	5
Electrician	2	2	Electrician	1	2	Head Plumbing Minstry	1	1	Pipeline Supervisor	3	3
Labo. Assist.	2	2	Pump Operator	3	9	Plumbing Mistry	12	9	Plumbing Mistry	8	9
Hight Lift Pump Operator	3	3	LIme Operator	2	3	Foreman (Tube - Well)	1	1	Electrician	0	2
Low Lift Pump Operator	1	3	Filter Operator	2	3	Electrician	1	2	Assist. Plumbing Mistry	17	16
Clarifier/Rapid Mixturte/			Chlorine Operator	2	3	Assist. Plumbing Mistry	15	16	Pump Operator	47	52
Desilting Basin Operator	3	3	Assist. Plumbing Mistry	0	3	Pump Operator	45	50	Assist. Pump Operator	7	21
Alum Operator	3	3	Helper	0	1	Assist. Pump Operator	7	14	Work Assistant	2	2
Filter Operator	3	3	Cleaner	1	2	Overseer	0	1	Valve Operator	5	3
Chlorine Operator	3	3	MLSS	1	2	Work Assistant	4	2	Lineman	1	1
Cleaner/Helper	4	5				Valve Operator	4	6	Meson	0	1
MLSS	0	2				Welder	1	1	MLSS	3	3
Sweeper	1	2				Helper	0	1	Sweeper	1	1
Overseer	2					Cleaner	1	2	Overseer	1	
						MLSS	1	3	Mechanic	1	
						Sweeper	0	1			
Total	36	43	Total	19	39		103	126		106	127

Source: CWASA

Table 3.3.1 Breakdown of Manpower Sanctioned and Actually Positioned for Main Operation Units (2)

CONSTRUCTION DIV. - I			CONSTRUCTION DIV. - II			STORE DIV.			SALES DIV.		
POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS	
	Actual	Sanctioned		Actual	Sanctioned		Actual	Sanctioned		Actual	Sanctioned
Executive Engr.	1	1	Executive Engr.	1	1	Executive Engr.	1	1	Executive Engr.	1	1
Assist. Engr.	2	2	Assist. Engr.	1	2	Assist. Engr.	1	2	Assist. Engr.	0	1
Sub-assist. Engr.	2	4	Sub-assist. Engr.	3	4	Sub-assist. Engr.	1	2	Sub-assist. Engr.	2	2
UDA	0	2	UDA	1	1	UDA	1	2	Overseer	0	2
LDA-Cum-Typist	2	2	LDA-Cum-Typist	0	4	LDA-Cum-Typist	1	3	UDA	2	1
Work Assistant	1	7	Surveyor	0	1	Store Keeper	1	2	LDA-Cum-Typist	1	2
MLSS	1	2	Work Assistant	1	5	Compressor Operator	0	1	Work Assistant	0	1
			MLSS	1	3	Mix. Machine Operator	0	1	Plumbing Mistry	2	6
						Cleaner	0	1	Assist. Plumbing Mistry	4	12
						MLSS	0	2	MLSS	2	2
Total	9	20	Total	8	21	Total	6	17		14	30

Source: CWASA

Table 3.3.1 Breakdown of Manpower Sanctioned and Actually Positioned for Main Operation Units (3)

METER REPAIRING WORKSHOP			BILLING GROUP - I			BILLING GROUP - II			DISCONNECTION SQUARD		
POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS		POSITION	NOS. OF PERSONS	
	Actual	Sanctioned		Actual	Sanctioned		Actual	Sanctioned		Actual	Sanctioned
Assist. Engr.	0	1	Revenue Officer	2	1	Revenue Officer	3	1	UDA	0	2
Meter Mechanic	0	2	Revenue Supervisor	5	4	Revenue Supervisor	2	4	LDA-Cum-Typist	1	5
Assist. Plumbing Mistry	0	2	UDA	2	2	Meter Inspector	1	12	Plumbing Mistry	3	6
MLSS	0	1	Meter Inspector	2	12	Meter Inspector	0	6	Assist. Plumbing Mistry	2	12
			LDA-Cum-Typist	7	2	UDA	2	1	MLSS	0	1
			MLSS	3	1	LDA-Cum-Typist	7	2			
			WA	4		MLSS	0	1			
			PLS	1							
			PO	13							
Total	0	6	Total	39	22	Total	15	27	Total	6	26

Source: CWASA

(4) Planning & Construction Circle:

The Planning & Construction Circle consists of four Divisions; Construction Division – I, Construction Division – II, Store Division, and Design Division. The Planning and Construction Circle is headed by a Superintendent Engineer. He carries out duties for Planning by himself while supervising overall works of this Circle. The current organization of the Engineering Department is organized for the operation and maintenance of the existing water production and distribution facilities; Mohara WTP, Kalurghat IRP, Booster Stations, Deep Tube Wells, and water distribution pipelines/ network systems. The reorganization and enhancement of the Engineering Department should be immediately implemented to meet the requirements for efficient operation and maintenance of new large-scale water treatment plants, water transmission/distribution pipelines and network which will be put in operation with the completion of the on-going Karnaphuli Water Supply Project and other projects to be implemented in the near future.

B. Finance Department

The Finance Department has a Commercial Manager under the Deputy Managing Director (Finance) to manage this department. It comprises Accounting Division, Sales Division, Revenue Division, Meter Repairing Workshop and System Analyst, each organized as follows:

(1) Accounts Division:

The Accounts Division is headed by a Chief Accountant and divided into two sub-divisions; Accounts Division (Finance) and Accounts Division (Management), each headed by a Deputy Chief Accountant.

(2) Sales Division:

The Sales Division is headed by an Executive Engineer. The main duties of this division are as follows:

1) Receiving applications for service connections and procedural works for service connections
2) Connection works including the installation of meters and saddles
3) Periodical check of leakage from service connections and repair or replacement of deteriorated facilities and/or meters

(3) Revenue Division:

The Revenue Division is headed by a Chief Revenue Officer and comprises four units as follows:

1) Billing Group I
2) Billing Group II
3) Disconnection Squad
4) Meter Replacement Unit

Billing Groups I and II carry out meter reading and billing to customers. Disconnection Squad carries out the expedition of payment collection and disconnection of services for customers that have not paid their bills. The Meter Replacement Unit carries out the replacement of non-functioning meters.

(4) Meter Repair Workshop:

This workshop is currently not operated.

(5) Computer System Group:

This group is currently not active.

The Finance Department, as explained above, is responsible not only for corporate financial and accounting functions but also for works in respect of service connections and disconnections, meter setting and maintenance, meter reading and billing, and collection of payments. This organizational structure includes a mixture of various business fields and expertise.

As the quantity of water supplied will be significantly increased with the completion of the on-going Karnaphuli Water Supply Project and the implementation of the Phase 2 Project, it is critical to establish an adequate organization and enhance staffing, in order to efficiently manage the expansion of service connections, meter setting, billings and payment collection.

As the same time, the Accounts Division should also be reorganized and enhanced so as to establish efficient financial and accounting system to meet the expansion of CWASA's business activities under corporate management with full autonomy.

C. Number of CWASA's Personnel

Table 3.3.2 shows a summary of CWASA's personnel sanctioned and actually positioned.

Table 3.3.2 Summary of CWASA's Personnel

No.	Name of Position	Numbers of Personnel	
		Actually Positioned	Sanctioned
1.	Managing Director	1	1
2.	Deputy Managing Director	3	3
3.	Chief Engineer	1	1
4.	Commercial Manager	1	1
5.	Secretary	1	1
6.	Superintendent Engineer	2	3
7.	Chief Accountant	1	1
8.	Chief Revenue Officer	1	1
9.	Magistrate	1	1
10.	Executive Engineer	10	10
11.	Deputy Chief Accountant	2	2
12.	Deputy Chief	1	1
13.	Deputy Secretary	1	1
14.	Senior Audit Officer	1	1
15.	Assistant Secretary	1	2
16.	Assistant Chief	0	1
17.	Research Officer	1	1
18.	Assistant Engineer	15	18
19.	Superintendent Water Works	0	1
20.	Public Relation Officer	1	1
21.	Revenue Officer	1	3
22.	Accounts Officer	1	2
23.	Budget Officer	0	1
24.	Purchase Officer	0	1
25.	Estate Officer	1	1
26.	Medical Officer	1	1
27.	System Analyst	0	1

No.	Name of Position	Numbers of Personnel	
		Actually Positioned	**Sanctioned**
28.	Chemist	1	1
29.	Computer Programmer	0	1
	Total Class I Officer	50	64
	Total Class II Officer	26	31
	Total Class III Staff	403	576
	Total Class IV Staff	131	154
	Grand Total	610	825

Source: CWASA

The actual number of CWASA's personnel, including the Managing Director, is 610 compared to 825 sanctioned, of which the actual number of Class I Officers is 50 compared to 64 sanctioned numbers, the actually positioned numbers of Class II Officers are 26 against 31 sanctioned, and the actual number of Class III Staff is 403 compared to 576 sanctioned.

The CWASA's MIS Report in March 2012 indicates the number of employees as 12.8 persons per 1,000 service connections

In view of the staffing of operational units, as shown in Table 3.3.2, the numbers of staff engaged in the works for service connections and meter setting, maintenance of service connection facilities and installed meters, meter reading and billing and collection of payments are inadequate to meet the increasing needs for these activities.

Foreseeing that CWASA's business activities will substantially expand with the completion of the on-going Karnaphuli Water Supply Project and the implementation of the Phase 2 Project, the following issues should be urgent tasks for CWASA:

(1) Establish an appropriate organization and adequate staffing for the operation and maintenance of the Karnaphuli Water Treatment Plant and water supply and distribution facilities which are now in construction under the Karnaphuli Water Supply Project and future facilities under the Phase 2 Project, including the adoption of efficient operation and maintenance systems and training of engineers, operators and technicians. The engineers who have experience in the operation and maintenance of water treatment plants and water transmission and distribution systems are very limited. Recruiting experienced key engineers as well as training young engineers is urgent.

(2) Establish an appropriate organization and adequate staffing for efficient management of service connections, installation and maintenance of service connection facilities and meters, meter reading and billing and collection of payments to meet substantial increase in the quantity of water supplied, including the adoption of more efficient management system and staff training.

(3) Reorganization of CWASA's overall organizational structures, administrative procedures and management systems.

3.3.3 Current Activities for Institutional Improvement of CWASA

Institutional improvement is a challenge for CWASA in order to reorganize the management and business administration systems as well as enhance the financial, operational and institutional capacity in the transition to management with autonomy.

(1) Business Plan

CWASA employed Institutional Development Consultants (IDC) to assist the organization for the above activities, by using a part of the JICA Loan provided for the on-going Karnaphuli Water Supply Project.

In accordance with the Terms of Reference, IDC has formulated, among others, a draft of CWASA's Business Plan, which outlines the direction and target for the performance to be achieved during the five years from FY 2011/12 to FY 2015/16.

CWASA organized a committee named Business Plan Committee for reviewing the draft Business Plan proposed by IDC. CWASA has approved the proposed Business Plan with some amendments, and submitted it to LGRD&C for their approval.

(2) Performance Agreement

Prior to the formulation of the Business Plan, CWASA concluded the Performance Agreement with GOB (LGRD&C) in early 2011 in accordance with the provision of Section 16 (3), Chapter IV of the WASA Act – 1996. This Performance Agreement sets the target for water service coverage to be attained up to the year 2015 as given in the following Table 3.3.3. The figures in planned and actual ones in 2011 are within a certain range of accuracy.

Table 3.3.3 Performance Agreement up to year 2015

Item	2010	2011	2012	2013	2014	2015
Population in Chittagong city (million)	3.975	4.050 (4.000)	4.125	4.200	4.275	4.350
Population in CCC area (mill.)	2.98	3.00 (2.60)	3.10	3.20	3.40	3.60
Population served with piped water (million)	1.190	1.230 (1.222)	1.302	1.376	2.72	2.88
Service Coverage (%)	40%	41% (47%)	42%	43%	80%	80%
No. of Service Connections	49,000	51,000 (45,000)	54,000	56,500	61,500	66,500
NRW (%)	30%	29% (33%)	28%	27%	26%	25%

Note: Figures in parenthesis in 2011 show updated information.

In addition, the Performance Agreement sets forth CWASA's targets for improvement of its business operation, including, among others, the following targets:

Table 3.3.4 Targets in Performance Agreement up to Year 2015

1. Technical Operation	1.1 Inspection and maintenance	・ Develop and keep up-to-date an inventory of all its water assets. ・ Develop and implement asset management procedures, including preventive maintenance procedures for all plants and networks.
	1.2 Water losses	・ Implement a NRW reduction program including zoning of the distribution system, leak detection, replacement of damaged meters and increase of the number of metered connections, reduction of illegal connections and other administrative and commercial losses to achieve a level of NRW of 25% by FY 2015.

		・ Use all the resources available, internally or externally, including the option of contracting the implementation of this program to the private sector.
2. Commercial Operation	Revenue collection	・ Improve the level of revenue collection to attain a ratio of 90% in 2015. ・ Implement billing and revenue collection procedures in order that all active accounts are billed on a monthly basis.
3. Customer Services	3.1 Customer relations	・ Improve commercial relations with customers along with prompt handling of queries and complaints so as to respond to a service complaint within 10 days. ・ Provide information to customers beforehand on expected water shortages, and reasons and estimated duration of the shortages.
	3.2 Media Campaign	・ Implement a media campaign to warm customers on the legal implication on the pilferage and theft of water. Implement a media campaign to bring awareness in customers of the benefit of the conservation of water resources.
4. Finance & Accounting	4.1 Improvement of cost coverage	・ Take adequate financial and regulatory measures to improve its total cost coverage ratio by at least 10% between 2010 and 2015. In 2015, the CWASA revenue shall at least cover the operation and financial costs (excluding depreciation).
	4.2 Computerization of accounting	・ Finalize computerization of accounting system, in particular, for revenue budget before 2013.
	4.3 Budget procedures	・ Review and update budget procedures, and issue manual of procedures and guidelines.
	4.4 Cash management, account and ledger reconciliations	・ Improve financial management in respect of cash management, account and ledger reconciliations and provide training to accounting staff to improve their efficiency.
5. Tariff Policy	・ Adapt a tariff structure leading towards the long-run marginal cost methodology. ・ Provide appropriate guidance to the charges to be applied to large, medium, small, commercial and domestic customers. ・ Take actions to adjust tariffs annually as required, based on an agreed inflation index, and to meet its financial objectives for the period 2010 – 2015, to enable it to achieve the performance targets.	

However, CWASA faces difficulty to achieve the targets, due to various constraints including limited availability of adequate internal human resources.

(3) Development of computerized accounting system

CWASA still follows traditional culture for business administration procedures, internal documentation, approval process and document control, and this is inefficient and time consuming for daily business activities. CWASA is currently carrying out the development of computerized billing system and accounting systems by outsourcing system experts under the financial assistance by the World Bank. The computerized billing system was recently completed and test run will be carried out soon. It is targeted to complete the development of the computerized accounting system by the middle of 2013. In view of the current business practice based on traditional culture and manual-based accounting, however, it is uncertain when the developed computerized accounting system can be adopted for practice.

Another problem that although the computerised accounting system currently being developed is linked to the billing system for water charges, it is not integrated with the system for the control of customers' billing and collection and MIS data, in particular with GIS based customer data.

Another task should be how to develop an integrated electronic data system that enables CWASA to monitor the performance of its overall operation.

(4) Restructuring of CWASA's organization

IDC's services include the investigation of the CWASA's organization for restructuring. According to IDC's roadmap, this task has been started in September 2012 and will be completed by the end of November 2012. Under these situations, restructuring of CWASA's organization will be implemented after IDC's recommendation on the restructuring.

3.3.4 Partnership Framework among Bangladesh Government and Development Partners

The Bangladesh Government and the Development Partners jointly entered into the partnership framework on November 10, 2007, in order to contribute to the Bangladesh's socio-economic development in the urban water supply and sanitation sector.

The partnership arrangements will be reviewed by the Working Group on a biannual basis by the Development Partners and the Bangladesh Government.

3.4 Financial Status of CWASA

3.4.1 Overview of CWASA's Current Financial Situation

The latest audited financial statements published by CWASA is for Fiscal Year (FY) 2008/09 (beginning at 1st July 2008 and ending at 30th June 2009). Hence the current financial situation of CWASA was reviewed on the basis of the audited financial statements for FY 2006/07, FY 2007/08 and FY 2008/09.

Table 3.4.1 shows a summary of the Income Statements in FY 2006/07, FY 2007/08 and FY 2008/09.

Table 3.4.1 Summary of Income Statements

(In BDT)

Particulars	FY2006/07 Amount	FY2007/08 Amount	FY2007/08 Inc./Dec. % *	FY2008/09 Amount	FY2008/09 Inc./Dec. % *
A. Water Supply Operation Income					
A-1. Water Revenue	300,123,533	342,267,601	14.0%	360,252,575	5.3%
A-2. Water Production/Supply Cost	(241,884,811)	(270,176,637)	11.7%	(275,991,022)	2.2%
A-3. Gross Profit from Water Supply Operation (A-1. - A-2.)	58,238,722	72,090,964	23.8%	84,261,553	16.9%
B. Other Operating Revenue					
B-1. Service Connection Charges & related revenue	10,738,554	26,370,414	145.6%	22,079,134	-16.3%
B-2. Licence and renewal fee of tubewells	70,769,345	61,381,909	-13.3%	54,468,935	-11.3%
B-3. Miscellaneous operating revenue	3,750,475	1,734,300	-53.8%	416,650	-76.0%
B-4. Other Operating Revenue - Total	85,258,374	89,486,623	5.0%	76,964,719	-14.0%
C. General & Administrative Expenses, incluing collection expenses	(76,778,819)	(80,240,336)	4.5%	(99,771,555)	24.3%
D. Gross Operating Income (A-3. + B-4. - C.)	66,718,277	81,337,251	21.9%	61,454,717	-24.4%
E. Non-operating Income					
E-1. Interest Income (Interest on Deposit)	25,778,332	45,462,895	76.4%	65,483,861	44.0%
E-2. Miscellaneous non-operational revenue	21,966,410	7,644,809	-65.2%	2,574,725	-66.3%
E-3. Paid Interest on Loans	(26,917,542)	(23,961,351)	-11.0%	(20,879,838)	-12.9%
E-4. Non-operating Net Income (E-1. + E-2. - E-3.)	20,827,200	29,146,353	39.9%	47,178,748	61.9%
F. Net Income (Profit/Loss) before tax (D. + E-4.)	87,545,477	110,483,604	26.2%	108,633,465	-1.7%
G. Tax paid	(3,125,397)	(3,034,367)	-2.9%	(7,989,626)	163.3%
H. Net Income (Profit/Loss) after tax	84,420,080	107,449,237	27.3%	100,643,839	-6.3%
(Cost Recovery Status of Water Revenue)					
A. Water Revenue	300,123,533	342,267,601	14.0%	360,252,575	5.3%
B. Water Production/Supply Cost	(241,884,811)	(270,176,637)	11.7%	(275,991,022)	2.2%
C. Gross Profit from Water Supply Operation	58,238,722	72,090,964	23.8%	84,261,553	16.9%
D. General & Administrative Expenses, incluing collection expenses	(76,778,819)	(80,240,336)	4.5%	(104,694,562)	30.5%
C. - D.	(18,540,097)	(8,149,372)	-56.0%	(20,433,009)	150.7%

Composition of Reveune Sources in Average of Three FYs (2006/07 - 2008/09)

Revenue Sources	Amount	Composition (%)
A. Water Revenue	334,214,570	70%
B. Other Operating Revenue	83,903,239	18%
C. Interest Income	45,575,029	10%
D. Miscellaneous Non-operational Revenue	10,728,648	2%
Total Revenue	474,421,486	100%

(Note) * Increase/Decrease % : against the previous year
(Source: CWASA Financial Statements: FY2006/07; FY2007/08; FY2008/09)

In view of the financial positions recorded during the three fiscal years (FY) of 2006/07, 2007/08 and 2008/09, CWASA recorded increasing profit every year even after deducting financial expenses.

The yearly increasing profit was derived from increases in the revenue. There are three categories of revenue sources, namely, (a) water revenue (main operation revenue), (b) other operation revenue, including (i) service connection charges and related charges, (ii) license and renewal fee of tube wells, and (iii) miscellaneous operating revenue, and (c) non-operation revenue including interest on deposit and miscellaneous non-operational revenue. Based on the average of the three years considered, the revenue earned from each of the three sources (a) to (c) indicated above accounts for about 70%, 18%, and 12% respectively of the total revenue.

Water revenue increased steadily each year during the period by 14.0% in FY 2007/08 and 5.3% in FY 2008/09, while other operating revenue (service connection fees and other revenue) were unstable with increasing by 5.0% in FY 2007/08 and decreasing by 14.0% in FY 2008/09.

Although the water production/supply cost increased year-on-year by 11.7% in FY 2007/08 and 2.2% in FY 2008/09, the Gross Profit from the Water Supply Operation (main operation) increased from BDT58.23 million in FY2006/07 to BDT72.09 million by 23.8% in FY2007/08 and further to BDT84.26 million by 16.9% in FY2008/09.

The Gross Operating Income including other operating revenue and general and administration expenses including collection expenses in addition to the water supply operation (main operation) income increased from BDT66.72 million in FY2006/07 to BDT81.34 million by 21.9% in FY2007/08, but decreased to BDT61.45 million in FY2008/09.

The non-operating income based on interest on deposit and miscellaneous non-operational revenue less paid interest on loans also increased from BDT20.83 million in FY2006/07 to BDT29.15 million by 39.9% in FY2007/08 and further to BDT47.18 million by 61.9% in FY2008/09.

In summing up, the Net Income recorded profit in the amount of BDT110.48 million before tax and BDT107.45 million after tax in FY2007/08 and in the amount of BDT108.63 before tax and BDT100.64 million after tax in FY2008/09.

In view of cost recovery status of the Water Revenue, the Water Revenue in FY2007/08 can recover the water production/supply cost plus about 89.8 % of the general and administration expenses including collection expenses, and the Revenue in FY2008/09 can recover the water production/supply cost plus about 80.0 % of the general and administration expenses including collection expenses.

The above implies that CWASA's financial position has remained in positive profit with contribution by operating revenue other than Water Revenue and non-operating income, even though the Water Revenue has been inadequate to recover the CWASA's overall costs and expenses.

Table 3.4.2 shows a summary of the operating expenses with a breakdown into major items of expenses.

Table 3.4.2 Summary of Operating Expenses

(In BDT)

Particulars	FY2006/07	FY2007/08		FY2008/09		Average of 3 FYs	
	Amount	Amount	Inc./Dec. %*	Amount	Inc./Dec. %*	Amount	Comp. %
A. Operation Cost for Water Production & Supply							
a. Personnel expenses	48,730,491	61,116,419	25.4%	60,589,054	24.3%	56,811,988	21.6%
b. Electricity & Power	106,982,612	122,190,346	14.2%	117,268,088	9.6%	115,480,349	44.0%
c. Chemicals	21,034,770	21,930,702	4.3%	29,638,489	40.9%	24,201,320	9.2%
d. Repair & maintenance	14,212,320	12,296,423	-13.5%	17,161,925	20.8%	14,556,889	5.5%
e. Depreciation	49,469,481	51,100,190	3.3%	49,284,105	-0.4%	49,951,259	19.0%
f. Office & miscellaneous expenses	1,455,137	1,542,557	6.0%	2,049,361	40.8%	1,682,352	0.6%
Total	241,884,811	270,176,637	11.7%	275,991,022	14.1%	262,684,157	100.0%
B. Overall Costs and Expenses for CWASA's Operation							
a. Personnel expenses	105,639,819	120,394,714	14.0%	132,828,255	25.7%	119,620,929	34.3%
b. Internal training, staff welfare, medical allowances	634,473	593,737	-6.4%	1,065,162	67.9%	764,457	0.2%
c. Electricity & Fuel	115,729,824	132,256,053	14.3%	126,832,873	9.6%	124,939,583	35.9%
d. Chemicals	21,034,770	21,930,702	4.3%	29,638,489	40.9%	24,201,320	6.9%
e. Repair & maintenance	16,979,874	14,516,991	-14.5%	20,099,156	18.4%	17,198,674	4.9%
f. Depreciation	49,469,481	51,100,190	3.3%	49,284,105	-0.4%	49,951,259	14.3%
g. Travelling & transportation expenses	514,287	661,087	28.5%	952,176	85.1%	709,183	0.2%
h. Insurance	575,933	632,004	9.7%	567,196	-1.5%	591,711	0.2%
i. Office & miscellaneous expenses	8,085,169	8,331,495	3.0%	14,495,165	79.3%	10,303,943	3.0%
Total	318,663,630	350,416,973	10.0%	375,762,577	17.9%	348,281,060	100.0%

(Note) *Increase/decrease %: against the expenses in FY2006/07

(Source: Financial Statements: FY2006/07; FY2007/08; FY2008/09)

In the table, Part A shows the Water Production/Supply Cost and Part B shows the CWASA's overall costs and expenses including the Water Production/Supply Cost, General and Administrative Expenses and Collection Expenses. The Water Production/Supply Cost includes all costs and expenses incurred for the production and distribution of water, including the operation and maintenance of the existing Mohara WTP, Kalurghat IR Plant, tube wells, booster pump stations, transmission and distribution pipelines, service connection facilities and meters.

Considering the average of the Water Production/Supply Cost during the three FYs (2006/07 – 2008/09), electricity and power account for about 44.0% of total, followed by 21.6% for personnel expenses, 19.0% for depreciation, 9.2% for chemicals and 5.5% for repair and maintenance. Comparing the expenses in FY2008/09 with FY2006/07, the Water Production/Supply Cost in FY2008/09 increased by 14.1% with increase in personnel expenses being 24.3%, electricity & power 9.6%, chemicals 40.9%, repair & maintenance 20.8%, and office and miscellaneous expenses 40.8%, although the depreciation decreased by 0.4%. It must be noted, however, that these figure show the operating costs for Mohara WTP and Kalurghat IRP on which the Rehabilitation were not completed yet. The depreciation will increase in FY2011/12 during which the Mohara and Kalurghat Rehabilitation Project was completed. Details of the depreciation schedule for FY2006/07 to FY2008/09 are enclosed in Supporting Report 3-1.

The financial expenses were interest of loans paid in each year. Table 3.4.3 shows details of interests paid during the three FYs (2006/07 – 2008/09).

Table 3.4.3 Details of Interests Paid during Three Years

(In BDT)

Particulars	FY 2006/07	FY 2007/08	FY 2008/09
	Amount	Amount	Amount
Financial Charges			
Interest on :			
a. First Interim WRSP Loan	9,949,000	9,949,000	9,949,000
b. Government loan, Non-project	0	0	253,830
c. Foreign Loan (IDA 1st Phase)	380,746	317,288	0
d. Foreign Loan (IDA 2nd Phase)	16,587,796	13,695,063	10,677,008
Sub-total	26,917,542	23,961,351	20,879,838
Bank charge	0	0	0
Total	26,917,542	23,961,351	20,879,838

(Source: Financial Statements: FY2006/07; FY2007/08; FY2008/09)

Details of debt-services in FY2006/07 to FY2008/09 are enclosed in Supporting Report 3-2.

Table 3.4.4 shows CWASA's Cash-flow Statements for FY2006/07, FY2007/08 and FY2008/09.

Table 3.4.4 Cash-Flow Statements

(Amounts in BDT)

Particulars		FY 2006/07 Amount	FY 2007/08 Amount	FY 2007/08 Inc./Dec. %*	FY 2008/09 Amount BDT	FY 2008/09 Inc./Dec. %*
A.	**Cash Beginning of Period**	146,762,444	177,711,567	21.09%	193,636,374	8.96%
B.	**Cash-flows from Operating Activities**					
B-1.	Cash received from Customers					
	Collection during the year	328,980,019	355,130,984	7.95%	368,526,953	3.77%
	Other Operating Revenue	128,716,413	137,402,323	6.75%	139,385,757	1.44%
	Total Receipts	457,696,432	492,533,307	7.61%	507,912,710	3.12%
B-2.	Payments					
	Cash paid to Suppliers, Contractors & Employees	317,478,040	426,242,014	34.26%	248,274,526	-41.75%
	Income Tax Paid	6,000,000	-		-	
	Cash paid to National Exchequer	5,000,000	5,000,000		-	
	Total Payments	328,478,040	431,242,014	31.28%	248,274,526	-42.43%
B-3.	Net Cash Flow from Operating Activities (B-1. less B-2.)	129,218,392	61,291,293	-52.57%	259,638,183	323.61%
C.	**Cash-flows from Investing Activities**					
	(Increase)/Decrease in Investment	(117,592,093)	(121,196,058)		19,042,103	
	Proceeds/(Purchase) Fixed Assets	(71,516,922)	(2,014,218)		(49,015,675)	
	Capital Work in Progress	(22,290,354)	(66,290,166)		(178,329,510)	
	Cash Inflow/(Outflow) from Investing Activities	(211,399,369)	(189,500,442)	-10.36%	(208,303,082)	9.92%
D.	**Financing Activities from Equity & Loans**					
	Fund Received	600,000	(10,779,000)	-1896.50%	(12,260,000)	13.74%
	Proceeds from Long Term Borrowing	210,000,000	282,881,315	34.71%	14,959,864	-94.71%
	Repayment of Long Term Borrowing	(97,469,900)	(127,968,358)	31.29%		
E.	**Net Cash Inflow/(Outgflow) from Financing Activities**	113,130,100	144,133,957	27.41%	2,699,864	-98.13%
F.	**Net Increase/Decrease in Cash & Cash Equivalent (B-3. + C. + D-4.)**	30,949,123	15,924,807	-48.55%	54,034,965	239.31%
G.	**Cash at End of the Period (A. + F.)**	177,711,567	193,636,374	8.96%	247,671,339	27.91%

(Note) * Increase/Decrease % : against the previous year

(Source: CWASA Financial Statements: FY2006/07; FY2007/08; FY2008/09)

Cash receipts increased from BDT457.70 million in FY2006/07 to BDT492.53 million by 7.6% in FY2007/08 and further to BDT507.91 million by 3.1% in FY2008/09 with increases in water revenue collection as well as the receipt of other operating and non-operational revenue. On the other hand, the payments remained always in an amount less than the receipts, and in particular it is remarked that the payments in FY2008/09 was substantially reduced in FY2008/09.

The net cash-flow from operating activities was positive during the period, because of cash payments limited to available cash by means of delay in or arrears in payments due as reviewed and discussed earlier on the Balance Sheet.

Table 3.4.5 shows a summary of Balance Sheets in FY 2006/07, FY 2007/08 and FY 2008/09.

Table 3.4.5 Summary of Balance Sheets

(Amount in BDT)

Assets	FY 2006/07 Amount	FY 2007/08 Amount	FY 2007/08 Inc./Dec. %*	FY 2008/09 Amount	FY 2008/09 Inc./Dec. %*
Non-Current Assets					
Property, Plant & Equipment	1,093,271,849	1,044,185,877	-4.5%	1,115,639,117	6.8%
Capital work in Progress	242,049,898	308,340,064	27.4%	486,669,574	57.8%
Deferred expenditure	135,514	135,514	0.0%	135,514	0.0%
Investment	419,265,568	540,461,626	28.9%	521,419,523	-3.5%
Total Non-Current Assets	1,754,722,829	1,893,123,081	7.9%	2,123,863,727	12.2%
Current Assets					
Stock & Stores	88,853,289	103,798,768	16.8%	102,688,791	-1.1%
Accounts Receivable	211,185,010	198,321,626	-6.1%	190,047,248	-4.2%
Other Receivable	15,435,241	20,627,245	33.6%	26,264,794	27.3%
Advance, deposits and prepayments	332,886,773	438,209,279	31.6%	376,406,959	-14.1%
Cash and bank balances	177,711,567	193,636,374	9.0%	247,671,339	27.9%
Total Current Assets	826,071,880	954,593,292	15.6%	943,079,131	-1.2%
Total Assets	2,580,794,709	2,847,716,373	10.3%	3,066,942,858	7.7%
Equity Fund					
Capital fund	1,070,887,680	1,060,108,680	-1.0%	1,224,722,777	15.5%
Excess value of assets due to physical verification	280,067	280,067	0.0%	280,067	0.0%
Surplus on revaluation of asset	45,473,332	45,473,332	0.0%	45,473,332	0.0%
Retained earnings	-545,705,113	-443,255,876	-18.8%	-342,612,037	-22.7%
Total Equity	570,935,966	662,606,202	16.1%	927,864,139	40.0%
Liabilities					
Non-Current Liabilities					
Long term liabilities	1,009,912,536	1,164,825,493	15.3%	1,074,632,927	-7.7%
Current Liabilities					
Accounts Payable	11,660,682	8,023,283	-31.2%	15,438,118	92.4%
Creditors for expenses	961,906,104	983,764,059	2.3%	1,016,190,722	3.3%
Creditors for other finance	25,429,121	27,562,161	8.4%	31,891,649	15.7%
Employees Provident Fund	950,300	935,175	-1.6%	925,302	-1.1%
Total Current Liabilities	999,946,207	1,020,284,678	2.0%	1,064,445,792	4.3%
Total Liabilities	2,009,858,743	2,185,110,171	8.7%	2,139,078,719	-2.1%
Total Equity and Liabilities	2,580,794,709	2,847,716,373	10.3%	3,066,942,858	7.7%

(Note) *Increase/Decrease % against the previous year.
(Source: Audited Financial Statements in FY2006/07; FY2007/08; FY2008/09)

In view of the Balance Sheets in FY 2006/07, FY 2007/08 and FY 2008/09, the following points can be highlighted:

(1) Non-current Assets and Non-current Liabilities

Non-current assets substantially increased from BDT1,754.72 million as at the end of FY 2006/07 to BDT1,893.12 million, an increase of 7.9%, as at the end of FY 2007/08 and further to BDT2,123.86 million, an increase of 12.2% as at the end of FY 2008/09 with the construction works for the Mohara and Kalurghat Rehabilitation Project being carried out during this period. Non-current liabilities based on long-term liabilities also increased from DBT1,009.91 million as at the end of FY 2006/07 to BDT1,164.83 million, an increase of 15.3%, as at the end of FY 2007/08 and then decreased to BDT1,074.63 million as at the end of FY 2008/09. The substantial increase in the long-term liabilities during FY 2007/08 was due to an increase in the loans received from GOB for the Karnaphuli Water Supply Project and Mohara and Kalurghat Rehabilitation Project, exceeding the repayment amounts of the outstanding loans incurred during FY 2007/08. The decrease in the long-term liabilities during FY 2008/09 was due to the funds for the Mohara and Kalurghat Rehabilitation Project received from GOB being in the form of Grant and GOB Equity (i.e., BDT74,339,097 in Grant and BDT102,535,000 in GOB Equity), resulting in the loans received from GOB being less than the repayment amounts of the outstanding loans incurred during FY 2008/09. (Refer to Details of Debt-Services given in Supporting Report 3-2 and Details of Change in Equity Capital enclosed in Supporting Report 3-3.)

(2) Current Assets and Current Liabilities

Current assets substantially increased from BDT826.07 million as at the end of FY 2006/07 to BDT954.59 million, an increase of 15.6%, as at the end of FY 2007/08, then decreased to BDT943.08 million, an increase of 1.2%, as at the end of FY 2008/09, while current liabilities increased from BDT999.95 million as at the end of FY 2006/07 to BDT1,020.28, an increase of 2.0%, as at the end of FY 2007/08 and further to BDT1,064.45, an increase of 4.3%, as at the end of FY 2008/09.

The major current assets are (a) Accounts Receivable, (b) Advance, Deposits and Prepayment and (c) Cash and Bank Balances, which account for about 22%, 42% and 23% respectively, and 87% in total of the current assets in average of the three FYs (2006/07 to 2008/09). Accounts Receivable was the outstanding balance of uncollected water bills, as at the end of each fiscal year, calculated by (i) adding billed amounts during the year to (ii) the opening balance as at the beginning of the year and (iii) deducting collected amounts during the year. Bank Balances indicate the paid water bill amounts, since the customers pay water bills into CWASA's accounts at the designated banks.

Table 3.4.6 summarizes a trend of the above three items of current assets during the three FYs indicated above.

Table 3.4.6 Trend of Major Items of Current Assets

Particulars	FY 2006/07	FY 2007/08		FY 2008/09	
	Amount (BDT)	Amount (BDT)	Inc./Dec. (%)*	Amount (BDT)	Inc./Dec. (%)*
a. Account Receivables (Water Bills)	211,185,010	198,321,626	-10.3%	190,047,248	-4.2%
b. Advance, Deposits and Prepayment	332,886,773	438,209,279	+31.6%	376,406,959	-14.1%
a. Cash and Bank Balances	177,711,567	193,636,374	+9.0%	247,671,339	+27.9%
Total (a. + b. + c.)	721,783,350	830,167,279	+15.0%	814,125,546	-1.9%

*Note:*Increase/decrease % against the previous year.*

Accounts Receivable decreased every year, while Cash and Bank Balances increased every year. This trend implies substantial improvement of the collection of water bills. Nevertheless, a large amount of the accounts receivable was accounted at the end of every fiscal year due to a longer collection period. MIS reports indicate a collection period of about 200 days.

The current ratio (Current Assets divided by Current Liabilities) was within an allowable range of 0.83 in FY2006/07, 0.93 in FY2007/08 and 0.81 in FY2008/09. However, it must be noted that such a relatively stable balance was due to the Current Liabilities controlled with delay in and arrears in various payments.

Current Liabilities consist of four major components, namely, A. Accounts Payable, B. Creditors for Expenses, C. Creditors for Other Finance and D. Employees Provident Fund, accounting for about 1.1%, 96.0%, 2.8% and 0.1% respectively of the total Current Liabilities in average of the three FYs (2006/07 – 2008/09). In particular, it must be remarked that Creditors for Expenses account for about 96% of the Current Liabilities in each of the three FYs (2006/07 – 2008/09), although there were no short-term loans during this period.

Table 3.4.7 shows details of the Creditors for Expenses and Creditors for Other Finance reported in the Audited Financial Statements. Creditors for Expenses and Other Finance mean delay in or arrears in payment due.

Table 3.4.7 Details of Creditors for Expenses and Other Finance

(Amount in BDT)

Particulars	FY 2006/07	FY 2007/08		FY 2008/09		Average of 3 FYs	
	Amount	Amount	Inc./Dec. %*	Amount	Inc./Dec. %*	Amount	Comp. %
Creditors for Expenses							
a. Salary and allowance payable	8,915	13,140	47.4%	165,799	1759.8%	62,618	0.0%
b. Staff welfare fund	16,450	13,204	-19.7%	13,190	-19.8%	14,281	0.0%
c. Advance received against deposit works	14,124,621	13,242,949	-6.2%	25,112,069	77.8%	17,493,213	1.8%
d. Accrued interest on:							
- 1st Interim Water Supply & Rehabilitation Project	201,270,464	211,219,464		221,168,464		211,219,464	
- IDA Loan (1st Phase)	2,521,768	2,017,414		1,513,060		2,017,414	
- IDA Loan (2nd Phase)	736,181,791	749,876,855		760,553,863		748,870,836	
Sub-total	939,974,023	963,113,733	2.5%	983,235,387	4.6%	962,107,714	97.4%
e. Salary and wage payable	11,995	41,848	248.9%	34,719	189.4%	29,521	0.0%
f. Miscellaneous payable	7,770,100	7,339,185	-5.5%	7,629,558	-1.8%	7,579,614	0.8%
Total	961,906,104	983,764,059	2.3%	1,016,190,722	5.6%	987,286,962	100.0%
Creditors for Other Finance							
a. Custmers Security Deposits	3,595,935	4,113,535	14.4%	4,521,735	25.7%	4,077,068	14.4%
b. Income tax deduction from contractors (non-project)	57,848	84,655	46.3%	640,982	1008.0%	261,162	0.9%
c. Security deposits and other deduction from contractors & suppliers	11,548,074	9,333,400	-19.2%	10,475,957	-9.3%	10,452,477	36.9%
d. Government Industries & Hotels etc.	10,116,350	13,608,350	34.5%	15,593,350	54.1%	13,106,017	46.3%
e. Lease of Street Hydrant	40,000	40,000	0.0%	24,217	-39.5%	34,739	0.1%
f. VAT deduction from contractors & suppliers	70,914	382,221	439.0%	635,408	796.0%	362,848	1.3%
Total	25,429,121	27,562,161	8.4%	31,891,649	25.4%	28,294,310	100.0%

(Note) *Increase/Decrease % against FY2006/07

(Source: Audited Financial Statements in FY2006/07; FY2007/08; FY2008/09)

In view of major items included in the Creditors for Expenses, accrued interest on loans account for about 97% of the total, increasing each year from BDT 939.97 million in FY2006/07 to BDT 963.11 million in FY2007/08 and further to BDT 983.24 in FY2008/09. This implies that CWASA falls into arrears in the payment of large amounts of loan interests to GOB.

(3) Equity Fund

The equity fund comprises four account items of A. Capital Fund, B. Excess Value of Assets due to Physical Verification, C. Surplus on Revaluation of Assets and D. Retained Earnings.

Retained Earnings recorded an accumulated loss in the amount of BDT545.71 million as at the end of FY2006/07, and then reduced to a loss of BDT 342.61 million as at the end of FY2007/09 with positive net income earned during this period. (Refer to Details of Retained Earning given in Supporting Report 3-4). The capital fund, which accounts for about 64% of total Equity Fund excluding the Retained Earnings, increased from BDT 1,070.89 million as at the end of FY2006/07 to BDT 1,224.72 million as at the end of FY2008/09. This increase was due to the GOB loans being transferred to GOB equity, as shown in the following table.

Table 3.4.8 shows details of the Capital Fund as at the end of FY2006/07, FY2007/08 and FY2008/09.

Table 3.4.8 Details of Capital Fund

(Amounts in BDT)

Particulars	As At End of FY 2006/07	As At End of FY 2007/08	As At End of FY 2008/09
a. Capital Grant	7,191,958	7,191,958	7,191,958
b. Grant for relief and rehabilitation from USA	899,393	899,393	899,393
c. Government Loan & Interest converted to Equity	192,641,712	192,641,712	192,641,712
d. Chittagong Pourasava Loan and Interest converted to Equity	1,028,748	1,028,748	1,028,748
e. Equity (2nd Phase)	565,777,869	565,777,869	565,777,869
f. Madunaghat Project Loan transferred to Equity	83,865,000	73,086,000	60,826,000
g. Equity for Sewerage Feasibility Study	200,000	200,000	200,000
h. 2nd IWSRP Loan converted to Grant	219,283,000	219,283,000	219,283,000
i. Grant for Mohara & Kalurghat Rehabilitation Project			74,339,097
j. Equity for Mohara Water Supply Project			102,535,000
Total	1,070,887,680	1,060,108,680	1,224,722,777

Source: CWASA Financial Statements: FY2006/07; FY2007/08; FY2008/09

It implies that CWASA's financial management has been heavily dependent on the financial subsidy provided by GOB in the form of grant or equity.

3.4.2 CWASA's Financial Structures and Sustainability

It is not known how CWASA's financial situations has changed in FY2009/10 and subsequently, as the Audited Financial Statements for these years have not been published yet. However, it is supposed that CWASA's financial situations should have changed considerably in FY2011/12 during which the Mohara and Kalurghat Rehabilitation Project was completed.

Nevertheless, the financial structures of CWASA reviewed on the basis of the Financial Statements for the three FYs (2006/07 – 2008/09), as discussed in Section 3.4.1, can be summarized as follows:

(1) CWASA's financial position showed a profit in each year, due to the contribution from non-operational revenue, even though the operational revenue has been marginal to recover even the operating expenses.
(2) If the operating revenue was confined to water revenue and service connection fees, it was inadequate to pay the financial expenses, although the financial expenses were limited only to the payment of interest of loans, not including the repayment of loans.
(3) Although current assets structure improved with substantial improvement in the collection of water bills, a comparatively large amount of the accounts receivable was accounted at the end of every fiscal year due to a longer collection period. MIS reports indicate a collection period of about 200 days.
(4) Despite of such position of accounts receivable, the position of the current assets and liabilities was maintained within a manageable range with the Current Liabilities controlled with delay in and creditors for various payments, including in particular arrears in the payment of large amounts of loan interest to GOB.
(5) In fact, large amounts of the project funds were provided in the form of grant or equity. In addition, large amounts of interests of the provided loans were transferred to grant or equity by GOB. As such, CWASA's financial management has been heavily dependent on the financial subsidy provided by GOB in the form of grant or equity.

In order to establish a financial structure that enables CWASA to manage with autonomy, it is vital for CWASA to take appropriate measures for improving the weakness of financial structure as stated above.

There are three factors affecting the CWASA's financial structure as enumerated below.

(1) Current tariff structure that is marginal to recover the operating and financial expenses
(2) Comparatively higher NRW in the distribution of water, constraining the water revenue while increasing unit water cost. The following Table 3.4.9 shows the records of water production and distribution volumes and billed water volumes reported in the Financial Statements in the three FYs (2006/07 – 2008/09):

Table 3.4.9 Water Production/Distribution Volume and Billed Water Volume

	FY 2006/07	FY 2007/08	FY 2008/09
A. Water Production Volume (m^3)	66,986,364	71,145,455	68,581,818
B. Water Distribution Volume (m^3)	64,490,909	68,345,455	63,259,091
C. Billed Water Volume (m^3)	44,795,455	48,636,364	49,504,545
D. (C-B)/C	30.54%	28.84%	21.74%

Source: CWASA Financial Statements: FY2006/07; FY2007/08; FY2008/09

(3) Longer charge collection time period recorded as 200 days, affecting cash inflow and liquidity.

It is vital task for CWASA to take appropriate measures for improving these problems.

3.4.3 Review of Current Water Revenue

(1) Overview of water revenue during the last four years

The water revenue is the main source of CWASA's revenue, accounting for about 70% of annual revenue reported in the Financial Statements for FY2006/07, FY2007/08 and FY2008/09 (see Table 3.4.1).

Table 3.4.10 shows the recent records of water revenue during the last four fiscal years (FY2008/09 to FY2011/12).

Table 3.4.10 Records of Water Revenue (2008/09 to 2011/12)

	Unit	2008/09	2009/10	2010/11	2011/12*
1. Billed Amounts (Increase/Decrease %)	BDT mil.	360.25	385.37 (+7.0%)	406.10 (+5.4%)	446.50 (+9.9%)
2. Collected Amounts (Increase/Decrease %)	BDT mil.	356.99	366.86 (+2.8%)	410.59 (+11.9%)	432.38 (+5.3%)
3. % of Collected Amounts vs. Billed Amount		99%	95%	101%	96%
4. Billed Water Vol. (Increase/Decrease %)	m^3 mil.	49.45	51.27 (+3.6%)	51.65 (+0.7%)	53.03 (+2.7%)
5. Average Billed Amount per Billed Water Volume (Increase/Decrease %)	BDT per m^3	7.29	7.52 (+3.2%)	7.86 (+4.5%)	8.42 (+7.1%)

Note: - Fiscal Year (FY): From 1st July until 30th June in the next year.
- Figures for 2011/12: Figures recorded up to May 2012 and added with an estimate for June 2012.
Source: CWASA Billing Reports

Billed amounts increased from BDT 360.25 million in FY 2008/09 to BDT385.37 million, an increase of 7.0%, in FY 2009/10, to BDT406.10 million, an increase of 5.4%, in FY 2010/11 and further to BDT446.50 million, an increase of 9.9%, in FY 2011/12. These increases were due to two factors;

increases in both the billed water volume billed water rates. The collected amounts account for about 98% of the billed amount in average during the four FYs.

(2) Water consumption and water revenue by categories of consumers

Water consumers are broadly classified into two categories of Domestic Consumers and Non-domestic Consumers, and Domestic Consumers and Non-domestic Consumers are further classified as given below.

A. Domestic Consumers
- A-1. Private
- A-2. Government
- A-3. Street Hydrant
- A-4. Religious Institution
- A-5. Loose Waster (Sold by Bowser)

B. Non-domestic Consumers
- B-1. Private
- B-2. Government

Table 3.4.11 compares the structures of water consumption and billed amounts by classified consumers in June 2009, June 2011 and May 2012.

Table 3.4.11 Comparison of Water Consumption and Billed Amounts by Classified Consumers (June 2009; June 2011; May 2012)

Categories of Consumers		June, 2009					June, 2011					May, 2012				
		Consumption		Billed Amount		Average Rate	Consumption		Billed Amount		Average Rate	Consumption		Billed Amount		Average Rate
		Vol. (m^3)	(%)	Amount (BDT)	(%)	(BDT/m^3)	Vol. (m^3)	(%)	Amount (BDT)	(%)	(BDT/m^3)	Vol. (m^3)	(%)	Amount (BDT)	(%)	(BDT/m^3)
A.	Domestic															
A-1.	Private	2,579,699	62.2%	13,961,057	45.2%	5.4	2,912,702	65.3%	17,384,481	48.6%	6.0	2,907,772	65.2%	18,453,690	51.6%	6.3
A-2.	Government	368,733	8.9%	1,995,544	6.5%	5.4	363,130	8.1%	2,166,851	6.1%	6.0	350,460	7.9%	2,196,360	6.1%	6.3
A-3.	Street Hydrant	375,367	9.1%	2,031,448	6.6%	5.4	375,367	8.4%	2,133,144	6.0%	5.7	387,879	8.7%	2,429,799	6.8%	6.3
A-4.	Religious Institution	33,414	0.8%	180,835	0.6%	5.4	33,414	0.7%	189,888	0.5%	5.7	33,414	0.7%	209,318	0.6%	6.3
A-5.	Loose Water (Sold by Bowser)	7,633	0.2%	830,762	2.7%	108.8	7,336	0.2%	893,250	2.5%	121.8	6,966	0.2%	1,229,430	3.4%	176.5
	Sub-total (A)	3,364,846	81.1%	18,999,646	61.6%	5.6	3,691,949	82.8%	22,767,614	63.7%	6.2	3,686,491	82.7%	24,518,597	68.6%	6.7
B.	Non-domestic															
B-1.	Private	477,016	11.5%	7,234,042	23.4%	15.2	496,682	11.1%	8,396,097	23.5%	16.9	475,858	10.7%	8,423,937	23.6%	17.7
B-2.	Government	304,681	7.3%	4,620,542	15.0%	15.2	271,019	6.1%	4,580,236	12.8%	16.9	299,793	6.7%	5,318,885	14.9%	17.7
	Sub-total (B)	781,697	18.9%	11,854,584	38.4%	15.2	767,701	17.2%	12,976,333	36.3%	16.9	775,651	17.4%	13,742,822	38.4%	17.7
Grand Total (A. + B.)		4,146,543	100.0%	30,854,230	100.0%	7.4	4,459,650	100.0%	35,743,947	100.0%	8.0	4,462,142	100.0%	38,261,419	107.0%	8.6

(Source: Billing Reports)

As an average of the records given above, about 82% of water consumption was by domestic consumers and 18% by non-domestic consumers. Consumption by domestic consumers comprises 78.2% by private consumers, 10.1% by government consumers, 10.6% by street hydrant, 0.9% by religious institution and 0.2% by water sold by bowsers, whereas consumption by non-domestic consumers comprise 62.3% by private consumers, 17.7% by government consumers and 20% by others.

Comparing June 2009, June 2011 and May 2012, average billed amount per m^3 increased by 5% every year as given in Table 3.4.12.

Table 3.4.12 Comparison of Average Billed Amount per Cubic Meter

(BDT/m^3)

Categories of Consumers	June 2009	June 2011	May 2012
A. Domestic			
Private	5.4	6.0	6.3
Government	5.4	6.0	6.3
Street Hydrant	5.4	5.7	6.3
Religious Institutional	5.4	5.7	6.3
B. Non-domestic			
Private	15.2	16.9	17.7
Government	15.2	16.9	17.7

Note: Average Billed Amount per m^3 was calculated by dividing billed amounts with consumption volumes given in Table 3.4.12.

(3) Performance of Service Connections and Water Distribution

Table 3.4.13 shows details of the service connection in June 2009, June 2011 and May 2012.

Table 3.4.13 Performance of Service Connections

(Nos. of connections)

Particulars	June 2010	June 2011	May 2012
A. Total Connection	48,146	50,808	53,152
B. Billable Connection			
B-1. Domestic	38,831	41,134	43,149
B-2. Non-domestic	4,259	4,436	4,764
Sub-total	43,090	45,570	47,913
B-3. Metered	30,318	34,872	37,895
B-4. Average-based bill	12,229	10,298	9,879
B-5. Non-meter bill	543	400	139
Sub-total	43,090	45,570	47,913
C. Billed Connection			
C-1. Domestic	37,834	39,612	42,390
C-2. Non-domestic	4,072	4,230	4,644
Sub-total	41,906	43,842	47,034
D. Unbilled Connection	1,183	1,782	879
Increase of Connections			
1. Total Connections		2,662	2,344
2. Billable Connections			
2-1. Domestic		2,303	2,015
2-2. Non-domestic		177	328
Total		2,480	2,343
3. Metered Connection		4,554	3,023
4. Billed Connection			
3-1. Domestic		1,778	2,778
3-2. Non-domestic		158	414
Total		1,936	3,192

Source: Billing Reports: June 2010; June 2011; May 2012

Although the above figures indicates progress in providing additional connections, in particular metered connections, an acceleration in the rate will be required in order to utilize the substantial additional quantity of water that will be produced after the completion of the on-going Karnaphuli Water Supply Project and after implementation of the Phase 2 Project.

Table 3.4.14 shows the current performance of water distribution.

Table 3.4.14 Current Performance of Water Distribution

(Million m^3)

Particulars	FY 2009/10	FY 2010/11	FY 2011/12
A. Produced Water Volume	73.50	76.40	70.84
B. Volume Available for Distribution	66.37	68.34	63.97
C. Billed Volume	51.27	51.65	53.03
D. % [(B – C)/B]	23.0%	24.0%	17.0%

Note: Figures for 2011/12: Figures recorded up to May 2012, with an estimate for June 2012.
Source: Billing Reports: June 2010; June 2011; May 2012

Although the figures indicate improvement of billing in the recent years, considerably higher NRW rate is reported. Continuous efforts for improvement of NRW are required.

(4) Water tariff

Table 3.4.15 shows the current water tariff set by CWASA.

Table 3.4.15 Water Tariff

Particulars		2010	2011	2012	2013	2014	2015	2016
A. Domestic customers; including street hydrant and religious institution	Rate per m^3 (BDT/m^3)	5.95	6.26	6.57	6.90	7.25	7.61	7.99
	Minimum Charge Vol. (m^3)	21	21	21	21	21	21	21
B. Non-domestic customers	Rate per m^3 (BDT/m^3)	16.89	17.73	18.61	19.55	20.53	21.56	22.64
	Minimum Charge Vol. (m^3)	21	21	21	21	21	21	21

Source: CWASA

The water tariff was set with upward adjustment every year. The tariff rates given for 2010 to 2012 are actually applied rates, and the rates in 2013 onward are those submitted to LGRD for their sanction. The rates were set with annual upward adjustment at 5% that was maximum range of increase allowed under the WASA Act 1996 (refer to Clause 22 (2) of the Act). The current water tariff of Dhaka WASA is shown below.

Revised Date	Tariff for Domestic (BDT/m^3)	Tariff for Non-domestic (BDT/m^3)
01-Aug-11	6.66	22.17
01-Jul-10	6.34	21.12
01-Jul-09	6.04	20.11

Comparing to the tariff of CWASA, the tariff of Dhaka WASA as of August 2011 is higher by about 6% for domestic and higher by about 25% for non-domestic. According to the HIES survey report in 2010 published by the Bangladesh Bureau of Statistics, the Average Monthly Household Nominal Income in Chittagong was BDT14,092, higher by 6.5% compared to BDT13,226 in Dhaka. The tariff of Dhaka WASA is much higher than the tariff of CWASA when the household income level is taken into account.

(5) Affordability of CWASA Water Tariff

According to the IDC Report submitted in July 2011, IDC assessed consumers' affordability to pay water tariff and concluded that consumers may be affordable to pay BDT30.22/m^3 as in 2011 based on the following assumptions:

1) Average monthly household income: BDT13,602
2) Affordable amount to pay for water: BDT408 per month (3% of the average income)
3) Water consumption per household: $13.50m^3$ per month
4) Affordable amount per m^3: $BDT408/13.50m^3 = BDT30.22/m^3$

The above assessment implies that domestic consumers may be affordable to pay by about 4 to 5 times of the CWASA's tariff.

The survey conducted by the JICA Preparatory Survey Team indicates average income of habitants in the service areas is in a range between BDT 20,000 and 29,000 per month. If 3% of the income is taken as an affordable amount to pay for water, the affordable amount is estimated as BDT600 to 870. Assuming average water consumption of 15 to $18m^3$ per month, the affordable payment range for water is estimated as BDT40 to 48 per m^3. These data indicate affordable amount for consumers to pay for water to be 6 to 7 times of the current CWASA tariff.

Considering these findings, consumers seem to be affordable to pay at least 4 times or more of the current tariff.

3.4.4 Review of Current Connection Charges

CWASA charges connection fees to the customers applying service connections. Table 3.4.16 shows the current connection fees set by CWASA.

Table 3.4.16 Service Connection Charges

(In BDT)

Particulars	Connection Size (Dia)				
	¾" (20mm)	1" (25mm)	2" (30mm)	4" (100mm)	6" (150mm)
Connection Fee	1,500	4,000	25,000	45,000	80,000
Cost of Meter	2,500	3,500	20,000	30,000	60,000
Meter Fitting Charge	200	250	-	-	-
Security	500	700	7,500	12,500	30,000
Development Charge (Tax)	2,525	4,150	11,250	19,250	42,000
Total	7,225	12,600	63,750	106,750	212,000

Source: CWASA

Foreseeing the needs for a significant increase in the number of service connections in order to meet the future water production volume, it would be prudent to review the current connection charges in order to ensure that the applied connection charges do not cause constraints in the planned increase in the number of service connections.

3.4.5 Debt Service Requirements for Loans

The Ministry of Finance of GOB issued a policy for re-lending terms of subsidiary loans provided to autonomous/semi-autonomous bodies and public sector corporations, under which CWASA is required to make repayment of subsidiary loan proceeds with 15 annual instalments within 20 years including 5 years grace period and also payment of interest at 4% per annul for local currency loans and 5% per annum for foreign currency loans.

The policy states that the Government will consider larger equity participation or limited grant by the Government because of public interest in terms of urbanization/human settlements, provided that recovery of full cost (investment and operation) should be justified.

CWASA obligates to make repayments of loan proceeds and payment of interest in respect of several loans previously provided by the Government. Repayment of those loans and payment of accrued interest cause burden to CWASA.

CWASA submitted a draft of Subsidiary Loan Agreement to the Government in relation to the JICA Loan provided for the on-going Karnaphuli Water Supply Project, however, the Government decided to suspend the execution of the Subsidiary Loan Agreement for the Phase 1 Project until the implementation of Phase 2 Project is determined.

CHAPTER 4

WATER DEMAND PROJECTION IN THE SURVEY AREA

CHAPTER 4 WATER DEMAND PROJECTION IN THE SURVEY AREA

In order to determine the extent of the area to be served by the Karnaphuli water treatment plant (hereinafter referred to as the "Karnaphuli Service Area"), water demand in the Chittagong City Cooperation area (hereinafter referred to as CCC area) will be projected ward by ward up to the target year 2030. Major factors for the water demand projection include population, unit water consumption rate (daily average/daily maximum), and connection percentages to the distribution system by type of house/building and NRW/leakage percentage, as practiced in the previous studies. The following are study results by concerned factor.

4.1 Population Projection

4.1.1 Population Census Results

(1) Population in Chittagong City Corporation Area

A sharp rise in the population of Chittagong Municipality occurred after the independence of the country in 1971. This rise was due to rural to urban migration of people in search of better jobs and other opportunities.

Growth of population and urbanization results in an increase in demand for clean water and hence the need for additional water supply to the city. Table 4.1.1 shows the growth in population since 1901 in the Chittagong municipal area, the boundary of which was extended between 1974 and 1981, resulting in a high annual increase in the population during this period, as shown in the above table. It should be noted that the result of the Population and Housing Census, which was conducted from the 15th to 19th of March, 2011 is not officially available as of June 1st, 2012 (Information from Director General, Bangladesh Bureau of Statistics).

Table 4.1.1 Population Census Results with Growth Rate in Chittagong Municipality (CCC Area)

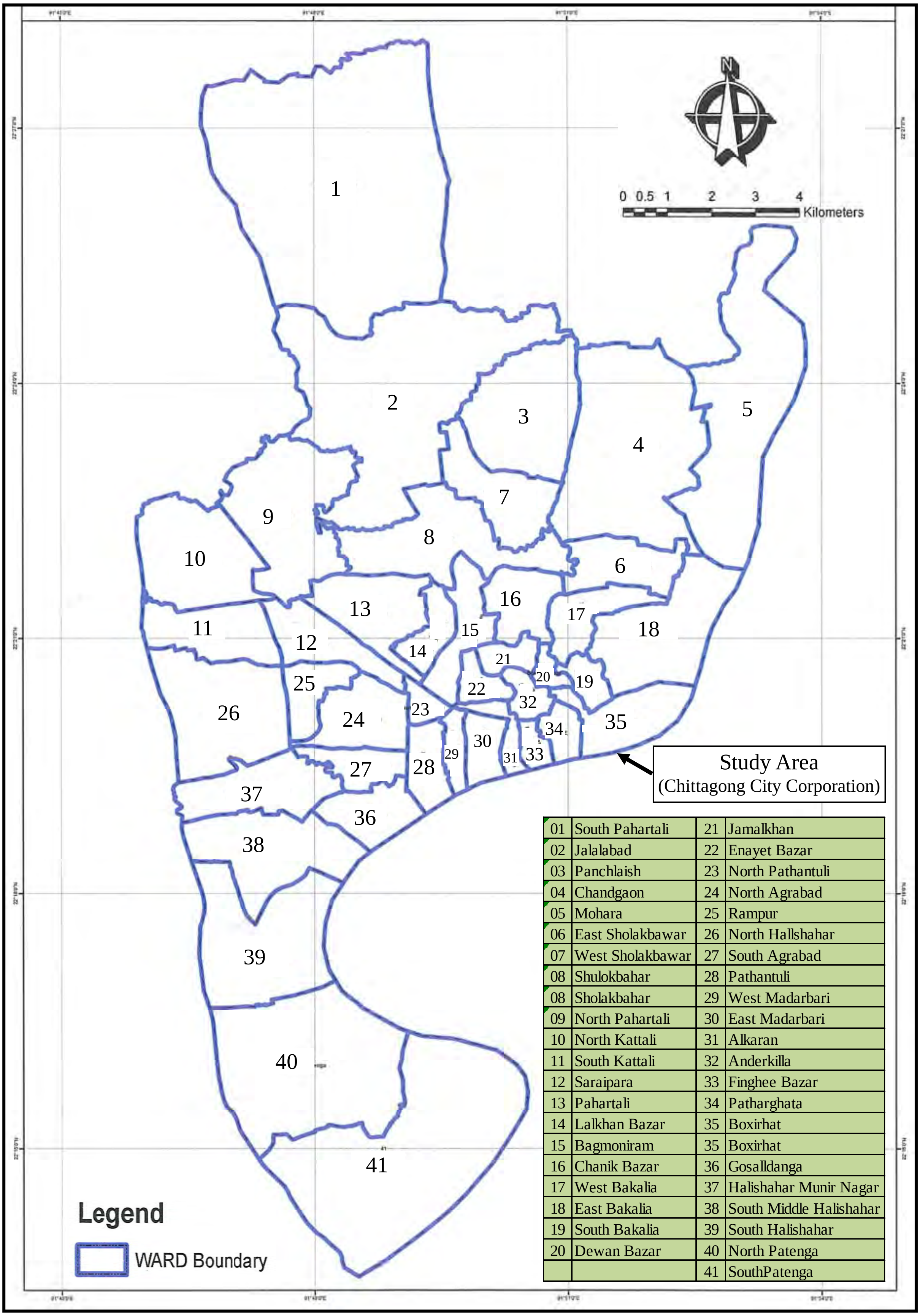
Year	Population*	Growth Period	Annual Increase Rate	Remark
1901	27,400	-	-	
1911	34,800	1901 - 1911	2.7%	
1951	143,300	1911 - 1951	7.7%	
1961	175,200	1951 - 1961	2.0%	
1974	633,600	1961 - 1974	6.7%[1]	
1981	1,209,500	1974 - 1981	9.7%[2]	
1991	1,599,000	1981 - 1991	3.0%	
2001	2,218, 000	1991 - 2001	3.3%	
2011	No official information released as of June 1, 2012			Conducted from 15th to 19th of March, 2011

Note: Round up to nearest thousand
Source: Population Census, the Bangladesh Bureau of Statistics (BBS).

(2) Composition of Wards and Historical Population in Chittagong City

Chittagong City (CCC) consists of 41 wards as shown in Figure 4.1.1, with Table 4.1.2 showing the Population Census results by Ward in 1974, 1981, 1991 and 2001 (official figures).

1 The 1974 population figure is for the extended boundary of the Municipality in this year. The high growth of 6.7% occurred mainly due to the increase in the area of the Municipality.
2 The above applies to the growth rate of 9.7% in the period from 1974 to 1981.



01	South Pahartali	21	Jamalkhan
02	Jalalabad	22	Enayet Bazar
03	Panchlaish	23	North Pathantuli
04	Chandgaon	24	North Agrabad
05	Mohara	25	Rampur
06	East Sholakbawar	26	North Hallshahar
07	West Sholakbawar	27	South Agrabad
08	Shulokbahar	28	Pathantuli
08	Sholakbahar	29	West Madarbari
09	North Pahartali	30	East Madarbari
10	North Kattali	31	Alkaran
11	South Kattali	32	Anderkilla
12	Saraipara	33	Finghee Bazar
13	Pahartali	34	Patharghata
14	Lalkhan Bazar	35	Boxirhat
15	Bagmoniram	35	Boxirhat
16	Chanik Bazar	36	Gosalldanga
17	West Bakalia	37	Halishahar Munir Nagar
18	East Bakalia	38	South Middle Halishahar
19	South Bakalia	39	South Halishahar
20	Dewan Bazar	40	North Patenga
		41	SouthPatenga

Figure 4.1.1 Location of Wards in CCC Area

Table 4.1.2 Historical Population Census Results by Ward

Mahallah Name with Deo-code				Population Census			
				1974	1981	1991	2001
		Chittagong City Corporation					
01	**16**	**Bayeijid Bostami Thana**		**0**	**46,071**	**99,377**	**239,550**
	01	Ward No.01	South Pahartali	N/A	46,071	26,391	101,370
	02	Ward No.02	Jalalabad	N/A	N/A	39,836	75,420
	03	Ward No.03	Panchlaish	N/A	N/A	33,150	62,760
02	**57**	**Panchlaish Thana**		**46,405**	**116,126**	**120,371**	**197,280**
	07	Ward No.07	West Sholakbawar	21,393	56,879	46,237	77,910
	08	Ward No.08(Part)	Shulokbahar	25,012	59,247	74,134	119,370
03	**19**	**Chandgaon Thana**		**58,520**	**94,800**	**106,543**	**178,050**
	04	Ward No.04	Chandgaon	24,674	37,695	43,724	73,070
	05	Ward No.05	Mohara	24,010	34,767	47,089	78,690
	06	Ward No.06	East Sholakbawar	9,836	22,338	15,730	26,290
04	**10**	**Bakalia**		**59,409**	**69,218**	**124,666**	**203,850**
	17	Ward No.17	West Bakalia	46,114	26,275	40,298	66,750
	18	Ward No.18	East Bakalia		10,400	25,732	42,620
	19	Ward No.19	South Bakalia		26,038	47,068	77,970
	35	Ward No.35(Part)	Boxirhat	13,295	6,505	11,568	16,510
05	**41**	**Kotwali Thana**		**132,963**	**224,853**	**235,325**	**287,760**
	15	Ward No.15	Bagmoniram	18,672	19,687	26,883	32,220
	16	Ward No.16	Chanik Bazar	15,195	32,940	33,418	45,750
	20	Ward No.20	Dewan Bazar	13,672	30,131	28,087	33,670
	21	Ward No.21	Jamalkhan	23,115	31,266	33,976	40,720
	22	Ward No.22	Enayet Bazar	16,134	21,031	25,158	30,150
	31	Ward No.31	Alkaran	12,441	17,133	24,618	29,510
	32	Ward No.32	Anderkilla	10,278	29,747	17,675	21,190
	33	Ward No.33	Finghee Bazar	13,413	13,171	19,330	23,170
	34	Ward No.34	Patharghata	10,043	29,747	26,180	31,380
	35	Ward No.35(Part)	Boxirhat				
06	**43**	**Khulshi Thana**		**53,120**	**149,434**	**125,050**	**200,210**
	08	Ward No.08(Part)	Sholakbahar				
	09	Ward No.09	North Pahartali	15,458	27,281	38,205	64,700
	13	Ward No.13	Pahartali	23,504	51,350	43,560	67,970
	14	Ward No.14	Lalkhan Bazar	14,158	70,803	43,285	67,540
07	**55**	**Pahartali**		**20,347**	**74,961**	**89,900**	**127,920**
	10	Ward No.10	North Kattali	N/A	N/A	20,705	29,560
	11	Ward No.11	South Kattali	N/A	N/A	22,655	31,910
	12	Ward No.12	Saraipara	20,347	74,961	46,540	66,450
08	**28**	**Double Mooring Thana**		**118,764**	**181,132**	**234,340**	**302,750**
	23	Ward No.23	North Pathantuli	14,131	5,819	26,501	33,900
	24	Ward No.24(Part)	North Agrabad	16,059	26,623	34,995	47,710
	27	Ward No.27	South Agrabad	24,544	52,367	71,210	91,110
	28	Ward No.28	Pathantuli	17,373	21,045	33,619	43,010
	29	Ward No.29	West Madarbari	24,365	46,860	37,452	47,920
	30	Ward No.30	East Madarbari	22,292	28,418	30,563	39,100
09	**35**	**Halishahar Thana**		**9,637**	**10,612**	**49,730**	**67,800**
	24	Ward No.24(Part)	North Agrabad				
	25	Ward No.25	Rampur	9,637	10,612	***22,501***	30,680
	26	Ward No.26	North Hallshahar	N/A	N/A	27,229	37,120
10	**20**	**Chittagong Port Thana**		**63,603**	**102,483**	**134,787**	**205,320**
	36	Ward No.36	Gosalldanga	10,225	20,773	19,819	30,190
	37	Ward No.37	Halishahar Munir Nagar	35,834	17,851	32,276	49,170
	38	Ward No.38	South Middle Halishahar		34,879	36,020	54,870
	39	Ward No.39	South Halishahar	17,544	28,980	46,672	71,090
11	**65**	**Patenga Thana**		**27,211**	**45,542**	**72,771**	**85,360**
	40	Ward No.40	North Patenga	14,421	22,294	39,828	46,720
	41	Ward No.41	SouthPatenga	12,790	23,248	32,943	38,640
		Municipality Total		**589,979**	**1,115,232**	**1,392,860**	**2,095,850**

4.1.2 Population Projection

(1) Population Projection in Previous Studies

With reference to water supply projects in Chittagong City (CCC area), the following studies have been conducted as of today.

1) The Feasibility Study of Extension and Expansion of MOHARA Water Treatment Plant in Chittagong, People's Republic Bangladesh; JICA, December 2000 – refer to Table 4.1.3.

Table 4.1.3 MOHARA WTP Study, December 2000, JICA

Name of Thana	Area (ha)	Population in 1991 Census	Population Projection		
			2000	2005	2010
Kotwali	625	283,433	352,600	400,600	457,500
Double Mooring	1,499	367,296	537,900	667,400	830,200
Panchlaish	2,601	221,974	309,700	372,800	449,000
Pahartali	4,663	228,330	352,900	450,800	576,700
Chandgaon	3,214	252,147	387,800	494,500	632,600
Chittagong Port	4,464	215,523	364,400	488,400	654,900
Hathazari (Munici)	2,938	30,297	45,000	56,100	69,900
Municipality (CCC) Total	20,004	1,599,000	2,350,300	2,930,600	3,670,800

2) Special Assistance for Project Formation (SAPROF) for Karnaphuli Water Supply Project; JBIC, November 2005 – refer to Tables 4.1. 4 and 4.1.5.

Table 4.1.4 SAPROF, November 2005, JBIC

Name of Thana		Area (ha)	Population in Census		Population Projection		
			1991	2001	2005	2010	2020
Zone-1	Kotwali	1,229	283,433	321,948	344,800	368,200	409,200
Zone-2	Double Mooring	1,224	367,296	456,210	478,800	503,600	542,800
Zone-3	Panchlaish	2,847	221,974	354,950	402,500	460,900	577,100
Zone-4	Pahartali	2,349	228,330	315,007	358,800	413,900	511,600
Zone-5	Chandgaon	3,100	252,147	386,619	445,200	512,000	643,800
Zone-6	Chittagong Port	3,736	215,523	275,624	334,200	403,100	542,400
Zone-7	Hathazari (J.D.Pahartali)	1,077	30,297	107,260	131,400	158,300	214,800
Municipality (CCC) Total		15,562	1,599,000	2,217,619	2,495,700	2,820,000	3,441,700

Table 4.1.5 Proposed Annual Growth Rate for Study Area in SAPROF

Present Density (pop./ hectare)	Proposed Growth Rate (2001-05)	Proposed Growth Rate (2005-10)	Proposed Growth Rate (2010-20)	Growth Rate (1981-1991 Average)
> 50	5.6%	4.8%	4.0%	3.3%
51 - 100	5.2%	4.4%	3.6%	5.7%
101- 150	4.4%	3.8%	3.1%	3.7%
151- 200	3.4%	2.8%	2.4%	2.1%
201 - 300	2.0%	1.6%	1.5%	2.4%
301 - 400	1.4%	1.2%	1.0%	-1.4%
401 - 500	1.0%	0.8%	0.6%	-0.1%
500 - 700	0.4%	0.4%	0.4%	-4.3%
700 <	0.0%	0.0%	0.0%	-0.1%
City Area Overall	3.0%	2.5%	2.0%	2.8%

3) Project Evaluation Report for Karnaphuli Water Supply Project (Detailed Design Stage); 2008 – refer to Tables 4.1.6 and 4.1.7.

Table 4.1.6 Detailed Design for KWSP, 2008, Phase 1 D/D

Name of Thana		Area (ha)	Census Population		Population Projection				
			1991	2001	2010	2015	2020	2025	2030
01	Bayeijid Bostami	1,758	121,827	168,051	227,000	260,600	299,100	336,800	379,100
02	Panchlaish	830	21,709	148,120	200,100	229,800	263,700	296,900	334,300
03	Chandgaon	2,532	111,210	178,390	281,600	349,300	433,200	517,100	617,000
04	Balkalia	1,233	113,446	196,877	266,000	305,400	350,600	394,800	444,400
05	Kotwali	768	201,175	282,975	320,600	340,200	361,300	379,700	399,000
06	Khulshi	1,312	152,657	243,351	328,900	377,600	433,500	488,000	549,500
07	Pahartali	1,331	95,618	127,243	171,800	197,300	226,500	255,000	287,200
08	Double Mooring	812	222,165	259,181	293,800	312,000	331,000	348,000	365,600
09	Halishahar	964	73,993	125,255	169,300	194,400	223,200	251,300	283,000
10	Chittagong Port	2,004	108,816	213,598	314,800	379,300	457,100	532,500	620,400
11	Patenga	3,263	78,924	80,448	87,900	91,400	95,200	98,100	101,000
Municipality (CCC) Total		16,807	1,301,540	2,023,489	2,661,800	3,037,300	3,474,400	3,898,200	4,380,500

Note) Population Census-2001; Bangladesh Bureau Statics, Planning Division, Ministry of Planning (2007)

Table 4.1.7 Proposed Annual Growth Rate for Study Area, 2008, Phase 1 D/D

Present Density (pop./ hectare)	Proposed Growth Rate (2001-10)	Proposed Growth Rate (2010-20)	Proposed Growth Rate (2020-30)	Growth Rate (1981-1991 Average)
> 50	5.6%	4.8%	4.0%	3.3%
51 - 100	5.2%	4.4%	3.6%	5.7%
101- 150	4.4%	3.8%	3.1%	3.7%
151- 200	3.4%	2.8%	2.4%	2.1%
201 – 300	2.0%	1.6%	1.5%	2.4%
301 – 400	1.4%	1.2%	1.0%	-1.4%
401 – 500	1.0%	0.8%	0.6%	-0.1%
500 – 700	0.4%	0.4%	0.4%	-4.3%
700 <	0.0%	0.0%	0.0%	-0.1%

4) Preparation of Detailed Area Plan (DAP) for Chittagong Metropolitan Master Plan (CMMP), Draft Final Report Report-IV; Chittagong Development Authority(CDA), January 2008– refer to Table 4.1.8

Table 4.1.8 CMMA by CDA, January, 2008

	Population in Census		Population Projection 2015
	1991	2001	
City Area	1,442,026	2,023,489	3,382,653

5) Preparation of Master Plan (MP) for Water Supply and Wastewater Management of the Detailed Planned Area of Chittagong, Bangladesh, Mater Plan for Water Supply; KOICA. August 2009 – refer to Table 4.1.9

Table 4.1.9 MP, August 2009, KOICA

Area (ha)		Population in Census		Population Projection			
		1991	2001	2007	2011	2021	2031
City Area (CCC)	15,562	1,392,860	2,095,850	2,700,000	2,900,000	3,800,000	4,700,000

Table 4.1.10 summarizes the results of the projections in the previous studies, in which the base and target years vary. The population in the CCC area in 2010/2011 is more than 3 million according to preliminary information from CWASA. In this regard, the projection in the KOICA MP is similar.

Table 4.1.10 Summary of Population Projection in the Previous Studies

			2007	2010	2011	2015	2020	2021	2025	2030	2031
Chittagong City Corporation	a. MOHARA, 2000,JICA	*Pop.*	-	3,670,800	-	-	-	-	-	-	-
	b. SAPROF, 2005,JBIC	*Pop.*	-	2,820,000	-	-	3,441,700	-	-	-	-
		Growth			2.01%						
	c. D/D, 2008, NJS	*Pop.*	-	2,661,800	-	3,037,300	3,474,400	-	3,898,200	4,380,500	-
		Growth			2,67%	2.73%		2.33%	2.36%		
	d. CMMA, 2008, CDA	*Pop.*	-	-	-	3,382,653	-	-	-	-	-
	e. M/P, 2009, KOICA	*Pop.*	2,700,000	-	2,900,000	-	-	3,800,000	-	-	4,700,000
		Growth		1.80%			2.74%			2.15%	

(2) Population Projection

As mentioned above, the results of the population census in 2011 have not been officially released as of June 1st, 2012. As such the projection in the most recent study (MP by KOICA) has been basically used for this study. According to the MP, annual growth rates of 1.8 – 4.3 % rates were applied between 1991 and 2031 for the population projection in the CCC area, as shown in Table 4.1.11.

Table 4.1.11 Population Projection by KOICA

		Area (ha)	Population in Census			Population Projection & Growth Rate		
			1991	2001	2007	2011	2021	2031
City Area (CCC)	Population	15,562	1,392,860	2,095,850	2,700,000	2,900,000	3,800,000	4,700,000
	Average Rate (%)			4.2	4.3	1.80	2.74	2.15

Note: Base year for the projection is Year 2001.
Population growth rates were estimated using projected population in the MP.

The population in each ward in the CCC area from 2015 to 2030 at five- year intervals has been projected using the MP assumptions on the annual growth rate by ward and using the 2011 population as the base year population. The growth rate which has been adopted for the projections in 2015 and 2020 is that in the MP for the projection from 2011 to 2021, while for the projections in 2025 and 2030, the growth rate in the MP from 2021 to 2031 has been used. Table 4.1.12 shows the projected population for each ward for the target year of 2030 and other years, together with the information on past census results, population density and growth rate assumed in the MP.

Table 4.1.12 Population Projection for the Phase 2 Project

Mahallah Name with Deo-code				Population								Proposed Growth Rate		Population Projection			
				1991	2001	2011	Population/ha			Growth Rate							
							1991	2001	2011	1991-2001	2001-2011	2011-2021	2021-2031	2015	2020	2025	2030
Chittagong City Corporation																	
01	**16**	**Bayeijid Bostami Thana**		**99,377**	**239,550**	**313,000**	**33**	**79**	**104**	**9.20%**	**5.49%**	**2.26%**	**1.85%**	**342,200**	**382,700**	**421,100**	**461,500**
	01	Ward No.01	South Pahartali	26,391	101,370	128,000	25	94	119	14.41%	4.78%	1.95%	1.63%	138,300	152,300	165,700	179,700
	02	Ward No.02	Jalalabad	39,836	75,420	105,800	29	56	78	6.59%	7.00%	2.84%	2.22%	118,300	136,100	152,800	170,500
	03	Ward No.03	Panchlaish	33,150	62,760	79,200	57	108	137	6.59%	4.76%	1.95%	1.64%	85,600	94,300	102,600	111,300
02	**57**	**Panchlaish Thana**		**120,371**	**197,280**	**304,500**	**132**	**217**	**335**	**5.06%**	**9.07%**	3.53%	2.60%	**349,800**	**416,200**	**477,500**	**543,000**
	07	Ward No.07	West Sholakbawar	46,237	77,910	120,300	114	191	296	5.36%	9.08%	3.54%	2.60%	138,200	164,500	188,700	214,600
	08	Ward No.08(Part)	Shulokbahar	74,134	119,370	184,200	148	238	367	4.88%	9.06%	3.53%	2.60%	211,600	251,700	288,800	328,400
03	**19**	**Chandgaon Thana**		**106,543**	**178,050**	**281,600**	**51**	**86**	**136**	**5.27%**	**9.60%**	3.69%	2.69%	**325,500**	**390,200**	**449,900**	**513,900**
	04	Ward No.04	Chandgaon	43,724	73,070	115,600	47	79	125	5.27%	9.61%	3.69%	2.69%	133,600	160,200	184,700	211,000
	05	Ward No.05	Mohara	47,089	78,690	124,500	52	87	138	5.27%	9.61%	3.70%	2.69%	144,000	172,600	199,000	227,300
	06	Ward No.06	East Sholakbawar	15,730	26,290	41,500	64	108	170	5.27%	9.56%	3.67%	2.69%	47,900	57,400	66,200	75,600
04	**10**	**Bakalia**		**124,666**	**203,850**	**317,300**	**94**	**154**	**240**	**5.04%**	**9.25%**	3.59%	2.63%	**365,300**	**435,700**	**500,800**	**570,300**
	17	Ward No.17	West Bakalia	40,298	66,750	105,600	166	275	435	5.18%	9.61%	3.70%	2.69%	122,100	146,400	168,800	192,700
	18	Ward No.18	East Bakalia	25,732	42,620	67,400	39	65	103	5.18%	9.60%	3.70%	2.69%	77,900	93,400	107,700	123,000
	19	Ward No.19	South Bakalia	47,068	77,970	123,400	371	614	972	5.18%	9.62%	3.70%	2.69%	142,700	171,100	197,300	225,300
	35	Ward No.35(Part)	Boxirhat	11,568	16,510	20,900	39	55	70	3.62%	4.83%	1.93%	1.65%	22,600	24,800	27,000	29,300
05	**41**	**Kotwali Thana**		**235,325**	**287,760**	**363,000**	**253**	**309**	**390**	**2.03%**	**4.76%**	1.94%	1.63%	**392,100**	**431,700**	**469,500**	**508,800**
	15	Ward No.15	Bagmoniram	26,883	32,220	40,600	149	179	226	1.83%	4.73%	1.96%	1.62%	43,900	48,400	52,600	57,000
	16	Ward No.16	Chanik Bazar	33,418	45,750	57,700	189	258	326	3.19%	4.75%	1.94%	1.62%	62,300	68,600	74,500	80,800
	20	Ward No.20	Dewan Bazar	28,087	33,670	42,500	720	863	1,090	1.83%	4.77%	1.96%	1.64%	45,900	50,600	55,100	59,700
	21	Ward No.21	Jamalkhan	33,976	40,720	51,300	447	536	675	1.83%	4.73%	1.95%	1.63%	55,400	61,000	66,400	71,900
	22	Ward No.22	Enayet Bazar	25,158	30,150	38,000	293	351	442	1.83%	4.74%	1.95%	1.61%	41,100	45,200	49,100	53,200
	31	Ward No.31	Alkaran	24,618	29,510	37,300	268	321	405	1.83%	4.80%	1.94%	1.64%	40,300	44,300	48,200	52,300
	32	Ward No.32	Anderkilla	17,675	21,190	26,800	167	200	253	1.83%	4.81%	1.95%	1.63%	28,900	31,900	34,700	37,600
	33	Ward No.33	Finghee Bazar	19,330	23,170	29,200	233	279	352	1.83%	4.73%	1.92%	1.63%	31,500	34,600	37,700	40,800
	34	Ward No.34	Patharghata	26,180	31,380	39,600	285	341	430	1.83%	4.76%	1.94%	1.63%	42,800	47,100	51,200	55,500
	35	Ward No.35(Part)	Boxirhat	0	0	0											
06	**43**	**Khulshi Thana**		**125,050**	**200,210**	**308,900**	**138**	**222**	**342**	**4.82%**	**9.06%**	3.53%	2.60%	**354,800**	**422,100**	**484,300**	**550,700**
	08	Ward No.08(Part)	Sholakbahar	0	0	0											
	09	Ward No.09	North Pahartali	38,205	64,700	99,800	69	117	181	5.41%	9.05%	3.52%	2.61%	114,600	136,300	156,400	177,900
	13	Ward No.13	Pahartali	43,560	67,970	104,900	192	299	462	4.55%	9.07%	3.52%	2.61%	120,500	143,300	164,400	186,900
	14	Ward No.14	Lalkhan Bazar	43,285	67,540	104,200	349	545	840	4.55%	9.06%	3.54%	2.60%	119,700	142,500	163,500	185,900
07	**55**	**Pahartali**		**89,900**	**127,920**	**144,800**	**102**	**145**	**164**	**3.59%**	**2.51%**	0.81%	0.76%	**149,600**	**155,700**	**161,800**	**168,000**
	10	Ward No.10	North Kattali	20,705	29,560	33,500	73	104	118	3.62%	2.53%	0.83%	0.77%	34,600	36,100	37,500	39,000
	11	Ward No.11	South Kattali	22,655	31,910	36,100	68	96	109	3.48%	2.50%	0.80%	0.74%	37,300	38,800	40,300	41,800
	12	Ward No.12	Saraipara	46,540	66,450	75,200	174	248	281	3.63%	2.50%	0.81%	0.76%	77,700	80,800	84,000	87,200
08	**28**	**Double Mooring Thana**		**234,340**	**302,750**	**363,800**	**304**	**393**	**472**	**2.59%**	**3.74%**	1.47%	1.28%	**385,400**	**414,800**	**443,000**	**472,000**
	23	Ward No.23	North Pathantuli	26,501	33,900	42,700	344	440	555	2.49%	4.72%	1.95%	1.63%	46,100	50,800	55,300	59,900
	24	Ward No.24(Part)	North Agrabad	34,995	47,710	54,000	168	229	260	3.15%	2.51%	0.82%	0.74%	55,800	58,100	60,400	62,600
	27	Ward No.27	South Agrabad	71,210	91,110	103,000	481	616	696	2.49%	2.48%	0.82%	0.75%	106,400	110,900	115,200	119,600
	28	Ward No.28	Pathantuli	33,619	43,010	54,300	276	353	445	2.49%	4.77%	1.94%	1.62%	58,600	64,500	70,200	76,100
	29	Ward No.29	West Madarbari	37,452	47,920	60,500	350	448	565	2.50%	4.77%	1.94%	1.63%	65,300	71,900	78,200	84,800
	30	Ward No.30	East Madarbari	30,563	39,100	49,300	280	359	452	2.49%	4.75%	1.93%	1.62%	53,200	58,600	63,700	69,000
09	**35**	**Halishahar Thana**		**49,730**	**67,800**	**76,700**	**56**	**77**	**87**	**3.15%**	**2.50%**	0.82%	0.76%	**79,200**	**82,500**	**85,700**	**89,000**
	24	Ward No.24(Part)	North Agrabad	0	0	0											
	25	Ward No.25	Rampur	22,501	30,680	34,700	117	159	180	3.15%	2.49%	0.81%	0.75%	35,800	37,300	38,700	40,200
	26	Ward No.26	North Hallshahar	27,229	37,120	42,000	40	54	61	3.15%	2.50%	0.83%	0.76%	43,400	45,200	47,000	48,800
10	**20**	**Chittagong Port Thana**		**134,787**	**205,320**	**293,100**	**71**	**108**	**155**	**4.30%**	**7.38%**	2.98%	2.30%	**329,300**	**381,800**	**430,400**	**482,400**
	36	Ward No.36	Gosalldanga	19,819	30,190	34,200	146	222	251	4.30%	2.53%	0.82%	0.76%	35,300	36,800	38,200	39,700
	37	Ward No.37	Halishahar Munir Nagar	32,276	49,170	62,000	85	130	164	4.30%	4.75%	1.96%	1.63%	67,000	73,900	80,300	87,100
	38	Ward No.38	South Middle Halishahar	36,020	54,870	85,800	66	101	158	4.30%	9.35%	3.62%	2.66%	98,900	118,100	135,900	155,000
	39	Ward No.39	South Halishahar	46,672	71,090	111,100	56	85	132	4.30%	9.34%	3.62%	2.65%	128,100	153,000	176,000	200,600
11	**65**	**Patenga Thana**		**72,771**	**85,360**	**133,300**	**37**	**43**	**67**	**1.61%**	**9.32%**	3.62%	2.64%	**153,700**	**183,600**	**211,100**	**240,500**
	40	Ward No.40	North Patenga	39,828	46,720	73,000	41	49	76	1.61%	9.34%	3.62%	2.65%	84,200	100,600	115,700	131,800
	41	Ward No.41	SouthPatenga	32,943	38,640	60,300	32	38	59	1.61%	9.31%	3.61%	2.64%	69,500	83,000	95,400	108,700
Municipality Total				**1,392,860**	**2,095,850**	**2,900,000**	**90**	**135**	**186**	**4.17%**	**6.71%**	2.74%	2.15%	**3,226,900**	**3,697,000**	**4,135,100**	**4,600,100**

Table 4.1.13 presents the projected population from 2015 to 2030 for the CCC area. The projected population in 2030 is 4.6 million (rounded up to the nearest thousand).

Table 4.1.13 Summary of Population Projection as a Total of CCC Area

unit: person

Item	2011	2015	2020	2025	2030
Population	2,900,000	3,226,900	3,697,000	4,135,000	4,600,000

The population by word is further distributed into the three categories of house /building types. The MP disregarded the composition of house/building types, seemingly in order to study from a more macroeconomic view point, covering the entire city. However, the composition of hose/building types varies considerably ward by ward.

Based on the composition percentages for respective wards by the type of house/building in the population censuses in 1991 and 2001, the SAPROF projected the shares of the three types of housing for the years 2010 and 2020 by ward. In this study, the shares of the housing types by ward for the years 2015, 2025 and 2030 are assumed according to the following conditions:

Year 2015: Pucca; proportionally increase using the ratio between 2010 and 2020
Kutcha; proportionally decrease using the ratio between 2010 and 2020
Semi-Pucca; 100% - (Pucca % + Kutcha %)

Year 2025 and Year 2030:
Pucca; proportionally increase using the ratio between 2010 and 2020
Kutcha; the percentage in 2020 is discounted
Semi-Pucca; 100%- (Pucca % + Kutcha %)

Table 4.1.14 presents the ranges of the shares by type of housing by ward in the past and future. It is assumed that the present year for the study is 2011 (base year of MP projection; data in year 2010 and 2012 are regarded as the same level in 2011). Table 4.1.15 shows the city average percentage by year as a result of the calculation for the concerned wards.

Table 4.1.14 Ranges of the Shares by Type of Housing by Ward

unit: %

Type of Housing	Population Census 1991	Population Census 2001	2011	2015	2020	2025	2030
Pucca	22-47	23-51	28-61	30-60	35-76	40-70	45-75
Semi-Pucca	30-39	20-30	30-39	25-35	22-29	25-35	25-35
Kutcha	18-43	23-49	4-35	2-35	0-35	0-35	0-35

Table 4.1.15 Population Shares assumed by Housing Type as a City Average

unit:%

Type of Housing	Population Census 1991	Population Census 2001	2011	2015	2020	2025	2030
Pucca	31	32	40	45	50	53	58
Semi-Pucca	34	39	34	30	25	30	28
Kutcha	35	29	26	25	25	17	14

4.2 Unit Water Consumption

Water consumption for the target and intermediate years will be assumed by domestic use (individual house connection and hydrant/communal faucet), and other uses; commercial, institutional and industrial. A uniform per capita consumption for individual house connections is applied to the three house/building types. For public hydrant/communal faucets, a lower consumption volume/person/day than that of individual house connections is used based on current practices. For other water users, a percentage of the domestic water consumption is used. This manner of calculation was adopted in previous studies.

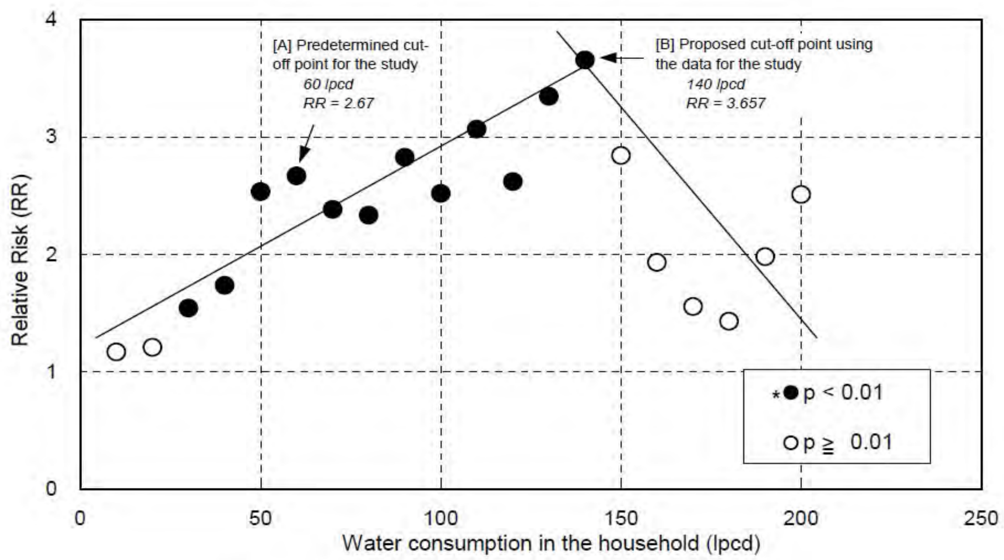
(1) Per Capita Water Consumption for House Connections and Public Hydrant

1) Daily Average Per Capita Water Consumption

Unit daily water consumption rate by different type of consumers shall be determined by referring to previous study results and findings by PANI, as well as figures which have been adopted for other cities in Bangladesh and neighbouring countries. As another reference, there is a report by the World Health Organization (hereinafter referred to as "WHO") in 2003 on the relationship between the water consumption rate and health conditions. In this report it is stated that a considerable reduction in water related/borne diseases can be expected with a consumption rate of 100 lpcd and the WHO recommends 140 lpcd to ensure healthy life. Table 4.2.1 shows the interrelationship between water consumption and health and Figure 4.2.1 presents water usage and health damage. Table 4.2.2 shows the assumptions on per capita water consumption rates in different projects.

Table 4.2.1 Summary of Water Supply Level for Promoting Health

Service level	**Access measure**	*Needs met*	**Level of health concern**
No access (quantity collected often below 5 l/c/d)	More than 1000m or 30 minutes total collection time	Consumption – cannot be assured Hygiene – not possible (unless practised at source)	Very high
Basic access (average quantity unlikely to exceed 20 l/c/d)	Between 100 and 1000m or 5 to 30 minutes total collection time	Consumption – should be assured Hygiene – handwashing and basic food hygiene possible; laundry/ bathing difficult to assure unless carried out at source	High
Intermediate access (average quantity about 50 l/c/d)	Water delivered through one tap on-plot (or within 100m or 5 minutes total collection time	Consumption – assured Hygiene – all basic personal and food hygiene assured; laundry and bathing should also be assured	Low
Optimal access (average quantity 100 l/c/d and above)	Water supplied through multiple taps continuously	Consumption – all needs met Hygiene – all needs should be met	Very low



* *P*-values in Chi-square test for a crosstable (e.g. Table 4).
Data source: Aiga H, *et al*. (1999). *Environ Health Prev Med*. **4** (3): 111-116.

Figure 4.2.1 Water Usage and Health Damage

Table 4.2.2 Summary of Daily Average Per Capita Water Consumption Rate

unit: lpcd

Project/organization		2011	2012	2020	2025	2030
Chittagong Water Supply projects	Mohara M/P	130				
	SAPROF	105		110		
	KOICA	115(2011)		145(2021)		180(2031)
	PANI	99 – 195 (100-130)				
WHO		100 - 140				
Other Projects	Khulna, Bangladesh			105	113	120
	Sri Lanka Killinochchi District Water Supply	120				
	Sri Lanka Jaffna Peninsula Water Supply	120				
	Goa, India	135 (Urban Area), 70 (Rural Area)				
	AGRA, India					150 (2036)

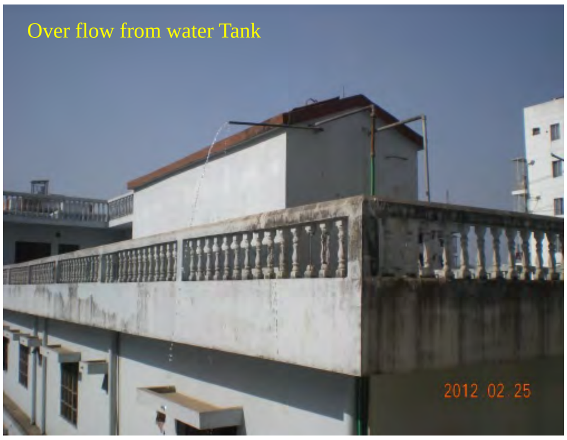
Note: PANI- The figures in parenthesis show adjusted ones judging from current practices by users (wasting water).

As shown in the above table, the consumption rates obtained in PANI area range from 99 lpcd to 195lpcd. Table 4.2.3 shows the results of analyses on the per capita consumption rate for respective survey points. Supporting Report 4.2.1 shows the location map of the survey points and survey results by the PANI team and CWASA calculation results using water charges collected. As a result of analyses on the background information on each survey point, the present consumption rate for residents with a higher living standard and under comparatively favourable water supply conditions, seems to be 100 lpcd -130 lpcd (Khulshi area falls in representative higher living standard area and the sample in Agrabad seems to be on the same level, 105-138 lpcd; refer to Table 4.2.3. These figures may be at least the targets as an overall average for the entire service area through the future, when water supply service would be improved.

Table 4.2.3 Analysis on Daily Average Per Capita Consumption by Survey Site

Survey Point	Location	lpcd	Analyses on per capita consumption
Chandgaon A	North east of PANI area	189-195	Located in Pucca area; No water supply through the day and residents store water in individual tanks during water supply period using private pump unit. It is common practice that water is overflowing from the tank without controlling inflow water by users. Thus, the consumption rate may be overestimated.
Chandgaon B	-do-	187-195	Almost same location as Chandgaon A and located in Pucca area; The practice of wasting water is same as that in Chandgaon A.
Khulshi	North west of MANI area	100-130	Residential area on the hill for people with a higher living standard. There are some areas where the water pressure is low due to higher ground elevation.
Agrabad	South west of PANI area	126-166 (105-138)	Located in commercial area. In this regard consumption rate seems to be higher than common residential area. Assuming commercial use of 20% of domestic demand, 105-138 lpcd coincides with domestic consumption.

Note: The picture shows overflow of water from private tank after utilisation of tank capacity in Chandgaon A. It means that actual water consumption is much less than estimated.



The domestic water consumption rate for the year 2030 may be set as 120 lpcd considering the water consumption rate by people with a comparatively higher living standard in PANI area (100-130 lpcd), and the target consumption rate in the Khulna and Sri Lanka projects (120 lpcd) as well as recommendations by WHO (100-140 lpcd). For public hydrants/communal faucets, the same figure as adopted by SAPROF is applied up to the year 2020, but from year 2025 it is assumed that there will be no public hydrant/communal faucets. The daily average per capita consumption for domestic use for the target and intermediate years is shown in Table 4.2.4 (The planned volume for house connection for the years 2010 and 2020 is used for the Phase 1 Project and the figures in other years are calculated proportionately).

Table 4.2.4 Per Capita Water Consumption (Domestic water supply)

unit: lpcd

Year/Type		**2010**	**2015**	**2020**	**2025**	**2030**
Domestic water supply	House Connection	105	108	110	115	120
	Hydrant	58	58	58	N.A	N.A

Note: N.A- Not Applicable

Upon completion of the Phase 2 Project, it is indispensable that proper use of water as planned shall be practiced by the consumers to realize the water supply services as planned with a limited supply capacity for the entire Karnaphuli service area. Therefore, CWASA shall be ready to manage the requirements to control the water supply amount and consumption before completion of the Phase 2 Project including improvement of tariff structure, proper metering maintenance and proper penalty rules, as well as enhancement of capacity for operation and management of the waterworks.

2) Daily Maximum Water Consumption and Hourly Maximum Water consumption

The peak factor for the estimation of daily maximum water consumption is assumed referring to the PANI survey results and plan in Khulna Water Supply Project as well as common experiences in the developing countries. The survey results by PANI showed 1.1 as the seasonal fluctuation in daily water consumption (refer to Supporting Report 4.2.2), while the Khulna water supply project adopted a factor of 1.15.

In consideration of the improvement of water use in the Karnaphuli service area by the year 2030 compared to the present situation, as well as the planning target figure used in some developing countries (1.2), a factor of 1.15 is adopted for the daily maximum water consumption in this project. For the factor of hourly maximum water consumption to daily maximum water consumption, 1.5 is adopted as is commonly used in developing countries, as there is no reliable in historical information and also considering the current levels of service (pressure, number of hours of water supply, etc.).

4.3 Service Connection Percentage by Type of Housing for Domestic Water Supply

The service connection percentages for the three types of housing up to year 2020 are assumed in the SAPROF study, common to all concerned wards. These have been used by other studies (MP assumed the percentage as an average for the CCC area). In this study, the percentages for 2025 and 2030 by type of housing for house connections are assumed as follows:

- Pucca: assumed that 100% in 2020 will be kept.
- Semi-Pucca: assumed at 95% in 2030
- Kutcha: assumed at 70% in 2030

For hydrant the following assumptions are used.

- Pucca: assumed that 0% in 2020 will be kept.
- Semi-Pucca: assumed at 0%
- Kutcha: assumed at 0%

Table 4.3.1 shows planned connection percentages for domestic water supply by house connection and hydrant.

Table 4.3.1 Planned Connection Percentage by Type of Housing for Domestic Connections

unit: %

Type of Housing		SAPROF (2010/2011)	Planned Connection			
			2015	2020	2025	2030
House Connection	Pucca	95	97.5	100	100	100
	Semi-Pucca	60	65	70	85	95
	Kutcha	25	27.5	30	50	70
Hydrant	Pucca	5	2.5	0	0	0
	Semi-Pucca	10	10	10	0	0
	Kutcha	11.5	18	25	0	0

Using the above mentioned connection percentages, about 94.7 % of the population in the CCC area will be considered as the potential population to be served in 2030. The GOB established "The Sixth National Five-Year Development Plan (2011-2015)" with a special emphasis on safe water supply to all people at an early stage. In the plan, the targets for service coverage for the four major cities in the country, including Chittagong are planned to be 65% in 2005, 90% in 2025 and 95% in 2050. In this regard, planned service coverage required is on the same level of 95% in 2030.

In connection with the achievement of the service coverage, water supply services shall be increased in provision of some self-contented water supply systems by the year 2030. The water supply for Karnaphuli service area through Phase 1 and 2 projects is one of the major countermeasures to meet the water demand required in the CCC area.

4.4 Water Demand Projection for Commercial, Institutional and Industrial Uses

Water demand for uses other than domestic use is calculated using percentages of domestic water demand. Such a manner of calculation has been adopted since "the Feasibility Study of Extension and Expansion of MOHARA Water Treatment Plant in 2000".

The MP projected the demand in two categories, non-domestic individual use (commercial and industrial uses) and non-domestic governmental use (institutional use). Uniform consumption rates common to all concerned wards in the entire city were adopted to calculate the demand for the two categories. Present land use and future prospects by ward were neglected in the MP. On the other hand, in the SAPROF study the CCC area was categorized into 7 zones in terms of general land use (residential, commercial and industrial uses) by referring to the existing land use. This study utilizes SAPROF study results to consider the differences by ward in land uses. Table 4.4.1 presents the composition of wards by zone categorized by land use type.

Table 4.4.1 Composition of Wards by Block Categorized in Terms of Land Use

Zone	Name of Thana	Land Use category	Composition of Wards
1	Kotwali	Residential	15. Bagmoniram, 16.Chanik Bazar, 20.Dewan Bazar, 21. Jamalkhan, 22. Enayat Bazar, 31. Alkaran, 32, Anderkilla, 33. Finghee Bazar, 34. Patharghata, 35. Boxirhat
2	Khulshi, Doble Mooring, Halishahar, Chittagong Port,	Residential	9. North Kattali, 14. Lalkhan Bazar, 24. North Agrabad, 25. Rampur, 27. South Agrabad, 28. Pathantuli, 29. West Madarbari, 30. East Madarbari, 36. Gosalldanga,
3	Bayazid Bostami, Panchlaish	Commercial	2. Jalalabd, 3. Panchlaish, 7. West Sholakbawar, 8. Shulokbahar,
4	Pahartali, Khulishi, Halishahar	Commercial	10. North Kattali, 11.South Kattali, 12. Saraipara, 13. Pahartali, 26. North Halishahar
5	Chandgaon, Balalia	Commercial	4. Chandgaon, 5. Mohara, 6. East Sholakbawar, 17. West Bakalia, 18. East Bakalia. 19. South Bakalia
6	Chittagong Port, Patenga	Industrial	37. Halishahar Munir Nagar, 38. South Middle Halishahar, 39. South Halishahar, 40. North Patenga, 41. South Patenga
7	Bayazid Bostami	Residential	1. South Pahartali

Water demand as percentages of domestic water demand by land use type are assumed for commercial, institutional and industrial uses. The percentages by different water uses for the years 2010 (2011) and 2020 in the SAPROF study are used. This study utilizes the same manner and percentages up to the year 2030 as shown in Table 4.4.2. Under the assumptions on the percentages, domestic and other water use in the CCC are about 70 % and 30% respectively (in the CCC area there are large industrial areas, which contribute to the percentage of 30% for others (non-domestic).

Table 4.4.2 Water Demand Percentages to Domestic Water Demand in Terms of Commercial, Institutional and Industrial Uses by Characterized Land Use Type

unit: %

Land use type	Commercial	Institutional	Industrial	Remarks
Residential area	5	2	0	Overall average figures present percentages in CCC area from 2010 to 2020 using the following formula. (Year 2010/2020 total water demand by water use type) divided by (Year 2010/2020 total domestic water demand)
Commercial area	20	15	30	
Industrial area	5	1	100	
Overall average	7	5	19	

4.5 NRW Percentage and Leakage Percentage

The NRW percentage at present is reported at 33% by CWASA. It is self-explanatory that without improvement of the water supply system in the future, the NRW percentage would not be improved keeping same figure of 33% at present (Case 1).

In the PANI replacement of water meters and old pipes was carried out, where leakage was observed in Pilot Area, resulting in a reduction in NRW from more than 50% to 15%. This result is evidence that it is possible to reduce NRW to about 15% in the CWASA service area by the provision of adequate countermeasures.

In addition, there is sufficient experience of the significant reduction in NRW in developing countries, as experienced in the PANI trial work, after the improvement of distribution facilities. In the Phase 2 Project, installation of new distribution pipelines with flow/pressure control arrangements is planned to achieve self-contained and physically separated area. In this context, NRW may be assumed to be improved significantly from 33% at present to 15% in 2030 (Case 2).

Table 4.5.1 shows the two cases; Case 1 – No improvement in NRW in the future and Case 2 - Provision of countermeasures through the implementation of appropriate projects such as the Karnaphuli water supply projects. In Case 2, the level of NRW from the present to the year 2030 is planned considering staged improvement after realization of the Phase 1 and Phase 2 projects (As of today, completion of Phase 2 Project to cover all distribution facilities in the service area is scheduled in 2018).

Table 4.5.1 Assumption of NRW Percentages for 2 Cases

unit: %

Case/Year	2011	2015	2020	2025	2030
Case 1	33	33	33	33	33
Case 2	33	33	20	15	15

Under the above assumptions on NRW percentages by case, leakage percentages are assumed for the two cases as shown in Table 4.5.2. In Case 1, about 75% of NRW is assumed as leakage and the figure will be the same in the future. However, in the provision of the Phase 1 and 2 projects (Case 2), the leakage percentages for planning purpose are assumed considering staged improvements. Before completion of the Phase 2 Project, the same percentage as case 1 is adopted, but a gradual reduction of the percentage is assumed finally to reach 10% in 2025 (about 60% of NRW).

Table 4.5.2 Assumption of Leakage Percentages for 2 Cases

unit:%

Case/Year	2010	2015	2020	2025	2030
Case 1	25	25	25	25	25
Case 2	25	25	15	10	10

4.6 Manner of Water Demand Calculation

Overall water demand in CCC area for target years is calculated using the factors studied in the previous sub-sections. Table 4.6.1 presents calculation method.

Table 4.6.1 Calculation Method of Water Demand

Items		Calculation	
Domestic a=a-1 + a-2 +a-3	Pucca	Population of each Ward x rate of Pucca x rate of Connection x Per-Capita Water Consumption	a-1
	Semi-Pucca	Population of each Ward x rate of Semi-Pucca x rate of Connection x Per-Capita Water Consumption	a-2
	Kutcha	Population of each Ward x rate of Kutcha x rate of Connection x Per-Capita Water Consumption	a-3
Public Hydrant b=b-1 + b-2 +b-3	Pucca	Population of each Ward x rate of Pucca x rate of Connection x Unit flow of Hydrant	b-1
	Semi-Pucca	Population of each Ward x rate of Semi-Pucca x rate of Connection x Unit flow of Hydrant	b-2
	Kutcha	Population of each Ward x rate of Kutcha x rate of Connection x Unit flow of Hydrant	b-3
Commercial; c		(a + b) x rate of Commercial at each Ward	c
Institution; d		(a + b) x rate of Institution at each Ward	d
Industrial; e		(a + b) x rate of Industrial at each Ward	e
Leakage ; f		(a + b + c + d + e) x Leakage% / (100 - Leakage%)	f
Total Water Demand at each Ward		a + b + c + d + e + f	

4.7 Water demand Projection in CCC Area

Based on the above study, water demand for the year 2030 in the CCC area is projected for two cases as follows:

(1) Water Demand Projection in 2030 assuming 25% of leakage (in case that there would be no improvement of water supply in the CCC area from present up to the year 2030)
(2) Water Demand Projection in 2030 assuming 10% of leakage (in case that planned improvement for Karnaphuli service area could be expanded to the entire CCC area)

Water Demand in the CCC area by water use type is summarized for the above mentioned two cases in Table 4.7.1 and shown in Figure 4.7.1. Table 4.7.2 presents the demand projection by ward for the two cases. The present demand (2011) of Qdmax=470,400 m^3/d will be more than double in 2030 in both cases: case1; Qdmax=1,215,700 m^3/d and case 2; Qdmax=1,012,900 m^3/d.

Water supply to slum areas in KASA is also considered in this plan.

Table 4.7.1 Water Demand in CCC Area by Target Year for 2 Cases

Item			2011	2015	2020	2025	2030
Case-1 Leakage 25% in 2030	Daily average water demand; Qdave	Service Connection	192,300	242,800	310,800	413,100	522,700
		Hydrant	14,400	16,300	17,600	0	0
		Others (Commercial, Institutional, and Industrial)	100,300	127,400	165,200	211,500	269,800
		Leakage	101,900	128,900	165,000	208,000	264,500
	Total (m^3/d)	Qdave	**408,900**	**515,400**	**658,600**	**832,600**	**1,057,000**
		Qdmax	**470,400**	**592,500**	**757,500**	**957,700**	**1,215,700**
Case-2 Leakage 10% in 2030	Daily average water demand; Qdave	Service Connection	192,300	242,800	310,800	413,100	522,700
		Hydrant	14,400	16,300	17,600	0	0
		Others (Commercial, Institutional, and Industrial)	100,300	127,400	165,100	211,400	269,800
		Leakage	101,900	128,900	87,400	69,300	88,300
	Total (m^3/d)	Qdave	**408,900**	**515,400**	**580,900**	**693,800**	**880,800**
		Qdmax	**470,400**	**592,500**	**668,200**	**797,800**	**1,012,900**

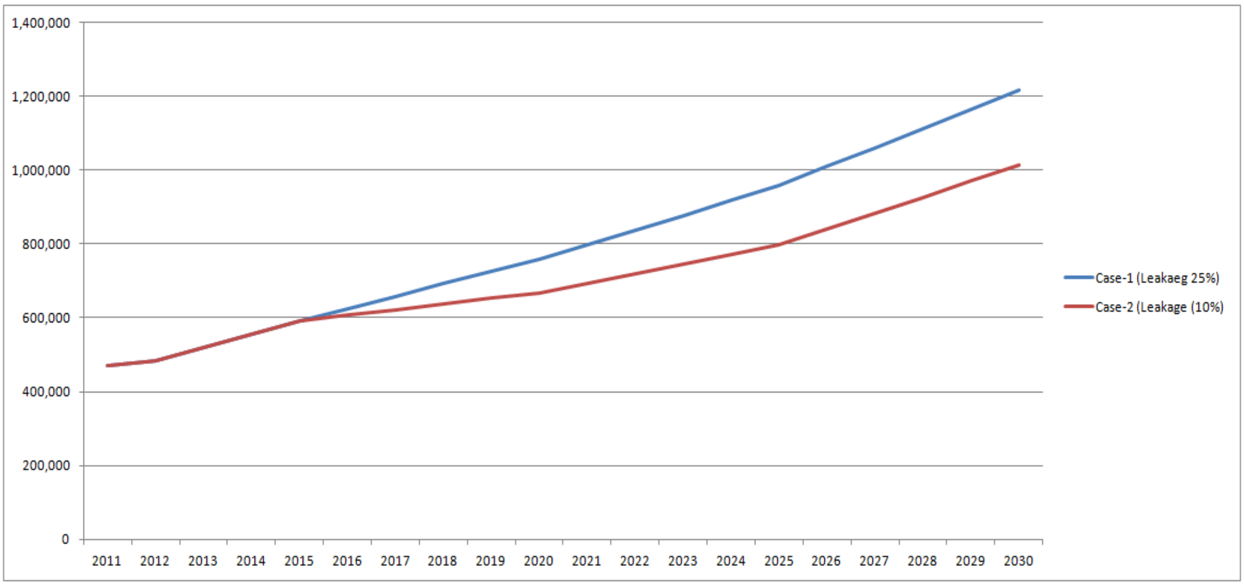


Figure 4.7.1 Water Demand in CCC

Table 4.7.2 (a) Case-1: Water Demand Projection by Ward assuming 25% Leakage from 2011 to 2030

Ward		Year		2011		2015		2020		2025		2030	
		Per-capita water consumption Lpcd		105		108		110		115		120	
		1.15	= Qdmax/Qdave	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax
01	**16**	**Bayeijid Bostami Thana**		**37,400**	**43,100**	**48,500**	**55,800**	**60,800**	**69,900**	**74,400**	**85,600**	**95,900**	**110,300**
	01	Ward No.01	South Pahartali	11,100	12,800	14,300	16,400	17,800	20,500	21,900	25,200	28,000	32,200
	02	Ward No.02	Jalalabad	15,000	17,300	19,800	22,800	25,400	29,200	31,400	36,100	41,100	47,300
	03	Ward No.03	Panchlaish	11,300	13,000	14,400	16,600	17,600	20,200	21,100	24,300	26,800	30,800
02	**57**	**Panchlaish Thana**		**46,800**	**53,800**	**60,900**	**70,000**	**80,200**	**92,300**	**104,200**	**119,900**	**135,100**	**155,400**
	07	Ward No.07	West Sholakbawar	18,500	21,300	24,100	27,700	31,700	36,500	41,200	47,400	53,400	61,400
	08	Ward No.08(Part)	Shulokbahar	28,300	32,500	36,800	42,300	48,500	55,800	63,000	72,500	81,700	94,000
03	**19**	**Chandgaon Thana**		**42,100**	**48,400**	**55,600**	**63,900**	**74,100**	**85,200**	**97,300**	**111,900**	**127,600**	**146,800**
	04	Ward No.04	Chandgaon	17,300	19,900	22,800	26,200	30,400	35,000	40,000	46,000	52,400	60,300
	05	Ward No.05	Mohara	18,600	21,400	24,600	28,300	32,800	37,700	43,000	49,500	56,400	64,900
	06	Ward No.06	East Sholakbawar	6,200	7,100	8,200	9,400	10,900	12,500	14,300	16,400	18,800	21,600
04	**10**	**Bakalia**		**45,200**	**52,000**	**59,600**	**68,600**	**79,700**	**91,700**	**105,100**	**120,900**	**139,300**	**160,300**
	17	Ward No.17	West Bakalia	15,000	17,300	19,900	22,900	26,800	30,800	35,400	40,700	47,100	54,200
	18	Ward No.18	East Bakalia	9,600	11,000	12,700	14,600	17,100	19,700	22,600	26,000	30,000	34,500
	19	Ward No.19	South Bakalia	17,600	20,200	23,300	26,800	31,300	36,000	41,400	47,600	55,000	63,300
	35	Ward No.35(Part)	Boxirhat	3,000	3,500	3,700	4,300	4,500	5,200	5,700	6,600	7,200	8,300
05	**41**	**Kotwali Thana**		**44,700**	**51,400**	**52,400**	**60,200**	**62,100**	**71,500**	**73,400**	**84,500**	**86,200**	**99,200**
	15	Ward No.15	Bagmoniram	5,000	5,800	5,900	6,800	6,900	7,900	8,200	9,400	9,700	11,200
	16	Ward No.16	Chanik Bazar	7,100	8,200	8,300	9,500	9,800	11,300	11,700	13,500	13,700	15,800
	20	Ward No.20	Dewan Bazar	5,200	6,000	6,100	7,000	7,300	8,400	8,600	9,900	10,100	11,600
	21	Ward No.21	Jamalkhan	6,300	7,200	7,400	8,500	8,800	10,100	10,400	12,000	12,200	14,000
	22	Ward No.22	Enayet Bazar	4,700	5,400	5,500	6,300	6,500	7,500	7,700	8,900	9,000	10,400
	31	Ward No.31	Alkaran	4,600	5,300	5,400	6,200	6,400	7,400	7,500	8,600	8,800	10,100
	32	Ward No.32	Anderkilla	3,300	3,800	3,900	4,500	4,600	5,300	5,400	6,200	6,400	7,400
	33	Ward No.33	Finghee Bazar	3,600	4,100	4,200	4,800	5,000	5,800	5,900	6,800	6,900	7,900
	34	Ward No.34	Patharghata	4,900	5,600	5,700	6,600	6,800	7,800	8,000	9,200	9,400	10,800
	35	Ward No.35(Part)	Boxirhat					0		0		0	
06	**43**	**Khulshi Thana**		**35,500**	**40,900**	**46,500**	**53,500**	**61,500**	**70,700**	**80,600**	**92,700**	**104,900**	**120,700**
	08	Ward No.08(Part)	Sholakbahar					0					
	09	Ward No.09	North Pahartali	9,700	11,200	12,700	14,600	16,800	19,300	22,000	25,300	28,600	32,900
	13	Ward No.13	Pahartali	15,700	18,100	20,600	23,700	27,200	31,300	35,600	40,900	46,400	53,400
	14	Ward No.14	Lalkhan Bazar	10,100	11,600	13,200	15,200	17,500	20,100	23,000	26,500	29,900	34,400
07	**55**	**Pahartali**		**21,200**	**24,400**	**25,100**	**28,900**	**29,000**	**33,400**	**34,700**	**39,900**	**41,600**	**47,800**
	10	Ward No.10	North Kattali	4,900	5,600	5,800	6,700	6,700	7,700	8,000	9,200	9,700	11,200
	11	Ward No.11	South Kattali	5,300	6,100	6,300	7,200	7,200	8,300	8,700	10,000	10,300	11,800
	12	Ward No.12	Saraipara	11,000	12,700	13,000	15,000	15,100	17,400	18,000	20,700	21,600	24,800
08	**28**	**Double Mooring Thana**		**37,200**	**42,800**	**44,500**	**51,100**	**53,000**	**60,900**	**62,100**	**71,400**	**77,300**	**88,900**
	23	Ward No.23	North Pathantuli	4,400	5,100	5,300	6,100	6,500	7,500	8,000	9,200	9,800	11,300
	24	Ward No.24(Part)	North Agrabad	5,500	6,300	6,500	7,500	7,400	8,500	8,700	10,000	10,300	11,800
	27	Ward No.27	South Agrabad	10,500	12,100	12,300	14,100	14,200	16,300	16,700	19,200	19,600	22,500
	28	Ward No.28	Pathantuli	5,600	6,400	6,800	7,800	8,200	9,400	10,100	11,600	12,400	14,300
	29	Ward No.29	West Madarbari	6,200	7,100	7,500	8,600	9,200	10,600	11,300	13,000	13,900	16,000
	30	Ward No.30	East Madarbari	5,000	5,800	6,100	7,000	7,500	8,600	7,300	8,400	11,300	13,000
09	**35**	**Halishahar Thana**		**10,100**	**11,600**	**11,800**	**13,600**	**13,700**	**15,700**	**16,100**	**18,500**	**18,900**	**21,700**
	24	Ward No.24(Part)	North Agrabad										
	25	Ward No.25	Rampur	3,500	4,000	4,100	4,700	4,800	5,500	5,600	6,400	6,600	7,600
	26	Ward No.26	North Hallshahar	6,600	7,600	7,700	8,900	8,900	10,200	10,500	12,100	12,300	14,100
10	**20**	**Chittagong Port Thana**		**61,900**	**71,200**	**76,200**	**87,500**	**98,800**	**113,600**	**125,500**	**144,300**	**154,300**	**177,400**
	36	Ward No.36	Gosalldanga	7,200	8,300	8,200	9,400	9,500	10,900	11,200	12,900	12,700	14,600
	37	Ward No.37	Halishahar Munir Nagar	13,100	15,100	15,500	17,800	19,100	22,000	23,400	26,900	27,900	32,100
	38	Ward No.38	South Middle Halishahar	18,100	20,800	22,900	26,300	30,600	35,200	39,600	45,500	49,600	57,000
	39	Ward No.39	South Halishahar	23,500	27,000	29,600	34,000	39,600	45,500	51,300	59,000	64,100	73,700
11	**65**	**Patenga Thana**		**26,800**	**30,800**	**34,300**	**39,400**	**45,700**	**52,600**	**59,200**	**68,100**	**75,900**	**87,200**
	40	Ward No.40	North Patenga	14,700	16,900	18,800	21,600	25,000	28,800	32,400	37,300	41,600	47,800
	41	Ward No.41	SouthPatenga	12,100	13,900	15,500	17,800	20,700	23,800	26,800	30,800	34,300	39,400
						0							
Chittagong City Corporation Total				**408,900**	**470,400**	**515,400**	**592,500**	**658,600**	**757,500**	**832,600**	**957,700**	**1,057,000**	**1,215,700**

Table 4.7.2 (b) Case-2: Water Demand Projection by Ward assuming 10% Leakage from 2011 to 2030

Ward		Year		2011		2015		2020		2025		2030	
		Per-capita water consumption Lpcd		105		108		110		115		120	
		1.15	= Qdmax/Qdave	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax
01	**16**	**Bayeijid Bostami Thana**		**37,400**	**43,100**	**48,500**	**55,800**	**53,600**	**61,700**	**62,000**	**71,200**	**79,900**	**91,900**
	01	Ward No.01	South Pahartali	11,100	12,800	14,300	16,400	15,700	18,100	18,200	20,900	23,300	26,800
	02	Ward No.02	Jalalabad	15,000	17,300	19,800	22,800	22,400	25,800	26,200	30,100	34,200	39,300
	03	Ward No.03	Panchlaish	11,300	13,000	14,400	16,600	15,500	17,800	17,600	20,200	22,400	25,800
02	**57**	**Panchlaish Thana**		**46,800**	**53,800**	**60,900**	**70,000**	**70,800**	**81,400**	**86,800**	**99,800**	**112,600**	**129,500**
	07	Ward No.07	West Sholakbawar	18,500	21,300	24,100	27,700	28,000	32,200	34,300	39,400	44,500	51,200
	08	Ward No.08(Part)	Shulokbahar	28,300	32,500	36,800	42,300	42,800	49,200	52,500	60,400	68,100	78,300
03	**19**	**Chandgaon Thana**		**42,100**	**48,400**	**55,600**	**63,900**	**65,300**	**75,000**	**81,100**	**93,300**	**106,200**	**122,100**
	04	Ward No.04	Chandgaon	17,300	19,900	22,800	26,200	26,800	30,800	33,300	38,300	43,600	50,100
	05	Ward No.05	Mohara	18,600	21,400	24,600	28,300	28,900	33,200	35,900	41,300	47,000	54,100
	06	Ward No.06	East Sholakbawar	6,200	7,100	8,200	9,400	9,600	11,000	11,900	13,700	15,600	17,900
04	**10**	**Bakalia**		**45,200**	**52,000**	**59,600**	**68,600**	**70,300**	**80,800**	**87,600**	**100,700**	**116,100**	**133,600**
	17	Ward No.17	West Bakalia	15,000	17,300	19,900	22,900	23,600	27,100	29,500	33,900	39,200	45,100
	18	Ward No.18	East Bakalia	9,600	11,000	12,700	14,600	15,100	17,400	18,900	21,700	25,000	28,800
	19	Ward No.19	South Bakalia	17,600	20,200	23,300	26,800	27,600	31,700	34,500	39,700	45,900	52,800
	35	Ward No.35(Part)	Boxirhat	3,000	3,500	3,700	4,300	4,000	4,600	4,700	5,400	6,000	6,900
05	**41**	**Kotwali Thana**		**44,700**	**51,400**	**52,400**	**60,200**	**54,600**	**62,900**	**61,300**	**70,500**	**71,700**	**82,500**
	15	Ward No.15	Bagmoniram	5,000	5,800	5,900	6,800	6,100	7,000	6,900	7,900	8,000	9,200
	16	Ward No.16	Chanik Bazar	7,100	8,200	8,300	9,500	8,700	10,000	9,700	11,200	11,400	13,100
	20	Ward No.20	Dewan Bazar	5,200	6,000	6,100	7,000	6,400	7,400	7,200	8,300	8,400	9,700
	21	Ward No.21	Jamalkhan	6,300	7,200	7,400	8,500	7,700	8,900	8,700	10,000	10,100	11,600
	22	Ward No.22	Enayet Bazar	4,700	5,400	5,500	6,300	5,700	6,600	6,400	7,400	7,500	8,600
	31	Ward No.31	Alkaran	4,600	5,300	5,400	6,200	5,600	6,400	6,300	7,200	7,400	8,500
	32	Ward No.32	Anderkilla	3,300	3,800	3,900	4,500	4,000	4,600	4,500	5,200	5,300	6,100
	33	Ward No.33	Finghee Bazar	3,600	4,100	4,200	4,800	4,400	5,100	4,900	5,600	5,800	6,700
	34	Ward No.34	Patharghata	4,900	5,600	5,700	6,600	6,000	6,900	6,700	7,700	7,800	9,000
	35	Ward No.35(Part)	Boxirhat					0		0		0	
06	**43**	**Khulshi Thana**		**35,500**	**40,900**	**46,500**	**53,500**	**54,300**	**62,400**	**67,000**	**77,000**	**87,500**	**100,600**
	08	Ward No.08(Part)	Sholakbahar					0					
	09	Ward No.09	North Pahartali	9,700	11,200	12,700	14,600	14,800	17,000	18,300	21,000	23,900	27,500
	13	Ward No.13	Pahartali	15,700	18,100	20,600	23,700	24,000	27,600	29,600	34,000	38,700	44,500
	14	Ward No.14	Lalkhan Bazar	10,100	11,600	13,200	15,200	15,500	17,800	19,100	22,000	24,900	28,600
07	**55**	**Pahartali**		**21,200**	**24,400**	**25,100**	**28,900**	**25,600**	**29,500**	**28,900**	**33,300**	**34,700**	**39,900**
	10	Ward No.10	North Kattali	4,900	5,600	5,800	6,700	5,900	6,800	6,700	7,700	8,100	9,300
	11	Ward No.11	South Kattali	5,300	6,100	6,300	7,200	6,400	7,400	7,200	8,300	8,600	9,900
	12	Ward No.12	Saraipara	11,000	12,700	13,000	15,000	13,300	15,300	15,000	17,300	18,000	20,700
08	**28**	**Double Mooring Thana**		**37,200**	**42,800**	**44,500**	**51,100**	**46,700**	**53,800**	**51,800**	**59,600**	**64,400**	**74,000**
	23	Ward No.23	North Pathantuli	4,400	5,100	5,300	6,100	5,700	6,600	6,700	7,700	8,200	9,400
	24	Ward No.24(Part)	North Agrabad	5,500	6,300	6,500	7,500	6,500	7,500	7,300	8,400	8,500	9,800
	27	Ward No.27	South Agrabad	10,500	12,100	12,300	14,100	12,500	14,400	13,900	16,000	16,300	18,700
	28	Ward No.28	Pathantuli	5,600	6,400	6,800	7,800	7,300	8,400	8,400	9,700	10,400	12,000
	29	Ward No.29	West Madarbari	6,200	7,100	7,500	8,600	8,100	9,300	9,400	10,800	11,600	13,300
	30	Ward No.30	East Madarbari	5,000	5,800	6,100	7,000	6,600	7,600	6,100	7,000	9,400	10,800
09	**35**	**Halishahar Thana**		**10,100**	**11,600**	**11,800**	**13,600**	**12,000**	**13,800**	**13,500**	**15,500**	**15,800**	**18,100**
	24	Ward No.24(Part)	North Agrabad										
	25	Ward No.25	Rampur	3,500	4,000	4,100	4,700	4,200	4,800	4,700	5,400	5,500	6,300
	26	Ward No.26	North Hallshahar	6,600	7,600	7,700	8,900	7,800	9,000	8,800	10,100	10,300	11,800
10	**20**	**Chittagong Port Thana**		**61,900**	**71,200**	**76,200**	**87,500**	**87,300**	**100,500**	**104,500**	**120,200**	**128,600**	**147,900**
	36	Ward No.36	Gosalldanga	7,200	8,300	8,200	9,400	8,400	9,700	9,300	10,700	10,600	12,200
	37	Ward No.37	Halishahar Munir Nagar	13,100	15,100	15,500	17,800	16,900	19,400	19,500	22,400	23,200	26,700
	38	Ward No.38	South Middle Halishahar	18,100	20,800	22,900	26,300	27,000	31,100	33,000	38,000	41,300	47,500
	39	Ward No.39	South Halishahar	23,500	27,000	29,600	34,000	35,000	40,300	42,700	49,100	53,500	61,500
11	**65**	**Patenga Thana**		**26,800**	**30,800**	**34,300**	**39,400**	**40,400**	**46,400**	**49,300**	**56,700**	**63,300**	**72,800**
	40	Ward No.40	North Patenga	14,700	16,900	18,800	21,600	22,100	25,400	27,000	31,100	34,700	39,900
	41	Ward No.41	SouthPatenga	12,100	13,900	15,500	17,800	18,300	21,000	22,300	25,600	28,600	32,900
						0							
Chittagong City Corporation Total				**408,900**	**470,400**	**515,400**	**592,500**	**580,900**	**668,200**	**693,800**	**797,800**	**880,800**	**1,012,900**

CHAPTER 5

ESTABLISHMENT OF KARNAPHULI SERVICE AREA

CHAPTER 5 ESTABLISHMENT OF KARNAPHULI SERVICE AREA

5.1 Manner of the Selection of Wards to Include in Karnaphuli Service Area

It was confirmed at the Steering Committee Meeting on the Preparatory Survey on Chittagong Water Supply Improvement Project on May 24, 2012 that the Karnaphuli Service Area should be self-contained and therefore, there should be no water transfer into the service area from the other water treatment plants in the future. In this context, the Karnaphuli service area is established in consideration of the balance between the water supply capacity from Karnaphuli water treatment plant (combined capacity of Phase 1 and 2 projects) and water demand in the CCC area for the year 2030.

The total water demand in the CCC area for the year 2030 is estimated at 1,012,900 m^3/d (daily maximum demand) as Case 2 in the previous Chapter assuming that improvement of distribution facilities would be realized in the entire CCC area. However, the water supply capacity from the Karnaphuli water treatment plant is limited to 286,000 m^3/d. Therefore, the area (wards) to be covered in the 41 wards is decided with priorities to the following areas:

- PANI Area
- Planned area to be covered with main/sub-main pipelines by Phase-1 Project
- Wards with a higher demand (more than 100m^3/d/ha) geographically being continuous from PANI area

5.2 Selection of Wards to be covered by Karnaphuli Service Area

Table 5.2.1 shows a summary of the evaluation of the wards to be included in the Karnaphuli service area, based on the selection criteria in Chapter 5.1. Supporting Report 5.2.1 presents detailed information by ward on the selection process. A total of 21 wards with a total area of 3,063 ha are selected for the service area.

Table 5.2.2 shows the wards to be covered in the Karnaphuli service area to meet a total supply amount of 286,000m^3/d by considering the priority areas in Section 5.1. Figure 5.2.1 presents concerned information on the selected wards to be covered by the Karnaphuli service area.

The service coverage in the CCC area in terms of service area and population to be served is as follows:

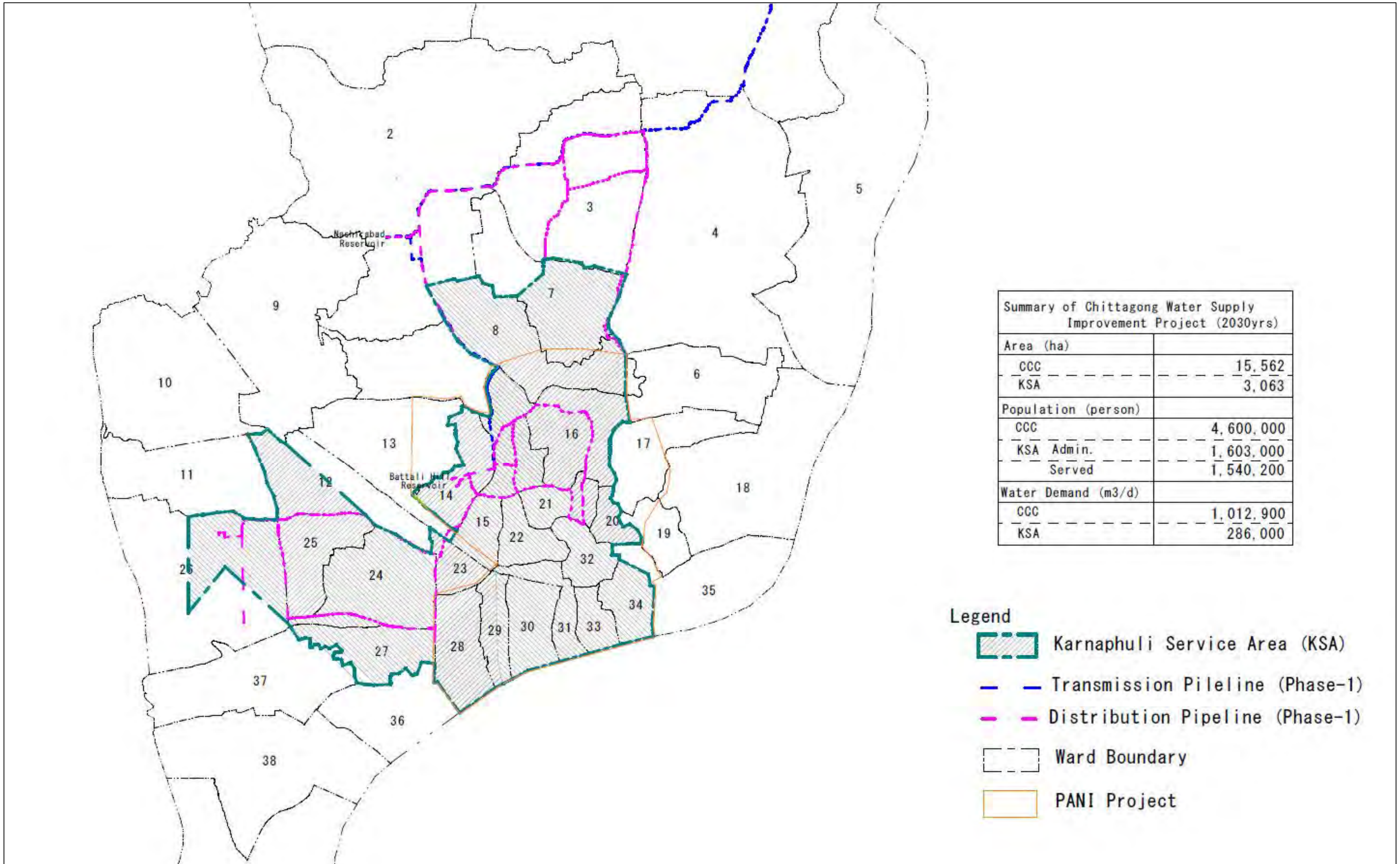
- Service area to be covered: 19.7 % (3,063 ha/ 15,562 ha)
- Population to be covered: 33.5 % (1,540,200/4,600,000)

Table 5.2.1 Selection of Wards for Karnaphuli Service Area

Chittagong City Corporation				2030 Water Demand (WD)			Priority Ward						Selected KSA
				WD by Ward	Area by Wrad	WD/ha	PANI	Phase-1 Project			Higher	less water	
				Qdmax(m3/d)	ha	m3/d/ha	Project	North	Central	South	Demand	supply	
01	16	Bayejjid Bostami Thana		**91,900**	**3,015**	**30.5**							
	01	Ward No.01	South Pahartali	26,800	1,077	24.9							
	02	Ward No.02	Jalalabad	39,300	1,358	28.9		✓					
	03	Ward No.03	Panchlaish	25,800	580	44.5		✓					
02	57	Panchlaish Thana		**129,500**	**909**	**142.5**							
	07	Ward No.07	West Sholakbawar	51,200	407	125.8		✓			✓		○
	08	Ward No.08(Part)	Shulokbahar	78,300	502	156.0	✓(part)	✓			✓		○
03	19	Chandgaon Thana		**122,100**	**2,075**	**58.8**							
	04	Ward No.04	Chandgaon	50,100	927	54.0							
	05	Ward No.05	Mohara	54,100	904	59.8							
	06	Ward No.06	East Sholakbawar	17,900	244	73.4							
04	10	Bakalia		**133,600**	**1,323**	**101.0**							
	17	Ward No.17	West Bakalia	45,100	243	185.6	✓(part)				✓		
	18	Ward No.18	East Bakalia	28,800	655	44.0							
	19	Ward No.19	South Bakalia	52,800	127	415.7					✓		
	35	Ward No.35(Part)	Boxirhat	6,900	298	23.2							
05	41	Kotwali Thana		**82,500**	**931**	**88.6**							
	15	Ward No.15	Bagmoniram	9,200	180	51.1	✓		✓				○
	16	Ward No.16	Chanik Bazar	13,100	177	74.0	✓		✓				○
	20	Ward No.20	Dewan Bazar	9,700	39	248.7	✓				✓		○
	21	Ward No.21	Jamalkhan	11,600	76	152.6	✓		✓		✓		○
	22	Ward No.22	Enayet Bazar	8,600	86	100.0	✓						○
	31	Ward No.31	Alkaran	8,500	92	92.4	✓						○
	32	Ward No.32	Anderkilla	6,100	106	57.5	✓		✓				○
	33	Ward No.33	Finghee Bazar	6,700	83	80.7	✓						○
	34	Ward No.34	Patharghata	9,000	92	97.8	✓						○
	35	Ward No.35(Part)	Boxirhat										
06	43	Khulshi Thana		**100,600**	**903**	**111.4**							
	08	Ward No.08(Part)	Sholakbahar										
	09	Ward No.09	North Pahartali	27,500	552	49.8							
	13	Ward No.13	Pahartali	44,500	227	196.0	✓(part)				✓		
	14	Ward No.14	Lalkhan Bazar	**28,600**	**124**	**230.6**	✓				✓		○
07	55	Pahartali		**39,900**	**882**	**45.2**							
	10	Ward No.10	North Kattali	9,300	283	32.9							
	11	Ward No.11	South Kattali	9,900	331	29.9							
	12	Ward No.12	Saraipara	20,700	268	77.2				✓		✓	○
08	28	Double Mooring Thana		**74,000**	**771**	**96.0**							
	23	Ward No.23	North Pathantuli	9,400	77	122.1	✓			✓	✓		○
	24	Ward No.24(Part)	North Agrabad	9,800	208	47.1				✓			○
	27	Ward No.27	South Agrabad	18,700	148	126.4				✓	✓		○
	28	Ward No.28	Pathantuli	12,000	122	98.4	✓			✓			○
	29	Ward No.29	West Madarbari	13,300	107	124.3	✓				✓		○
	30	Ward No.30	East Madarbari	10,800	109	99.1	✓						○
09	35	Halishahar Thana		**18,100**	**881**	**20.5**							
	24	Ward No.24(Part)	North Agrabad										
	25	Ward No.25	Rampur	6,300	193	32.6				✓		✓	○
	26	Ward No.26	North Hallshahar	11,800	688	17.2				✓		✓	○
10	20	Chittagong Port Thana		**147,900**	**1,896**	**78.0**							
	36	Ward No.36	Gosalldanga	12,200	136	89.7							
	37	Ward No.37	Halishahar Munir Nagar	26,700	378	70.6							
	38	Ward No.38	South Middle Halishahar	47,500	542	87.6							
	39	Ward No.39	South Halishahar	61,500	840	73.2							
11	65	Patenga Thana		**72,800**	**1,976**	**36.8**							
	40	Ward No.40	North Patenga	39,900	962	41.5							
	41	Ward No.41	SouthPatenga	32,900	1014	32.4							
Total				**1,012,900**	**15,562**	**65.1**							**21**

Table 5.2.2 Information on the Selected Wards for Karnaphuli Service Area at Year 2030

Ward No.	Ward Name	Area (ha)	Population (person)		Daily max Water Demand (m^3/d)
			Administrative	To be served	
07	West Sholakbawar, (Part)	330	173,800	163,900	41,500
08	Shulokbahar (part)	236	154,300	145,500	36,800
12	Saraipapa (part),	134	43,600	40,900	10,400
14	Lalkhan Bazar,	124	185,900	174,700	28,600
15	Bagmoniram	180	57,000	56,400	9,200
16	Chanik Bazar ,	177	80,800	79,800	13,100
20	Dewan Bazar	39	59,700	59,000	9,700
21	Jamalkhan,	76	71,900	71,000	11,600
22	Enayet Bazar,	86	53,200	52,500	8,600
23	North Pathantuli,	77	59,900	57,200	9,400
24	North Agrabad,	208	62,600	59,900	9,800
25	Rampur,	193	40,200	38,400	6,300
26	North Halishahar (part),	344	24,400	23,300	5,900
27	South Agrabad,	148	119,600	114,300	18,700
28	Pathantuli,	122	76,100	72,700	12,000
29	West Madarbari,	107	84,800	81,000	13,300
30	East Madarbari,	109	69,000	65,900	10,800
31	Alkaran	92	52,300	51,600	8,500
32	Anderkilla	106	37,600	37,100	6,100
33	Finghee Bazar	83	40,800	40,300	6,700
34	Patharghata	92	55,500	54,800	9,000
	Total 21 wards	**3,063**	**1,603,000**	**1,540,200**	**286,000**



Summary of Chittagong Water Supply Improvement Project (2030yrs)	
Area (ha)	
CCC	15,562
KSA	3,063
Population (person)	
CCC	4,600,000
KSA Admin.	1,603,000
Served	1,540,200
Water Demand (m3/d)	
CCC	1,012,900
KSA	286,000

Figure 5.2.1 Locations of Wards to be covered by Karnaphuli Service Area

5.3 Basic Concept and Manner of Operation of Karnaphuli Water Supply System

5.3.1 Justification of KSA

(1) Major issues and problems on the existing water supply

Currently the water supply in the CCC area is provided by water from two WTPs (Mohara and Kalurghat). Under the present arrangements of water supply, CWASA has no option but to supply customers on a case by case basis without effective control of water supply from the WTPs to and throughout the distribution system. The exact locations of the distribution pipes have not yet been determined, except for the main distribution pipelines from the WTPs; because of the non-existence of proper information/ inaccuracy on existing pipes. The quantity of and breakdown of NRW in the distribution network is not known, except to some extent in areas where work has been carried out under the PANI. Furthermore, based upon the investigation carried out in the PANI, rehabilitation of existing pipes is not an appropriate solution, which means that pipe replacement is required. Replacement also allows the capacity of the system to be increased to allow for future water demands and for the design pressure.

The time required to address the above issues as well as to develop a functional and realistic hydraulic model of the existing system, which could then be used to develop an optimized and efficient water supply and distribution system for the long term, is likely to be several years. On completion of the above works several years would be required to implement the first phase of measures, allowing for arranging finance, design, procurement, construction, etc.

(2) The reason for the establishment of KSA

The comprehensive and up to date Master Plan for water supply, including a construction plan for the distribution network to cover the entire Chittagong city does not exist up to now. However, operation of water supply facilities planned in the Phase 1 Project is scheduled to start in 2014. Once existing network receives water from KWSP 1, it is obvious to arise the following:

- Leakage will be more serious as existing network consists of old AC pipes, and
- Customers still cannot receive sufficient water as capacity of existing network is too small.

Therefore, it is urgent to construct distribution network to deliver water through the main/ sub-main distribution pipelines to be constructed by the Phase 1Project.

KWSP 1 and 2 cannot satisfy water demand in entire CCC area. In this case, CWASA has two choices as follows:

- Enough pressure and continuous supply with minimum water losses in the limited area. At the same time, CWASA has to consider countermeasures outside KSA.
- Low pressure and intermittent supply with considerable water losses in whole CCC area.

The water supply for KSA is planned to provide the customers with sustainable access to safe water with appropriate water pressure on a 24/7 basis in consideration of the water supply capacity of the Karnaphuli WTP (286,000m^3/d). The KSA should be independent from other water supply systems as a self-contained system, in order to ensure that the above mentioned service levels are met. There are a lot of cases of water supply system operated independently (except for in emergency cases) by dividing the overall system in the city into several sub-systems, which are supplied by different water sources/WTPs in order to achieve effective O&M of water supply facilities.

(3) Manner of selection of the KSA and the establishment of Sectors and DMAs

KSA is selected to cover high priority area (PANI area) in consideration of the balance between water supply capacity from Karnaphuli WTPs and water demand in 2030 in the priority area. KSA boundary does not have to follow ward boundary and not based on any hydraulic considerations.

The provisions of sectors and DMAs will allow for the monitoring and effective control of water supply in terms of water quality, flow rate and water pressure. In addition, information required to manage NRW will be easily collected through measurement of the flow rates in the system.

On the establishment of the 10 sectors, the following conditions were taken into account in order to ensure effective and fair distribution of water to all concerned sectors.

- Location of the Wards
- Topographic conditions
- Location of major infrastructure (main roads, railway, canals/rivers)
- Main/sub-main pipeline routes planned in the Phase 1 Project
- Planned water demand by sector in the range of about 20,000m^3/d to 50,000m^3/d (manageable size)

Each Sector will have only one inlet with a flow meter, a pressure gauge and a pressure regulating valve. This arrangement will allow for the adjustment of water pressure at the inlet chamber resulting in the promotion of equitable water distribution to all sectors. Flow and pressure measurement data will be transmitted on a continuous basis through a SCADA system to the Central Control Room located at Karnaphuli WTP. Instructions will be made, as required for the adjustment of the water pressure at the inlet pipe to each sector.

For the effective control of NRW, each sector will be further divided into a number of small DMAs. On average, each DMA will be designed so that they can be hydraulically isolated from the rest of the distribution network by 3 to 4 valves whenever necessary. This arrangement will allow for the collection of accurate data on leakage and NRW in each DMA. For example, the quantity of leakage in a DMA can be estimated through measuring minimum night flow by using a vehicle on-board electro-magnetic flow meter.

(4) The reason of new construction of distribution pipes in KSA instead of rehabilitation of existing pipes

As of today, the exact locations, material types and conditions of the existing distribution pipes as well as the interconnection details and location have not yet been determined. Therefore it is a pre-requisite for evaluation of the possibility for reusing existing pipelines to conduct extensive field investigations, including trial excavations. However, based on the difficulties encountered in the trial excavations carried out under the PANI (limited to a central part of the city), investigation covering a large service area is not realistic in terms of both time and cost requirements, aside from the huge magnitude of disturbances to the residents and traffic in the built up area. Even if existing pipes are found, reuse of deteriorated AC pipes in the areas with a high population density area may be difficult. In addition, the diameters of the existing pipes are not sufficient for the present demand because those pipes were thought to be installed more than 20 years ago. Furthermore, frequent and long interruptions to water supply in a large are would occur if rehabilitation of existing pipes is implemented because CWASA does not have accurate data on the locations of existing pipes especially secondary and tertiary mains and it is difficult for CWASA to identify the location with higher priority. This may cause the large inconvenience of customers due to the ineffective construction work. On the other hand, the time period for interruption of water supply can be minimized under construction of new distribution pipes up to the service connections because cut off of the water supply is necessary only when new service connection is connected to existing service pipes in the premises of each customer.

Accordingly, new construction of pipelines is advantageous in order to provide effective water supply facilities in terms of reduction of leakage from the start of operation of the system and without causing major problems during the construction period. The construction cost and period required are also reduced considerably as extensive trial excavations for existing pipes will not be required. However, existing distribution mains, which run through KSA and deliver water outside KSA, remain as they are (e.g. Mohara WTP –Patenga B.P).

5.3.2 FAQs regarding KSA

(1) Changes in the water supply plan from SAPROF/Phase 1 to Phase 2

Water supply improvement plan for two phases was prepared by SAPROF in 2005 and Detailed Design of Phase 1 facilities in 2008. After the previous study/design, preparatory survey for Phase 2 was conducted in 2012. The comparison of framework between SAPROF and JICA Survey is summarized in Table 5.3.1. Supporting Report 5.3.1 presents the comparison of basic conditions among SAPROF, Phase 1Project and Phase 2 Projects.

KSA must be smaller than that in SAPROF, as

- CCC's water demand in 2030 is 1.65 times as much as that in 2020, however,
- Production volume of KWSP 1& 2 is almost same.

It is not likely that WTPs are materialized as scheduled in SAPROF report except for KWSP 1&2. Current situation is different from what was planned in SAPROF

Table 5.3.1 Comparison of Framework between SAPROF and JICA Survey

Item		SAPROF (2005)	JICA (2012)
Target Year		2020	2030
Water Demand in CCC (m^3/d)		614,000 (2020)	668,200 (2020) 1,012,900 (2030)
Water Production (m^3/d)	Karnaphuli	272,000	286,000
	Other WTPs	(2020) - Mohara 1&2 181,800 - Kalurghat 68,200 - Madunaghat 1&2 91,000	(current situation) - Mohara 1 90,000 - Kalurghat 68,200
	Total	614,000	445,100

Table 5.3.2 shows the comparison on Karnaphuli water supply system between SAPROF and JICA Survey.

Table 5.3.2 Karnaphuli Service Area

Item	SAPROF (2005)	JICA Survey (2012)
Reservoir	Nashirabad & Battali Hill	
Way to establish service area	Adjust service area by means of meeting both water demand in service area and supply volume from WTPs	
Priority area to be covered	None	-PANI -Area along distribution mains to be installed under KWSP 1 -Neighboring area of PANI area with high demand

Two reservoirs (Nashirabad and Battali Hill) are included in Karnaphuli water supply system in SAPROF. The capacity of the two reservoir isn't still sufficient for KSA, even though KSA doesn't receive Madunaghat WTP water. As for priority area to be covered, in KSA, it is considered to include priority areas where water demand is high and urgent measures are needed, while, in SAPROF, no consideration is given to priority area (Its service area is simply set at hillside area).

(2) Needs of accurate GIS data and maps for hydraulic simulation and rehabilitation work

WB recognizes that existing GIS data and maps are not accurate in terms of location. Besides location, following data and information are required;

- Materials (AC pipes must be replaced, no matter how fine they look.)
- Diameter (which hydraulic model depends on, but there are no accurate data)
- Conditions (Leakage occurs everywhere in unreliable network, but only limited information is available)

We must recognize that all data and information necessary for hydraulic simulation and rehabilitation work aren't available at present. There are two options to solve this problems follows:

- Conduct trial excavation along all the pipelines laid in CCC area, then hydraulic simulation and rehabilitation work, or
- Abandon all existing network, then design completely brand-new network.

(3) Expansion of water supply toward outside of KSA

It will take a longer time for CWASA to construct water supply systems required to cover the entire Chittagong city. Therefore, it is reasonable for CWASA to apply a staged construction of water supply systems with priority for different areas. If the planned quantity of water for the KSA (286,000m^3/d) is used for the entire city area, some improvements such as a longer supply time (than presently practiced) may be expected. However, such arrangement will mean that the service levels for the KSA in terms of drinking water quality, adequate water pressure on a 24/7 basis will never be met. It is an obligation of CWASA to provide customers with safe and sufficient water supply services.

It should be noted that the water currently supplied from Mohara and Kalurghat WTPs to planned KSA (more than half of the quantity of water, i.e. more than 100,000m^3/d) will be used in the future in the areas outside of the KSA due to the change in the water source and supply. This shall contribute to the improvement of water supply service in terms of the quality and quantity of water supplied to areas around KSA. Figure 5.3.1 shows projected expansion of water supply services in provision of KWSP 1 and 2 from present to year 2020.

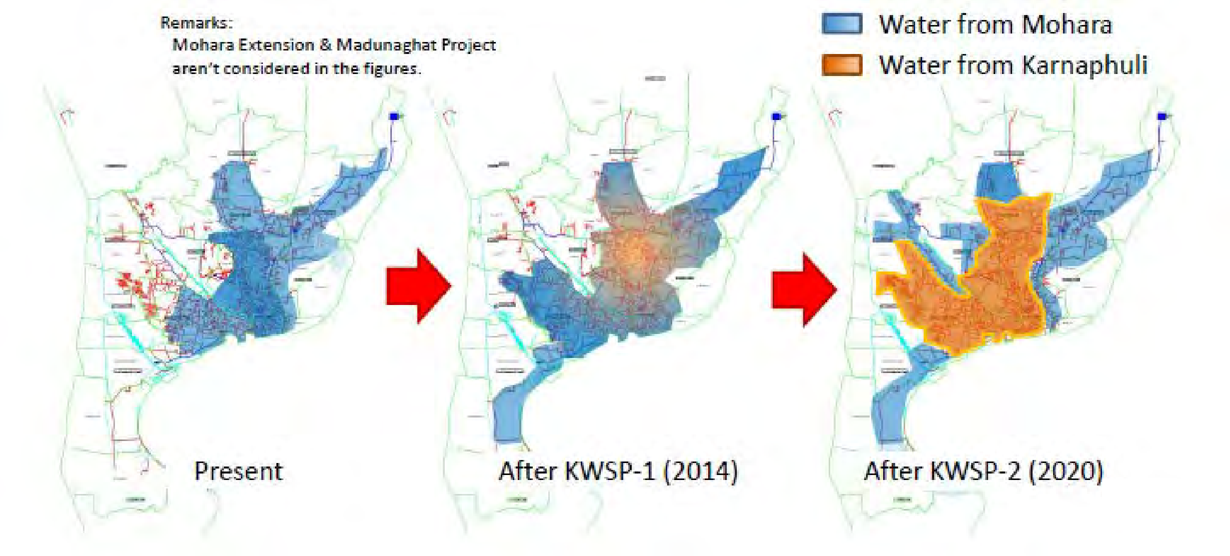


Figure 5.3.1 Contribution of KWSP 1 & 2 to the Areas outside of KSA

On the other hand, before effective design and construction such as KSA are achieved in the areas around KSA, careful and effective operation should be basically kept to avoid the deterioration of water supply service in KSA because sudden reduction in water pressure as well as the outflow of a large amount of water without flow control would occur if water supply to the surrounding area of KSA would be made by opening the valve(s) installed to stop the outflow to neighboring distribution systems (in the target year 2030). Except for emergency cases, water supply systems between KSA and neighboring distribution areas should be kept independent to maintain the control of the service level for KSA and surrounding areas.

All water supply systems to be constructed in the city shall be managed independently and at the same time operated comprehensively, supplementing each other and in consideration of countermeasures in emergency cases for each water supply system.

The Karnaphuli water supply system will play a role as a pilot water supply system in the process of the formation of an integrated water supply for the city. Thus it is important for all concerned parties to recognize the Karnaphuli water supply system as the pre-condition in the preparation of Master Plan for the realization of the integrated water supply covering the entire city area.

(4) Huge social impact of different water supply quality inside and outside of KSA

Service boundary shall be established anyway both in JICA study and WB study unless supply capacity can satisfy the entire water demand of whole CCC area. CWASA shall make efforts to establish the appropriate water supply areas outside KSA with support from GOB and/or donors.

Water supply service will be significantly improved even outside KSA after completion of KWSP 1 and 2. The supply conditions outside KSA can be further improved if additional supply from the Madunaghat WTP is materialized.

(5) Combination of new network and existing not abandoned in KSA

The new pipes in KSA are planned to be connected to existing pipes in some locations. However, the two areas; the KSA and the areas served by the existing pipes (outside of the KSA) will be under different and independent water supply systems separated by valves.

If water supply in surrounding areas of the KSA is highly necessary, CWASA may conduct water supply to such areas as a temporary measure until the year 2030. However, the following conditions should be satisfied in order to provide the temporary measures and avoid serious deterioration of service in the KSA.

- CWASA shall monitor the overall water supply conditions up to 2030 and confirm the possibility of surplus water (excess of the demand in the KSA available for use in limited parts of the surrounding areas).
- Hydraulic study and analysis shall be carried out in order to confirm the technical feasibility of the above option and to determine necessary low cost countermeasures for the service area outside of the KSA.
- Agreement shall be made between CWASA and concerned residents/other consumers to confirm the following conditions with full cooperation from the consumers.
    - Explain to and get understanding from the residents on the staged expansion of water supply systems by CWASA to finally cover the entire Chittagong city and the position of KSA in the overall water supply of the city
    - The service is limited in terms of the use of surplus water from KSA and 2030 in latest date for use of surplus water. In this regard, the service is beyond the normal operation of the Karnaphuli water supply system and is provided as temporary countermeasures.

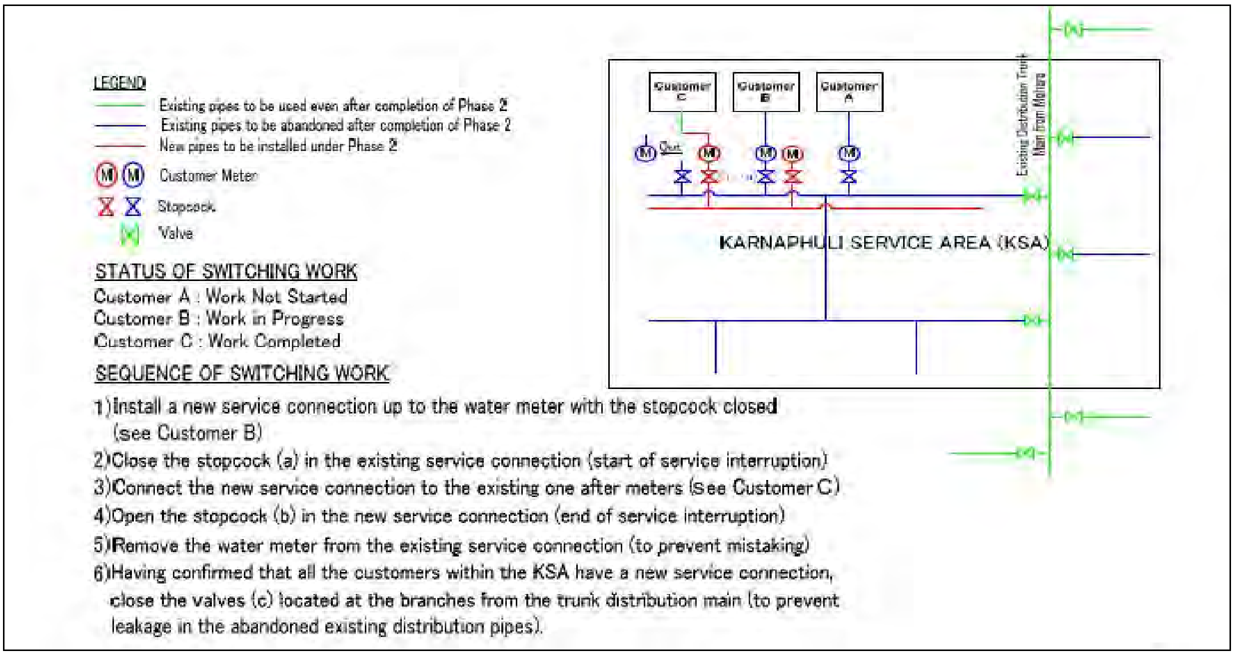


Figure 5.3.2 Service Connection

(6) Countermeasures to reduce leakage in KSA in early stage

KWSP 2 will give a construction priority to the priority sectors in PANI to commence normal water supply starting from year 2016, as shown in Figure 5.3.3.

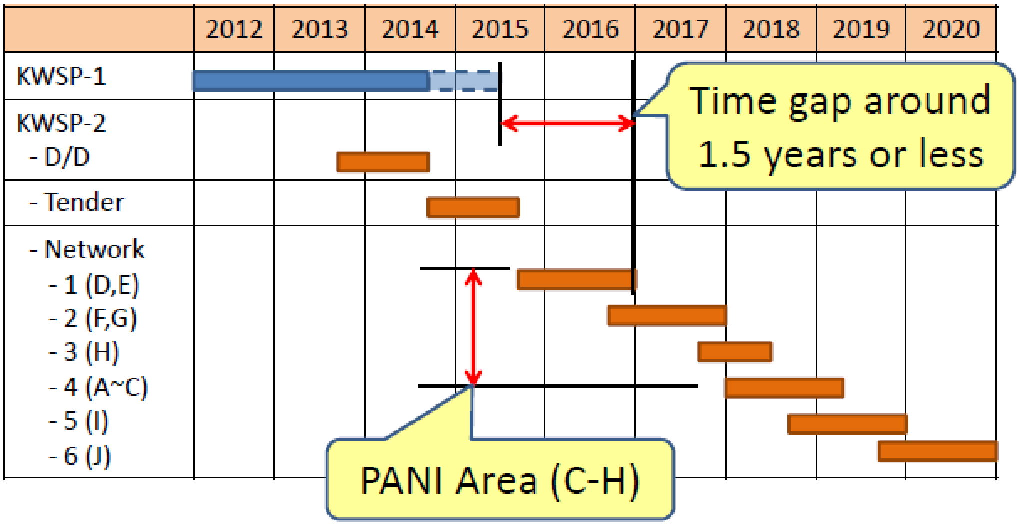


Figure 5.3.3 Construction Schedule of Distribution Network to expedite Water Delivery to Priority Areas

CHAPTER 6

DISTRIBUTION SYSTEM

CHAPTER 6 DISTRIBUTION SYSTEM

6.1 Planned Arrangements for Distribution Networks

The main objectives to be followed in the planning of the distribution network within the Karnaphuli Service Area are ‘equitable distribution’ and ‘control of non-revenue water’.

In order to achieve these objectives, the distribution network within the Karnaphuli Service Area is subject to large-scale sectorization. This is expected to facilitate operation and maintenance of the system, and realize proactive and effective control of non-revenue water.

For the purpose of enhancing equitable distribution, the Karnaphuli Service Area shall be divided into hydraulically independent ‘Sectors’. Each Sector will have only one inlet provided with a flow meter, a pressure gauge and a pressure regulating valve. Flow and pressure measurement data will be transmitted through the SCADA system to the Central Control Room located at the Karnaphuli water treatment plant, for monitoring and recording purposes on a 24/7 basis. Pressure regulating valves will automatically adjust the pressure at the outlets to match set points, which can be changed in the Central Control Room by operators. The set points for each Sector will initially be determined based on hydraulic analyses, but will be changed later by taking actual pressure conditions and measurements within each Sector into consideration.

For the effective control of non-revenue water, each Sector will be further divided into a number of small District Metered Areas (DMAs). On average, each DMA will be sized such that it includes approximately 2 to 4 km of distribution pipes. DMAs will be designed so that whenever it is necessary they can be hydraulically isolated from the rest of the distribution network by closing 2 to 4 valves in known locations. In principle, each DMA will have only one inlet provided with proper arrangements as shown in Figure 6.1.1 for the measurement of minimum night flow with the use of a vehicle-mounted electromagnetic flow meter. Figure 6.1.2 presents standard chamber for flow measurement.

The majority of the pipes that comprise the existing distribution network are made of asbestos cement and low quality polyvinyl chloride. They were installed more than 30 years ago, mostly on an ad-hoc basis without long-term planning, and are now severely deteriorated and undersized. Aside from such conditions, the extensive field investigations conducted by the PANI team (including excavation at various locations) demonstrated that the extent of the problems regarding the existing distribution network was much worse than had been previously anticipated. The investigation showed that the existing information on the distribution pipes with respect to their size, material, location and the state of interconnections with other parts of the network is either inadequate or inaccurate. The overall assessment of the investigation results suggested that establishing an entirely new distribution network is more effective than rehabilitating the existing network in order to create an equitable and controllable network with low levels of NRW.

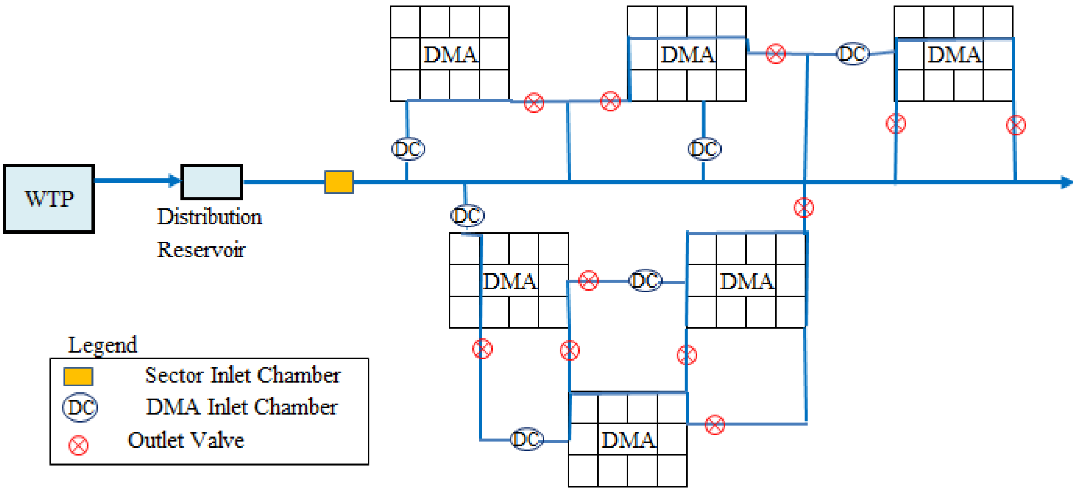


Figure 6.1.1 Standard Layout Plan of DMA

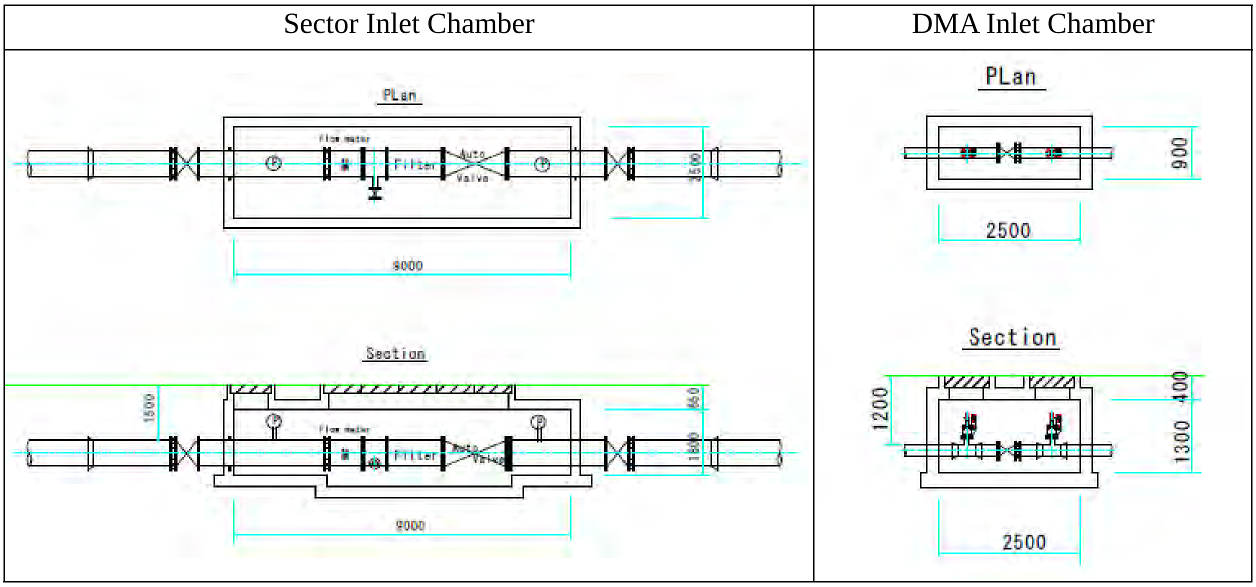


Figure 6.1.2 Standard Chamber of Sector Inlet and DMA Inlet

6.2 Configuration of Distribution System for Karnaphuli Service Area

6.2.1 Manner of Study for the Establishment of Distribution Networks in Karnaphuli Service Area

The area selected as the Karnaphuli Service Area is characterized for the planning of the distribution system as follows:

(1) The service area is located about 30 km from Karnaphuli WTP
(2) Available land in the CCC area is quite limited and it is difficult to obtain land for the construction of distribution reservoir/s in a location where the ground elevation allows gravity flow to the service area.

Under the above constraints, the Phase 1 Project planned to construct a ground reservoir at Nashirabad to transmit water to some distribution reservoirs/elevated tanks. Figure 6.2.1 shows the planned water supply system in the Phase 1 Project.

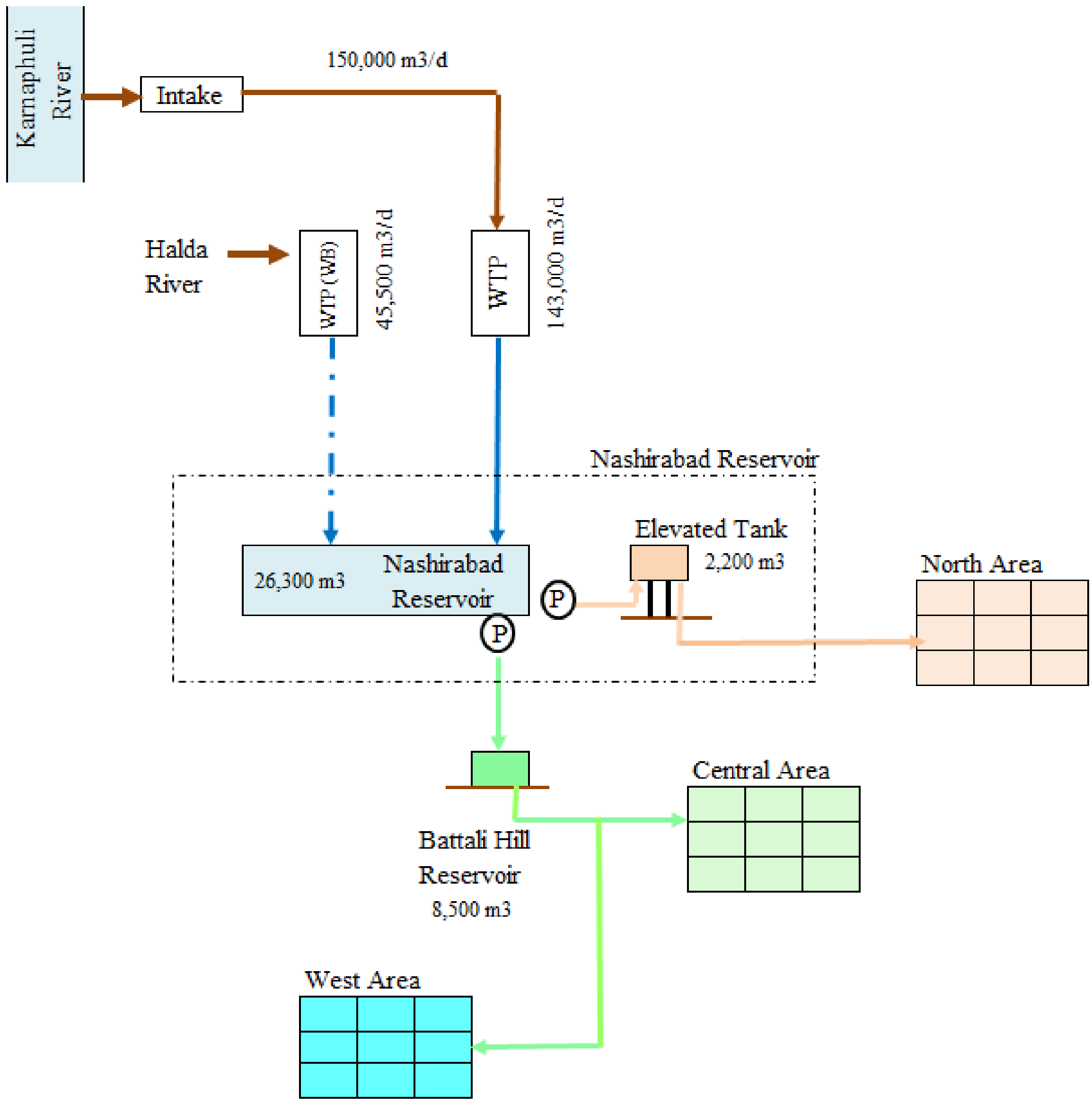


Figure 6.2.1 Water Supply System Planned in Phase 1 Project

There are three units of distribution reservoir/elevated tank in Phase-1 Project, Nashirabad Reservoir, Nashirabad Elevated Tank and Battali Hill Reservoir, all of which are under construction. Nashirabad Reservoir, planned to receive water from Karnaphuli WTP (143,000 m^3/d) and Madunaght WTP (45,500 m^3/d), has the function of providing a storage volume of 26,300 m^3 before transmitting water to Battali Hill distribution reservoir (V=8,500m^3) to supply the central and western areas, as well as pumping water to Nashirabad Elevated Tank to supply the northern area.

In the Phase-1 Project, yard pipes for the transmission pipeline from Madunaghat WTP to Nashirabad Reservoir (as planned under a WB project) were included in the reservoir site. However, the above pipeline will be cancelled in order to maintain a self-contained Karnaphuli water supply system.

6.2.2 Water Transmission Method from Nashirabad Reservoir to Distribution Reservoirs /Elevated Tanks

(1) Alternative water distribution methods

There are three options for planning of water distribution systems; (1) gravity distribution method, (2) direct pumping distribution method and (3) combination of the above two methods.

In the application of the gravity distribution method, the transmitted daily maximum volume from Nashirabad Reservoir to the distribution reservoirs/ elevated tanks is delivered to the service area as gravity flow throughout the day, provided that the low water level in the reservoir/ elevated tank is maintained. Under this arrangement, appropriate water pressure is maintained up to the end of the distribution pipeline, such that there is no risk of the inflow of polluted water occurring. In addition, the transmission pumps at Nashirabad Reservoir are arranged for the fixed water head and flow rate throughout the day for each reservoir/elevated tank. This arrangement facilitates economical and easy operation of the water supply system. In this connection, the gravity type distribution method is advantageous.

(2) Water transmission method from Nashirabad Reservoir to distribution reservoir/elevated tank under the conditions of limited capacity of distribution reservoir/elevated tank

The distribution reservoir has different functions including the following:

a) Adjustment of distribution volume to meet the hourly fluctuation in daily water demand
b) Adjustment of water pressure in the distribution system
c) Combination of the above two functions

Nashirabad Reservoir cannot be used for the adjustment of water pressure unless a distribution pump is provided for direct delivery of the hourly maximum water to the service area, as its ground elevation is not high enough to ensure gravity flow to the service areas. In this regard, the combined use of Nashirabad Reservoir and each distribution reservoir/elevated tank is necessary to achieve the function as a distribution reservoir to cater for the hourly peak demand in the service area, thus ensuring gravity delivery of water (coinciding with item c) in the above mentioned categories).

Treated water from Karnaphuli WTP is transmitted from the WTP to Nashirabad Reservoir at a constant hourly flow rate through the day, in order to meet the daily maximum water demand. Then, water is further transmitted to Battali Hill distribution reservoir, Nashirabad Elevated Tank and others, as required, to cater for the hourly peak demand, ensuring gravity delivery of water in the respective service areas.

If the capacity of the distribution reservoir/elevated tank is adequate to meet the standard design retention time (five hours at daily maximum demand in the subject service area), a constant flow to meet the daily maximum demand may be transmitted from Nashirabad Reservoir. However, the capacities of the distribution reservoir/ elevated tank (at least Nashirabad Elevated Tank and Battali Hill reservoir planned in Phase 1 Project) are not sufficient enough to meet the required retention time. In this connection, the retention time required for distribution of water to each service area shall be managed together with the capacity of Nashirabad Reservoir.

The "Design Criteria for Waterworks Facilities 2000 (Japan Water Works Association)" refers to the standards for the design of distribution reservoirs for different functional purposes as follows:

a) Adjustment to meet the hourly fluctuation in daily water demand: The capacity of the reservoir shall be more than 1-3 hours of the daily maximum water demand.
b) Adjustment of water pressure in the distribution system: The capacity of reservoir shall be

more than 30 minutes of the hourly maximum water demand.

Under the above conditions, the transmission pump facilities at Nashirabad Reservoir for the reservoir/elevated tank without the required capacity shall be planned for the hourly maximum demand. Planned elevated tank in this Project falls in this category due to the limited size of the tank and design demand (more than 20,000 m^3/d).

In case that the reservoir/ elevated tank satisfies the above conditions (refer to items a) and b), the following study may be made for reducing the cost of both the construction and O&M of the facilities. Namely, the hourly maximum demand for each service area shall be catered for by increasing the pumping rate to daily maximum flow rate from Nashirabad Reservoir to the distribution reservoir/Elevated tank, where necessary. The required transmission rate/hour is estimated using the following data/information and guideline.

1) Hourly fluctuation pattern of water use in the service area

There is no record of the diurnal variation in water consumption in Chittagong city. Therefore, the diurnal variation in water consumption for a big city in another Asian country is used for the purposes of this study. The daily maximum water demand by subject service area is distributed to each hour throughout a day using the hourly water consumption in Cirebon city, Indonesia (260,000 served population). The fluctuation in hourly water consumption in Cirebon is included, as a similar reference, in Supporting Report 6.2.1.

2) Daily maximum water demand for selected sectors by the territory of distribution reservoir/ elevated tank

The daily maximum water demand to be covered by the distribution reservoir/elevated tank is estimated by referring to the projected demand for each sector.

3) Fixed capacity of distribution reservoir/elevated tank

The possible/fixed capacity of the distribution reservoirs/elevated tank is used in the study to determine the hourly flow rate required for the transfer of water from Nashirabad Reservoir to the distribution reservoir/ elevated tank.

4) Calculation process to determine the required capacity of distribution reservoir/elevated tank in the case that the retention time for the reservoir can be provided as required: refer to Design Criteria for Water works Facilities, Japan Water works Association.

The above guideline is designed to calculate the required capacity of the distribution reservoir/ elevated tank, when the daily maximum flow is sent from the clear water reservoir at WTP. The manner of calculation in the guideline is used in this study.

In the case that the capacity of the distribution reservoir/ elevated tank is fixed and is less than the design capacity required, a trial calculation is made to determine the appropriate flow rate to transfer water from Nashirabad Reservoir, in order to cater for the hourly fluctuation in water demand throughout the day in the subject service area.

6.2.3 Distribution System in Karnaphuli Service Area

(1) Sectorization in Karnaphuli service area

The Karnaphuli service area (3,063 ha), with a projected population to be served in 2030 of 1,540,200, is divided into 10 sectors (A - J) in consideration of the following factors.

1) Locations of wards
2) Topographical conditions
3) Locations of major infrastructure; major roads, railway, canal, etc.
4) Distribution main pipeline routes planned in the Phase 1 Project
5) The daily maximum water demand per sector should be in the range from 20,000m^3/d to 50,000m^3/d

Figure 6.2.2 shows the locations of major roads and railways in the Karnaphuli service area, which are referred to in the sectorization of the entire service area.

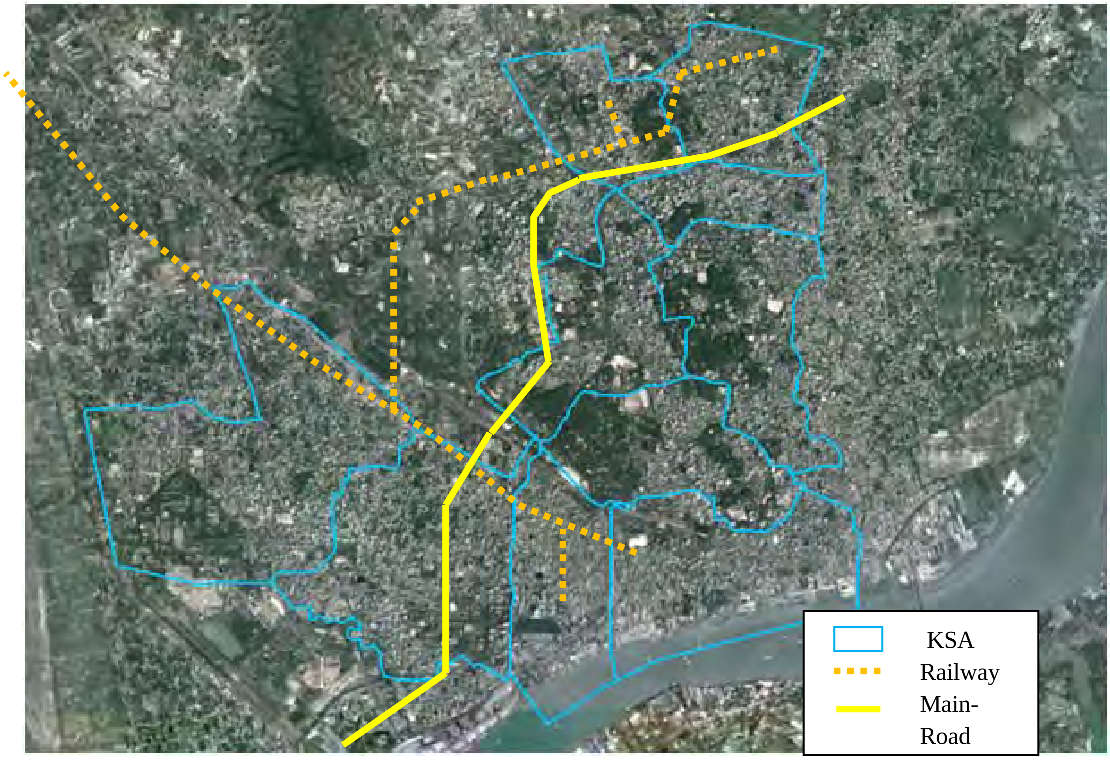


Figure 6.2.2 Locations of Major Roads and Railways in Karnaphuli Service Area

Figure 6.2.3 presents the locations of the proposed sectors, together with the water demand in each sector (daily maximum). Table 6.2.1 shows the water demand projection by ward up to the year 2030 in the CCC area. Table 6.2.2 presents the daily maximum water demand in 2030 by ward for each sector in the Karnaphuli service area.

(2) Alternative study of distribution systems

Following sectorization of the Karnaphuli service area, alternative distribution systems are studied in consideration of the following conditions.

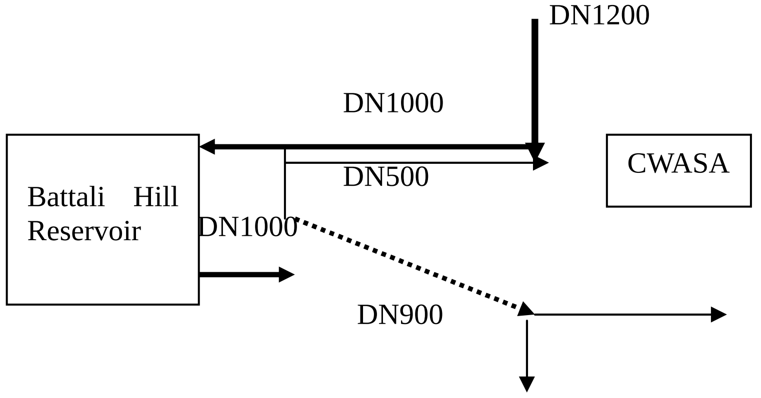
1) Effective use of distribution facilities planned in Phase 1 Project; reservoirs and pipelines

- Nashirabad reservoir (26,300m$^{3)}$
- Elevated Tank at Nashirabad reservoir site (2,200m^3)

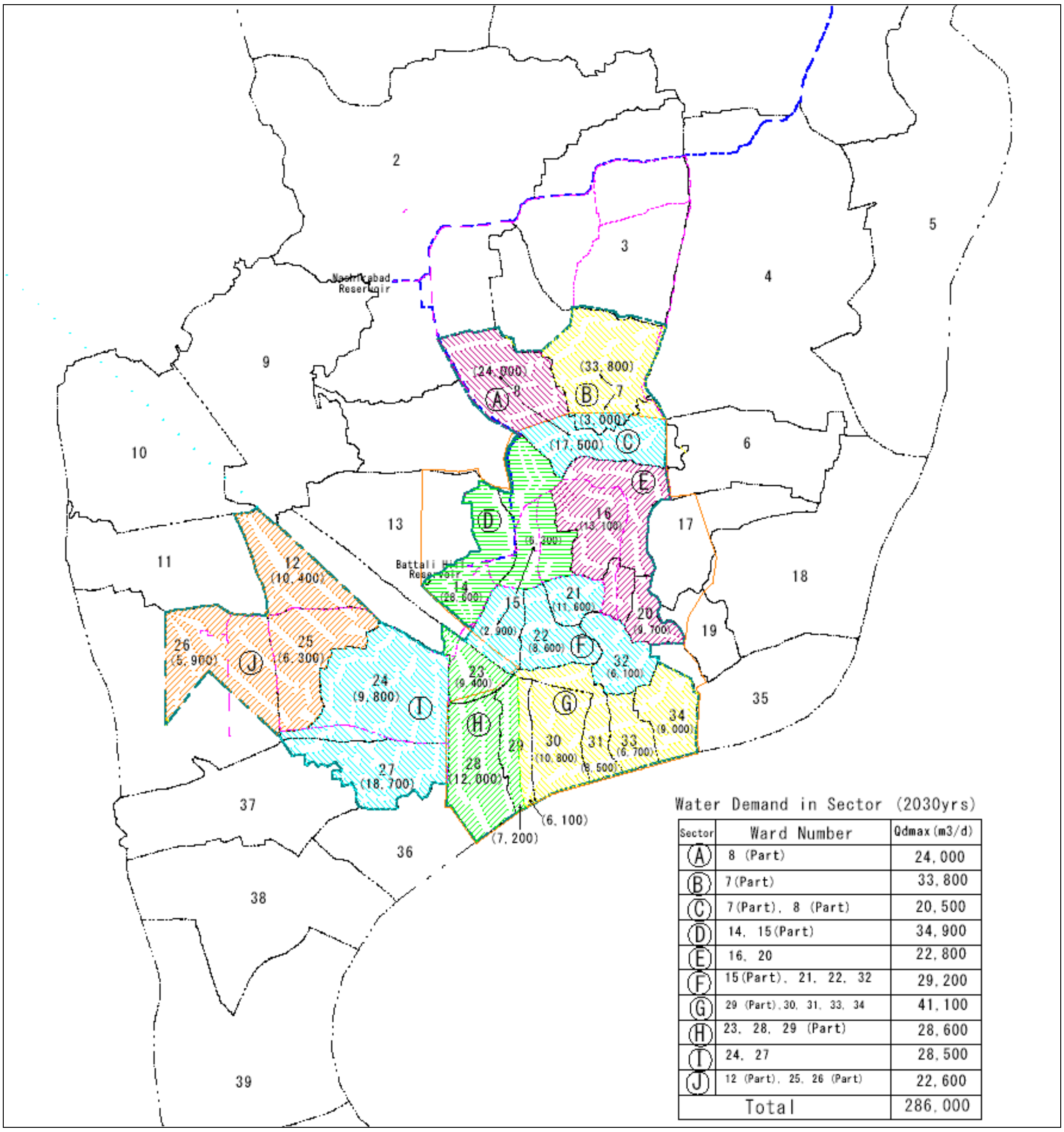
- Transmission pipeline from Nashirabad Reservoir to Battali Hill Distribution Reservoir (DN 1,200mm)
- Battali Hill Distribution Reservoir (8,500m^3)

2) Limited space in the road for construction of pipelines from the premises of CWASA to Battali Hill Reservoir along the transmission route from Nashirabad Reservoir

Transmission and distribution pipelines in the section between the CWASA area and Battali Hill Reservoir site are planned in the Phase 1 Project, as shown in the figure below. Pipe diameters are limited due to narrow roads and there is no space to construct additional pipelines along this route. Using possible pipelines, the allowable capacity of the transmission pipeline from Nashirabad Reservoir to Battali Hill Reservoir may be in the range of 150,000m^3/d (v=1.5m/s)～195,000m^3/d (v =2.0m/s).



In addition, along the route of the distribution main pipes from Battali Hill Reservoir to the southern part of the central area and the western area, there is not sufficient space to install an additional pipeline with a capacity of 140,000 m^3/d-150,000 m^3/d in hourly maximum demand (in the case of service for Sectors D, E, F and G). In the Phase 1 Project it was decided to utilize existing pipes which have a diameter of 900mm, as there is space for the installation of new pipes. The above problems suggest the need for a sub-system for the western area and part of central area.



Water Demand in Sector (2030yrs)

Sector	Ward Number	Qdmax (m3/d)
A	8 (Part)	24,000
B	7 (Part)	33,800
C	7 (Part), 8 (Part)	20,500
D	14, 15 (Part)	34,900
E	16, 20	22,800
F	15 (Part), 21, 22, 32	29,200
G	29 (Part), 30, 31, 33, 34	41,100
H	23, 28, 29 (Part)	28,600
I	24, 27	28,500
J	12 (Part), 25, 26 (Part)	22,600
Total		286,000

Figure 6.2.3 Locations of Sectors in Karnaphuli Service Area

Table 6.2.1 Water Demand Projection by Ward up to Year 2030

Ward		Year		2011		2015		2020		2025		2030	
		Per-capita water consumption Lpcd		105		108		110		115		120	
		1.15	= Qdmax/Qdave	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax	Qdave	Qdmax
01	**16**	**Bayeijid Bostami Thana**		**37,400**	**43,100**	**48,500**	**55,800**	**53,600**	**61,700**	**62,000**	**71,200**	**79,900**	**91,900**
	01	Ward No.01	South Pahartali	11,100	12,800	14,300	16,400	15,700	18,100	18,200	20,900	23,300	26,800
	02	Ward No.02	Jalalabad	15,000	17,300	19,800	22,800	22,400	25,800	26,200	30,100	34,200	39,300
	03	Ward No.03	Panchlaish	11,300	13,000	14,400	16,600	15,500	17,800	17,600	20,200	22,400	25,800
02	**57**	**Panchlaish Thana**		**46,800**	**53,800**	**60,900**	**70,000**	**70,800**	**81,400**	**86,800**	**99,800**	**112,600**	**129,500**
	07	Ward No.07	West Sholakbawar	18,500	21,300	24,100	27,700	28,000	32,200	34,300	39,400	44,500	51,200
	08	Ward No.08(Part)	Shulokbahar	28,300	32,500	36,800	42,300	42,800	49,200	52,500	60,400	68,100	78,300
03	**19**	**Chandgaon Thana**		**42,100**	**48,400**	**55,600**	**63,900**	**65,300**	**75,000**	**81,100**	**93,300**	**106,200**	**122,100**
	04	Ward No.04	Chandgaon	17,300	19,900	22,800	26,200	26,800	30,800	33,300	38,300	43,600	50,100
	05	Ward No.05	Mohara	18,600	21,400	24,600	28,300	28,900	33,200	35,900	41,300	47,000	54,100
	06	Ward No.06	East Sholakbawar	6,200	7,100	8,200	9,400	9,600	11,000	11,900	13,700	15,600	17,900
04	**10**	**Bakalia**		**45,200**	**52,000**	**59,600**	**68,600**	**70,300**	**80,800**	**87,600**	**100,700**	**116,100**	**133,600**
	17	Ward No.17	West Bakalia	15,000	17,300	19,900	22,900	23,600	27,100	29,500	33,900	39,200	45,100
	18	Ward No.18	East Bakalia	9,600	11,000	12,700	14,600	15,100	17,400	18,900	21,700	25,000	28,800
	19	Ward No.19	South Bakalia	17,600	20,200	23,300	26,800	27,600	31,700	34,500	39,700	45,900	52,800
	35	Ward No.35(Part)	Boxirhat	3,000	3,500	3,700	4,300	4,000	4,600	4,700	5,400	6,000	6,900
05	**41**	**Kotwali Thana**		**44,700**	**51,400**	**52,400**	**60,200**	**54,600**	**62,900**	**61,300**	**70,500**	**71,700**	**82,500**
	15	Ward No.15	Bagmoniram	5,000	5,800	5,900	6,800	6,100	7,000	6,900	7,900	8,000	9,200
	16	Ward No.16	Chanik Bazar	7,100	8,200	8,300	9,500	8,700	10,000	9,700	11,200	11,400	13,100
	20	Ward No.20	Dewan Bazar	5,200	6,000	6,100	7,000	6,400	7,400	7,200	8,300	8,400	9,700
	21	Ward No.21	Jamalkhan	6,300	7,200	7,400	8,500	7,700	8,900	8,700	10,000	10,100	11,600
	22	Ward No.22	Enayet Bazar	4,700	5,400	5,500	6,300	5,700	6,600	6,400	7,400	7,500	8,600
	31	Ward No.31	Alkaran	4,600	5,300	5,400	6,200	5,600	6,400	6,300	7,200	7,400	8,500
	32	Ward No.32	Anderkilla	3,300	3,800	3,900	4,500	4,000	4,600	4,500	5,200	5,300	6,100
	33	Ward No.33	Finghee Bazar	3,600	4,100	4,200	4,800	4,400	5,100	4,900	5,600	5,800	6,700
	34	Ward No.34	Patharghata	4,900	5,600	5,700	6,600	6,000	6,900	6,700	7,700	7,800	9,000
	35	Ward No.35(Part)	Boxirhat					0		0		0	
06	**43**	**Khulshi Thana**		**35,500**	**40,900**	**46,500**	**53,500**	**54,300**	**62,400**	**67,000**	**77,000**	**87,500**	**100,600**
	08	Ward No.08(Part)	Sholakbahar					0					
	09	Ward No.09	North Pahartali	9,700	11,200	12,700	14,600	14,800	17,000	18,300	21,000	23,900	27,500
	13	Ward No.13	Pahartali	15,700	18,100	20,600	23,700	24,000	27,600	29,600	34,000	38,700	44,500
	14	Ward No.14	Lalkhan Bazar	10,100	11,600	13,200	15,200	15,500	17,800	19,100	22,000	24,900	28,600
07	**55**	**Pahartali**		**21,200**	**24,400**	**25,100**	**28,900**	**25,600**	**29,500**	**28,900**	**33,300**	**34,700**	**39,900**
	10	Ward No.10	North Kattali	4,900	5,600	5,800	6,700	5,900	6,800	6,700	7,700	8,100	9,300
	11	Ward No.11	South Kattali	5,300	6,100	6,300	7,200	6,400	7,400	7,200	8,300	8,600	9,900
	12	Ward No.12	Saraipara	11,000	12,700	13,000	15,000	13,300	15,300	15,000	17,300	18,000	20,700
08	**28**	**Double Mooring Thana**		**37,200**	**42,800**	**44,500**	**51,100**	**46,700**	**53,800**	**51,800**	**59,600**	**64,400**	**74,000**
	23	Ward No.23	North Pathantuli	4,400	5,100	5,300	6,100	5,700	6,600	6,700	7,700	8,200	9,400
	24	Ward No.24(Part)	North Agrabad	5,500	6,300	6,500	7,500	6,500	7,500	7,300	8,400	8,500	9,800
	27	Ward No.27	South Agrabad	10,500	12,100	12,300	14,100	12,500	14,400	13,900	16,000	16,300	18,700
	28	Ward No.28	Pathantuli	5,600	6,400	6,800	7,800	7,300	8,400	8,400	9,700	10,400	12,000
	29	Ward No.29	West Madarbari	6,200	7,100	7,500	8,600	8,100	9,300	9,400	10,800	11,600	13,300
	30	Ward No.30	East Madarbari	5,000	5,800	6,100	7,000	6,600	7,600	6,100	7,000	9,400	10,800
09	**35**	**Halishahar Thana**		**10,100**	**11,600**	**11,800**	**13,600**	**12,000**	**13,800**	**13,500**	**15,500**	**15,800**	**18,100**
	24	Ward No.24(Part)	North Agrabad										
	25	Ward No.25	Rampur	3,500	4,000	4,100	4,700	4,200	4,800	4,700	5,400	5,500	6,300
	26	Ward No.26	North Hallshahar	6,600	7,600	7,700	8,900	7,800	9,000	8,800	10,100	10,300	11,800
10	**20**	**Chittagong Port Thana**		**61,900**	**71,200**	**76,200**	**87,500**	**87,300**	**100,500**	**104,500**	**120,200**	**128,600**	**147,900**
	36	Ward No.36	Gosalldanga	7,200	8,300	8,200	9,400	8,400	9,700	9,300	10,700	10,600	12,200
	37	Ward No.37	Halishahar Munir Nagar	13,100	15,100	15,500	17,800	16,900	19,400	19,500	22,400	23,200	26,700
	38	Ward No.38	South Middle Halishahar	18,100	20,800	22,900	26,300	27,000	31,100	33,000	38,000	41,300	47,500
	39	Ward No.39	South Halishahar	23,500	27,000	29,600	34,000	35,000	40,300	42,700	49,100	53,500	61,500
11	**65**	**Patenga Thana**		**26,800**	**30,800**	**34,300**	**39,400**	**40,400**	**46,400**	**49,300**	**56,700**	**63,300**	**72,800**
	40	Ward No.40	North Patenga	14,700	16,900	18,800	21,600	22,100	25,400	27,000	31,100	34,700	39,900
	41	Ward No.41	SouthPatenga	12,100	13,900	15,500	17,800	18,300	21,000	22,300	25,600	28,600	32,900
						0							
Chittagong City Corporation Total				**408,900**	**470,400**	**515,400**	**592,500**	**580,900**	**668,200**	**693,800**	**797,800**	**880,800**	**1,012,900**

Table 6.2.2 Water Demand in 2030 by Sector

Table		Composition of Wards to be selected for Karnaphuli Service Area																				(120Lpcd)
Chittagong City Corporation				2030 Water Demand (WD)			Priority Ward					WD by Sector in Karnaphuli Service Area										rate of Area in partially covered Ward (%)
				WD by Ward	Area by Wrad	WD/ha	PANI	Phase-1 Project			Higher	A	B	C	D	E	F	G	H	I	J	
				Qdmax(m3/d)	ha	m3/d/ha	Project	North	Central	South	Demand	m3/d										
01	**16**	**Bayeijid Bostami Thana**		**91,900**	**3,015**	**30.5**																
	01	Ward No.01	South Pahartali	26,800	1,077	24.9																
	02	Ward No.02	Jalalabad	39,300	1,358	28.9		✓														
	03	Ward No.03	Panchlaish	25,800	580	44.5		✓														
02	**57**	**Panchlaish Thana**		**129,500**	**909**	**142.5**																
	07	Ward No.07	West Sholakbawar	51,200	407	125.8		✓			✓	24,000		17,500								72%
	08	Ward No.08(Part)	Shulokbahar	78,300	502	156.0	✓(part)	✓			✓		33,800	3,000								53%
03	**19**	**Chandgaon Thana**		**122,100**	**2,075**	**58.8**																
	04	Ward No.04	Chandgaon	50,100	927	54.0																
	05	Ward No.05	Mohara	54,100	904	59.8																
	06	Ward No.06	East Sholakbawar	17,900	244	73.4																
04	**10**	**Bakalia**		**133,600**	**1,323**	**101.0**																
	17	Ward No.17	West Bakalia	45,100	243	185.6	✓(part)				✓											
	18	Ward No.18	East Bakalia	28,800	655	44.0																
	19	Ward No.19	South Bakalia	52,800	127	415.7					✓											
	35	Ward No.35(Part)	Boxirhat	6,900	298	23.2																
05	**41**	**Kotwali Thana**		**82,500**	**931**	**88.6**																
	15	Ward No.15	Bagmoniram	9,200	180	51.1	✓		✓						6,300		2,900					
	16	Ward No.16	Chanik Bazar	13,100	177	74.0	✓		✓							13,100						
	20	Ward No.20	Dewan Bazar	9,700	39	248.7	✓				✓					9,700						
	21	Ward No.21	Jamalkhan	11,600	76	152.6	✓		✓		✓						11,600					
	22	Ward No.22	Enayet Bazar	8,600	86	100.0	✓										8,600					
	31	Ward No.31	Alkaran	8,500	92	92.4	✓											8,500				
	32	Ward No.32	Anderkilla	6,100	106	57.5	✓		✓								6,100					
	33	Ward No.33	Finghee Bazar	6,700	83	80.7	✓											6,700				
	34	Ward No.34	Patharghata	9,000	92	97.8	✓											9,000				
	35	Ward No.35(Part)	Boxirhat																			
06	**43**	**Khulshi Thana**		**100,600**	**903**	**111.4**																
	08	Ward No.08(Part)	Sholakbahar																			
	09	Ward No.09	North Pahartali	27,500	552	49.8																
	13	Ward No.13	Pahartali	44,500	227	196.0	✓(part)				✓											
	14	Ward No.14	Lalkhan Bazar	28,600	124	230.6	✓				✓				28,600							
07	**55**	**Pahartali**		**39,900**	**882**	**45.2**																
	10	Ward No.10	North Kattali	9,300	283	32.9																
	11	Ward No.11	South Kattali	9,900	331	29.9																
	12	Ward No.12	Saraipara	20,700	268	77.2				✓											10,400	50%
08	**28**	**Double Mooring Thana**		**74,000**	**771**	**96.0**																
	23	Ward No.23	North Pathantuli	9,400	77	122.1	✓			✓	✓								9,400			
	24	Ward No.24(Part)	North Agrabad	9,800	208	47.1				✓										9,800		
	27	Ward No.27	South Agrabad	18,700	148	126.4				✓	✓									18,700		
	28	Ward No.28	Pathantuli	12,000	122	98.4	✓			✓									12,000			
	29	Ward No.29	West Madarbari	13,300	107	124.3	✓				✓							6,100	7,200			54%, 46%
	30	Ward No.30	East Madarbari	10,800	109	99.1	✓											10,800				
09	**35**	**Halishahar Thana**		**18,100**	**881**	**20.5**																
	24	Ward No.24(Part)	North Agrabad																			
	25	Ward No.25	Rampur	6,300	193	32.6				✓											6,300	
	26	Ward No.26	North Hallshahar	11,800	688	17.2				✓											5,900	50%
10	**20**	**Chittagong Port Thana**		**147,900**	**1,896**	**78.0**																
	36	Ward No.36	Gosalldanga	12,200	136	89.7																
	37	Ward No.37	Halishahar Munir Nagar	26,700	378	70.6																
	38	Ward No.38	South Middle Halishahar	47,500	542	87.6																
	39	Ward No.39	South Halishahar	61,500	840	73.2																
11	**65**	**Patenga Thana**		**72,800**	**1,976**	**36.8**																
	40	Ward No.40	North Patenga	39,900	962	41.5																
	41	Ward No.41	SouthPatenga	32,900	1014	32.4																
Total				**1,012,900**	**15,562**	**65.1**						24,000	33,800	20,500	34,900	22,800	29,200	41,100	28,600	28,500	22,600	
Note) Higher water demand Area; Expansion ward area from PANI Project with higher water demand for water (more than $100m^3/d/ha$)												286,000										

3) Service areas to be covered for higher ground elevation areas under insufficient ground elevation of reservoir/ height of elevated tank

The service areas in Sector D and E cover comparatively higher elevation areas, with 20m to 30m GL, although other areas are less than 10m GL.

The sectors to be covered by each distribution reservoir/ elevated tank shall be selected in consideration of the higher areas, with consideration of the required hydraulic conditions for proper water distribution.

4) Alternative distribution systems

The Karnaphuli service area consists of the Northern, Central and Western areas geographically. Important considerations in planning are; No space to install pipes in the area surrounding Battali Hill Reservoir; and the location and elevation differences of the study areas compared to the planned distribution reservoir/elevated tank in the Phase 1 Project.

Under the above conditions, Nashirabad Elevated Tank may serve the Northern area and Battali Hill reservoir the Central area. An additional distribution reservoir/ elevated tank may be considered for the Western area considering its location, which is distant from Battali Hill reservoir, the presence of a railway (which divides the Central and Western areas) and the difficulty of installing additional pipes in the area surrounding Battali Hill Reservoir. The following are the capacities of the reservoir/ elevated tank considered for the study of the alternatives for the distribution system.

a) Nashirabad Elevated Tank: 2,200 m^3 (planned in Phase 1 Project)
b) Battali Hill Reservoir: 8,500 m^3 (planned in Phase 1 Project)
c) Halishahar Elevated Tank: 2,400 m^3 (assumed to serve the Western area by providing a similar capacity to the Nashirabad Elevated Tank, with the soil conditions at both tanks being similar)

The capacity of Nashirabad Reservoir shall be determined for each alternative to supplement the storage volume, due to the limited capacities of the respective reservoirs/ elevated tanks.

Two Alternative distribution systems are established for comparative study in full consideration of the Phase 1 Project and the restrictions mentioned above. Three sub-systems are considered covering the Northern, Central and Western areas.

a) Alternative 1: The Northern area is served by Nashirabad Elevated Tank and the Central area by Battali Hill Reservoir, with both sub-systems being served by gravity type distribution of water. The Western area is served by the direct pumping method from Nashirabad Reservoir.
b) Alternative 2: The three areas are served by respective reservoir/elevated tanks; the Northern area by Nashirabad Elevated Tank, the Central area by Battali Hill Reservoir and the Western area by Halishahar Elevated Tank

Table 6.2.3 Comparison of Alternative Distribution Systems

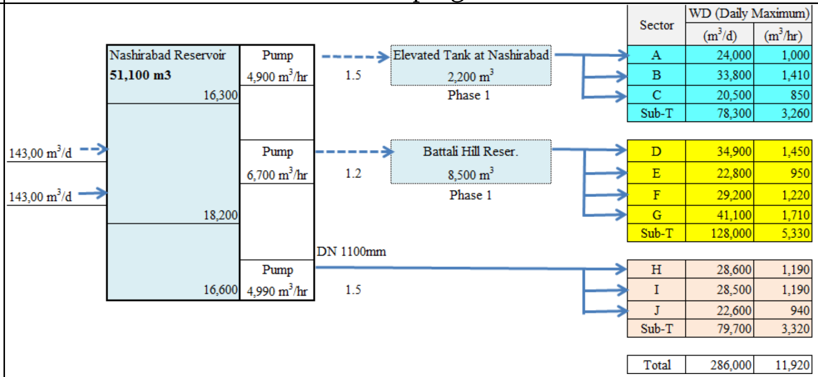
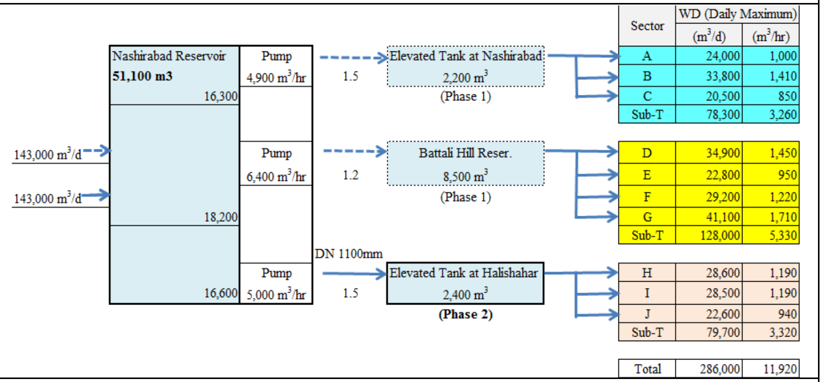
Alternatives	Alternative-1: Gravity Type for Northern & Central areas, but Direct Pumping method for Western area	Alternative-2: Gravity type for all three areas
Schematic plan of Distribution System Composition of Sectors by served reservoir/ E.T and water demand		
Composition of sectors by sub-system and demand (daily max & hourly max)	<u>Sub-system</u> <u>Sectors</u> <u>Reservoir/E.T</u> <u>Water Demand (Daily & Hourly Max; m^3/d)</u> Northern A,B & C Nashirabad E.T 78,300 90,100 Central D, E, F & G Battali Hill Re. 128,000 147,200 Western H, I & J None 79,700 91,700	<u>Sub-system</u> <u>Sectors</u> <u>Reservoir/E.T</u> <u>Water Demand (Daily & Hourly Max; m^3/d)</u> Northern A,B & C Nashirabad E.T 78,300 90,100 Central D, E, F & G Battali Hill Re. 128,000 147,200 Western H, I & J Halishahar E.T 79,700 91,700
Retention time in reservoir/E.T and transmission required from Nashirabad Re. to each reservoir/E.T at daily max demand	<u>Sub-system</u> <u>Reservoir/E.T</u> <u>Retention Time</u> <u>Transmission from Nashirabad: m^3/d</u> Northern Nashirabad E.T 27 min 90,100 (1.5 x Dmax) Central Battali Hill Res. 1.6 hr 154,600 (1.2 x Dmax) Western None - 91,700 (1.5 x Dmax)	<u>Sub-system</u> <u>Reservoir/E.T</u> <u>Retention Time</u> <u>Transmission from Nashirabad: m^3/d</u> Northern Nashirabad E.T 27min 90,100 (1.5 x Dmax) Central Battali Hill Re. 1.6 hr 154,600 (1.2 x Dmax) Western Halishahar E.T 29 min 91,700 (1.5 x Dmax)

Table 6.2.3 Comparison of Alternative Distribution Systems (cont'd)

Alternatives	Alternative-1: Gravity Type for Northern & Central areas, but Direct Pumping method for Western area	Alternative-2: Gravity type for all three areas
Expansion needs for Nashirabad Reservoir	Sub-system / Reservoir/E.T / Nashirabad Reservoir (m^3) Northern / Nashirabad E.T / 16,300 Central / Battali Hill Re. / 18,200 Western / None / 16,600 Total = 51,100 m^3 Additional 24,800 m^3	Sub-system / Reservoir/E.T / Nashirabad Reservoir (m^3) Northern / Nashirabad E.T / 16,300 Central / Battali Hill Re. / 18,200 Western / Halishahar E.T / 16,600 Total= 51,100m^3 Additional 24,800m^3
Required Additional Cost (Million Yen)	Sub-system / Transmission/Distribution pipes / E.T / Total Northern / 300 / - Central / 286 / - Western / 1,150 500 / - / 2,236	Sub-system / Transmission/Distribution pipes / E.T / Total Northern / 300 / - Central / 286 / - Western / 1,150 500 / - / 2,236
Issues & Problem and Advantages /disadvantage	1) The capital cost for this alternative is about 100 million yen lower than Alternative 2. 2) O&M cost is higher than for Alternative 2, due to application of direct pumping method for Western area. 3) O&M of facilities in Western area is difficult in terms of pump operation and water pressure near the pump station is higher than required to transmit water throughout the day, considering the water pressure and flow rate required at the farthest point in the service area.	1) The capital cost for this case is about 100 million yen higher than Alternative 1. 2) O&M cost for this alternative is lower than for Alternative 1, due to application of gravity type distribution for all sub- systems. 3) O&M of the facilities is much easier than Alternative 1 in use of three reservoir/elevated tanks. 4) In case of power failure, remaining water in the tanks will be used to provide continuous water supply until the start of operation of the generator sets.
Evaluation	Not Recommended due to the difficulty in O&M	Recommended

Table 6.2.3 summarizes the comparison of the two alternatives. In the case of the use of Battali Hill Reservoir, the required volume for transmission from Nashirabad Reservoir to Battali Hill Reservoir is calculated at 1.2 times of the daily maximum water demand in the Battali Hill sub-service area. Supporting Report 6.2.2 includes the calculation which uses the hourly fluctuation in water demand in the case of Cirebon city, Indonesia. On the other hand, the hourly maximum water demand is considered for the transmission pump facilities at Nashirabad Reservoir site, both for the Nashirabad and Halishahar Elevated Tanks, which both have a retention time of less than 30 minutes for adjustment of the water pressure.

As a result of comparison of the alternatives, Alternative 2 is recommended. The following which is a comparison of the two alternatives, explains the rational for this.

a) Common conditions for both:

- Sectors covered by sub-system and demand (daily max) by sub-system: Northern area 78,300 m^3/d, Central area 128,000m^3/d and Western area 79,700 m^3/d
- Transmission pump capacities and transmission/distribution pipeline from Nashirabad Reservoir to Elevated Tank/ inlet to sub-service area (western area)
- Expansion capacity of Nashirabad Reservoir (24,800 m^3)

b) Different conditions (advantages and disadvantages) of the two alternatives:

- The construction cost of Alternative 1 is about 100 million yen lower than Alternative 2, which requires an elevated tank in Halishahar. Land acquisition for construction of the elevated tank is not required.
- O&M cost for Alternative 1 is higher than for Alternative 2 and there are difficult in O&M for the direct pumping method to the Western area (Alternative 1)
- There are many advantages in the application of gravity distribution for all sub-systems, as in Alternative 2, as discussed previously.
- A continuous water supply from Halishahar Elevated Tank to the Western area can be provided in Alternative 2, in the case of power failure, before it is necessary to start a generator. The elevated tank provides for about 30 minutes storage at the daily maximum water demand of the service area.

c) Comprehensive evaluation

- Although the construction cost of Alternative 1 is about 100 million yen lower than Alternative 2, the O&M cost of this alternative will be higher.
- O&M of the Western area will be difficult in the case of Alternative 1.
- There are various advantages in application of gravity flow through the use of Halishahar Elevated Tank.
- The site on which Halishahar elevated tank will be constructed is owned by CWASA and there are no environmental impacts within the site and the surrounding area.

Figure 6.2.4 presents a schematic of Water Supply Flow, with an emphasis on the selected distribution system. The following is the definition of distribution pipes in accordance with the plan of the distribution network in the KSA.

a) Primary Distribution Main Pipe: Pipeline from Nashirabad Elevated Tank/ Battali Hill Reservor/ Halishahar Elevated Tank to the entrances to the respective sectors
b) Secondary Distribution Pipe: Pipeline installed in the DMAs to distribute water in each Sector maintaining the required water pressure. In principle, there should be no direct connec-

tion of service pipes to the Secondary Pipeline.

c) Tertiary Distribution Pipe: Distribution pipeline being branched from the Secondary Distribution Pipeline with diameters from 75mm to 150mm
d) Lateral Pipe: A ditch, pipe, or other conduit entering or leaving a water main from the side. A secondary conduit diverting water from a main conduit for delivery to service connections.
e) Service Connection: Water supply facilities being branched from the Tertiary Distribution Pipelines up to the water meter including saddle, valve, connection pipe and water meter

6.2.4 Configuration of Main Pipelines with Inlets to Respective Sectors

(1) Transmission pipeline from Nashirabad Reservoir to each reservoir/elevated tank

Transmission pipelines from Nashirabad Reservoir to Nashirabad Elevated Tank for Northern area and Battali Hill Reservoir for Central area are planned in the Phase 1 Project, while for the Western area an economical and realistic pipeline route shall be selected for the Phase 2 Project. The proposed pipeline route between Nashirabad Reservoir and Halishahar Elevated Tank is shown in Figure 6.2.5. The route will be finalized before the preliminary design of the facilities is carried out.

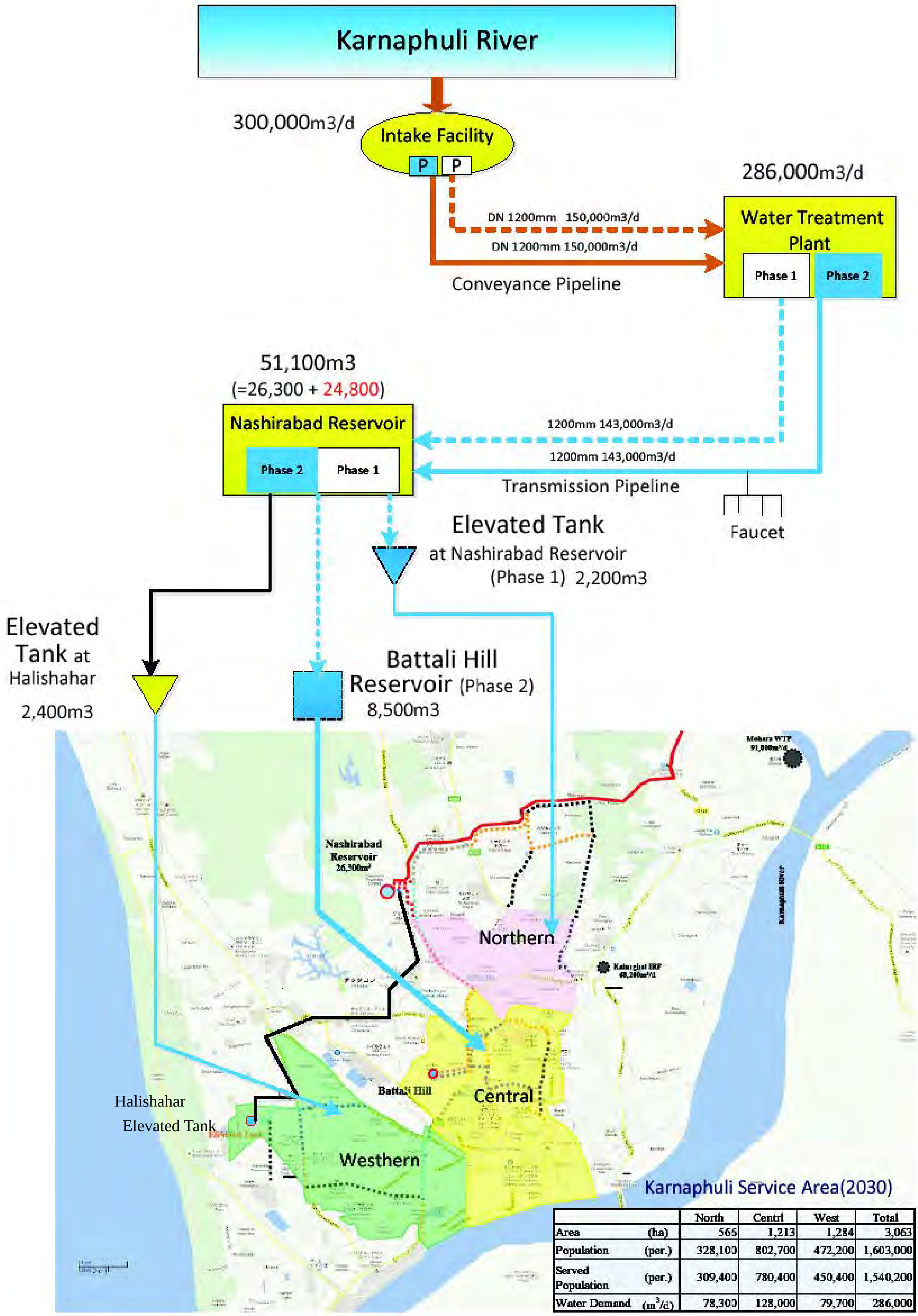
(2) Distribution main pipeline with inlets to each sector

The main pipeline routes with inlets to the respective sectors by sub-system are studied in view of economic and realistic pipe lying, considering the following conditions.

5) Main pipeline routes and pipeline capacities planned by Phase 1 Project
6) Geographical features of the component sectors in each sub-system
7) Hydraulic advantage for the selection of inlet points to the sectors with reference to the distance from the reservoir/ elevated tank to the subject sector
8) Availability of space in the roads for the installation of Phase 2 pipelines

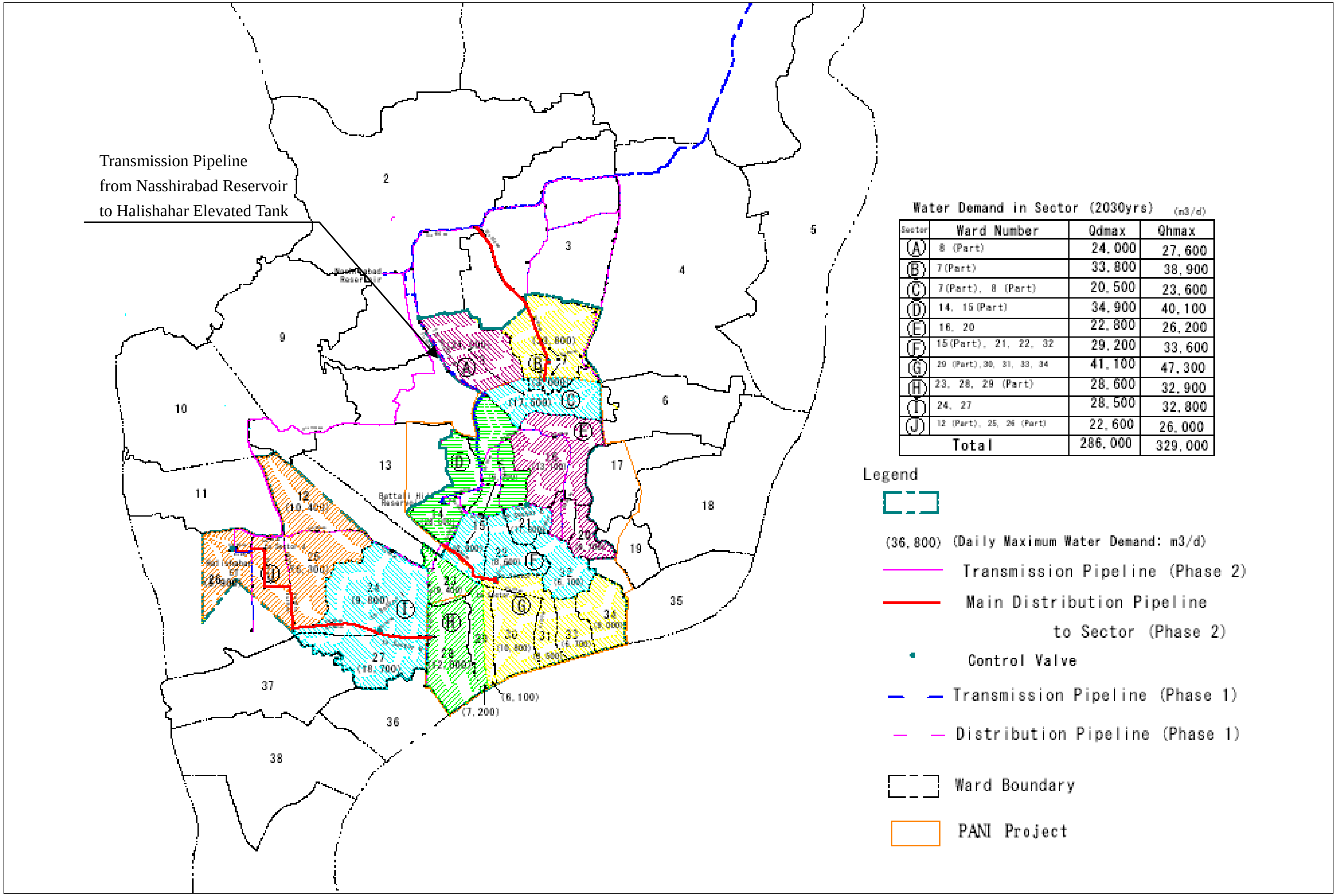
Hydraulic calculations were made for the hourly maximum water demand, which is calculated by sector for the year 2030 in order to determine the pipe diameter and water head losses along the main pipelines. Figure 6.2.6, which presents a schematic of the main pipelines in the Karnaphuli service area, shows the pipe diameter and demand by sector. Figure 6.2.7 shows the results of the hydraulic calculations of the main distribution network (on the topographic map) and includes the ground elevation at major points, pipe diameter and flow velocity.

Figure 6.2.8 and 6.2.9 show the Distribution Pipelines by each Sector.



	North	Centrl	West	Total
Area (ha)	566	1,213	1,284	3,063
Population (per.)	328,100	802,700	472,200	1,603,000
Served Population (per.)	309,400	780,400	450,400	1,540,200
Water Demand (m^3/d)	78,300	128,000	79,700	286,000

Figure 6.2.4 Schematic Water Supply Flow in Distribution System



Water Demand in Sector (2030yrs) (m3/d)

Sector	Ward Number	Qdmax	Qhmax
A	8 (Part)	24, 000	27, 600
B	7 (Part)	33, 800	38, 900
C	7 (Part), 8 (Part)	20, 500	23, 600
D	14, 15 (Part)	34, 900	40, 100
E	16, 20	22, 800	26, 200
F	15 (Part), 21, 22, 32	29, 200	33, 600
G	29 (Part), 30, 31, 33, 34	41, 100	47, 300
H	23, 28, 29 (Part)	28, 600	32, 900
I	24, 27	28, 500	32, 800
J	12 (Part), 25, 26 (Part)	22, 600	26, 000
Total		286, 000	329, 000

Figure 6.2.5 Transmission and Distribution Main Pipelines with Inlets to concerned Sectors

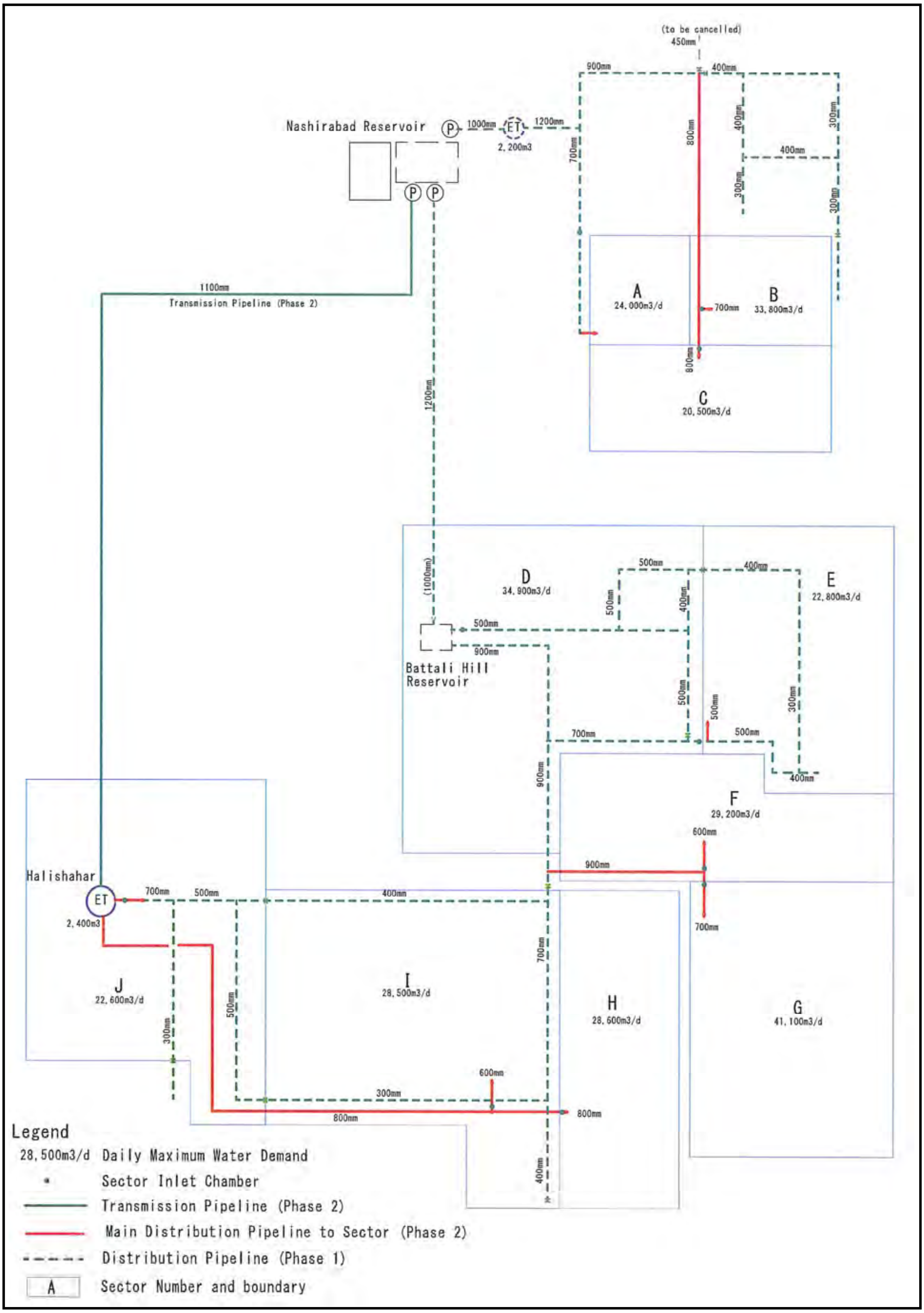


Figure 6.2.6 Schematic Configuration of Main Pipelines with Inlets to Sectors

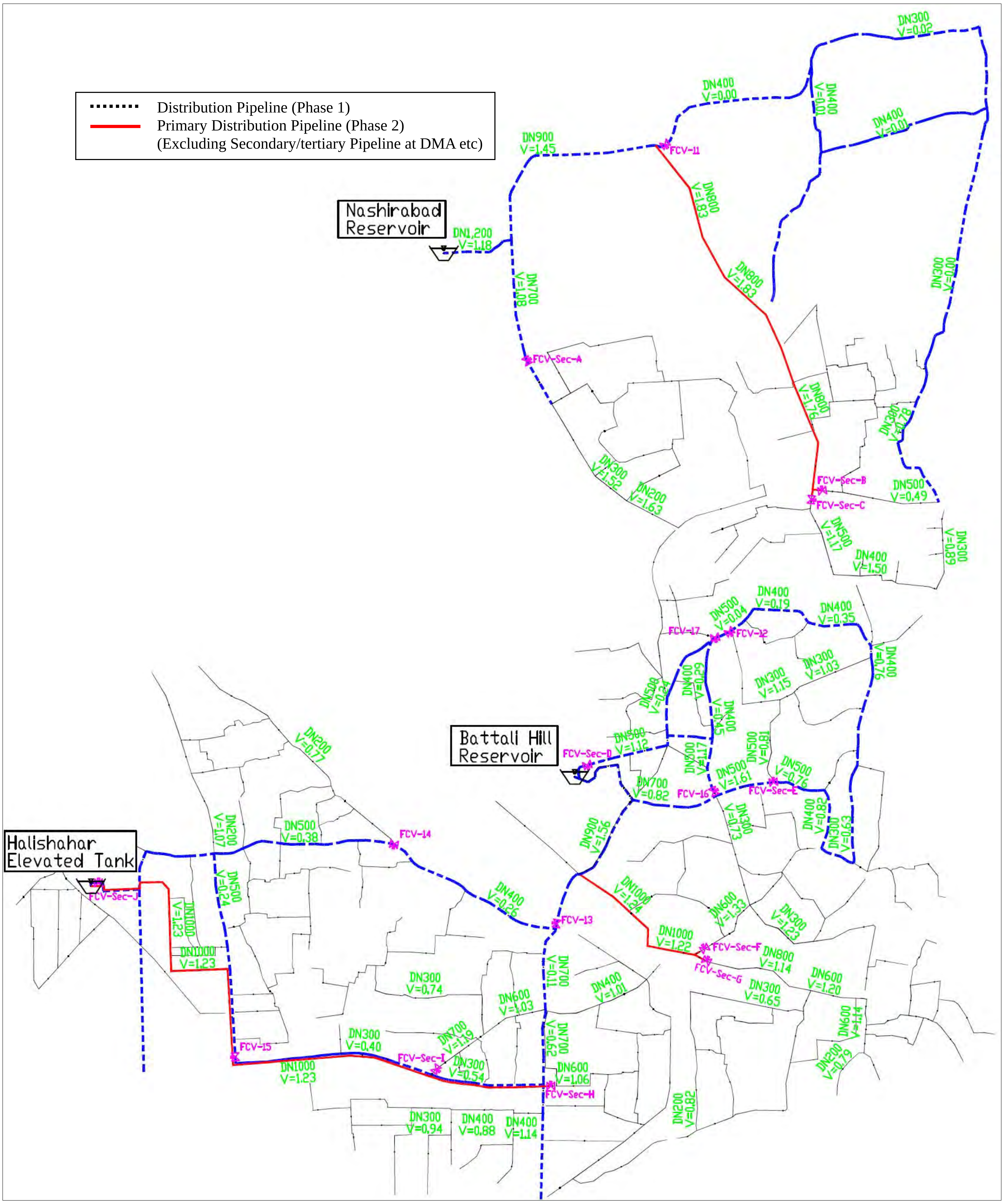


Figure 6.2.7 Hydraulic Calculation of Main Distribution Network

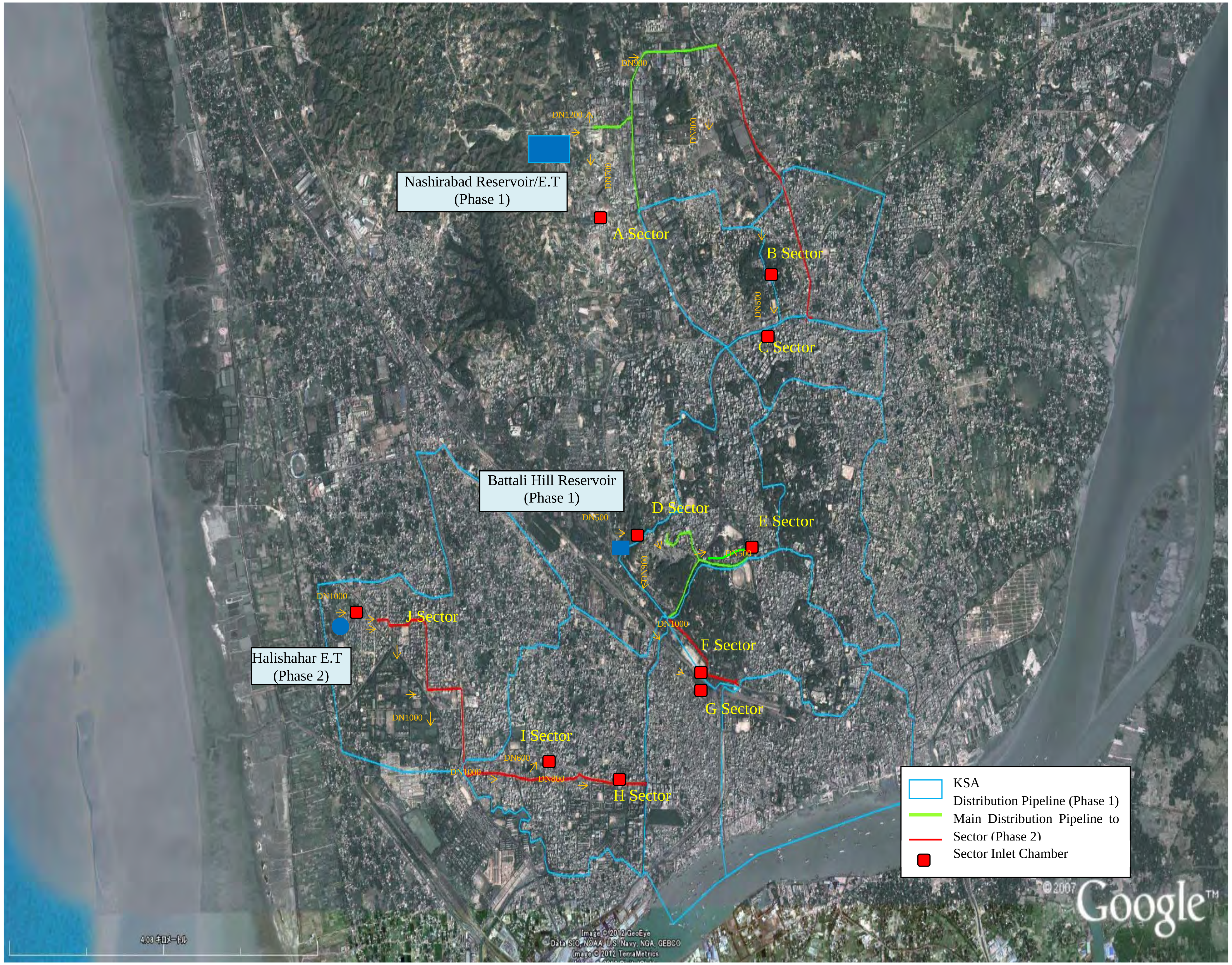


Figure 6.2.8 Configuration of Main Pipelines with Inlets to Sectors

Figure 6.2.9 (1) Distribution Pipeline in Sector – A

Figure 6.2.9 (2) Distribution Pipeline in Sector –B

Figure 6.2.9 (3) Distribution Pipeline in Sector – C

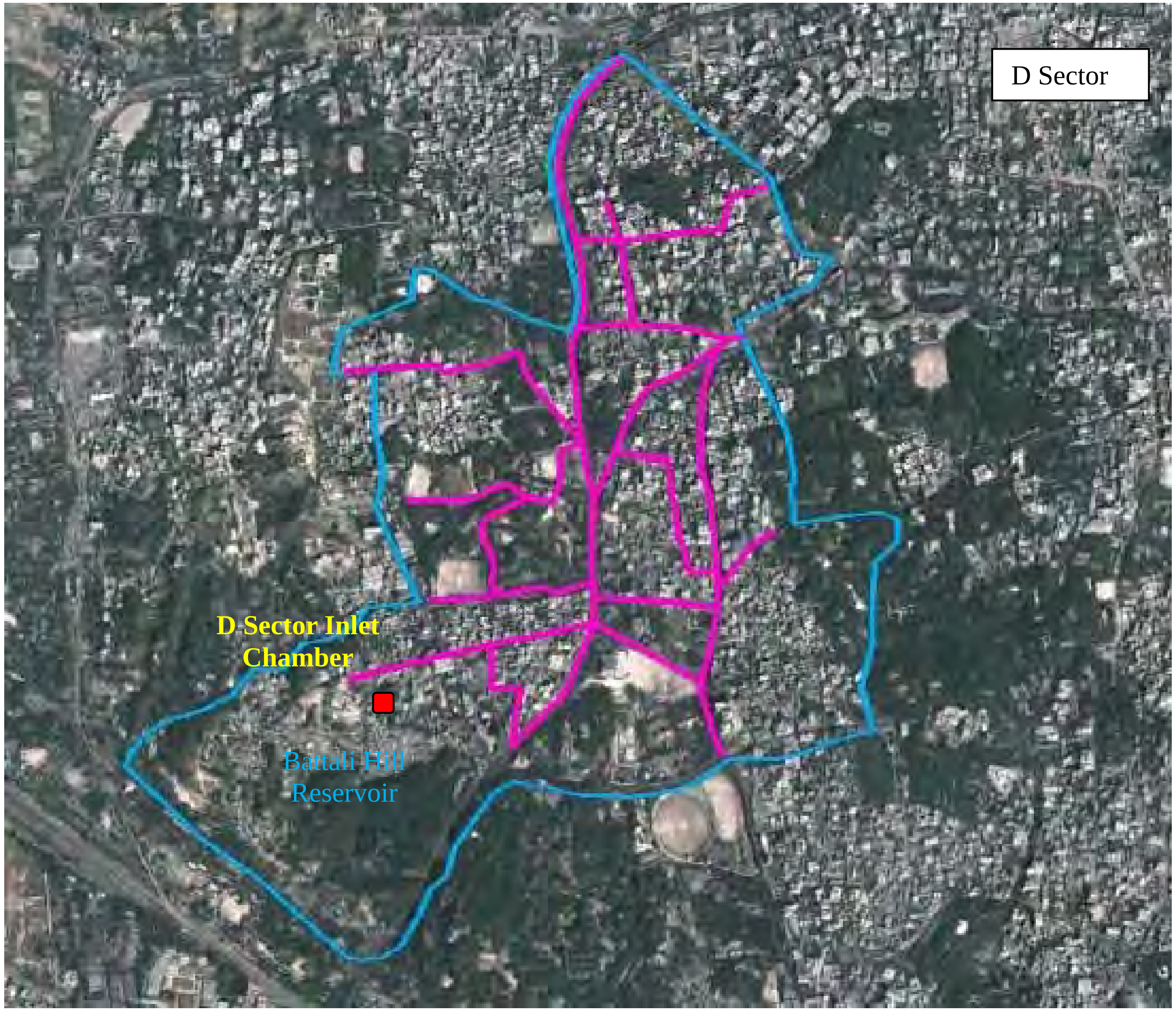


Figure 6.2.9 (4) Distribution Pipeline in Sector – D

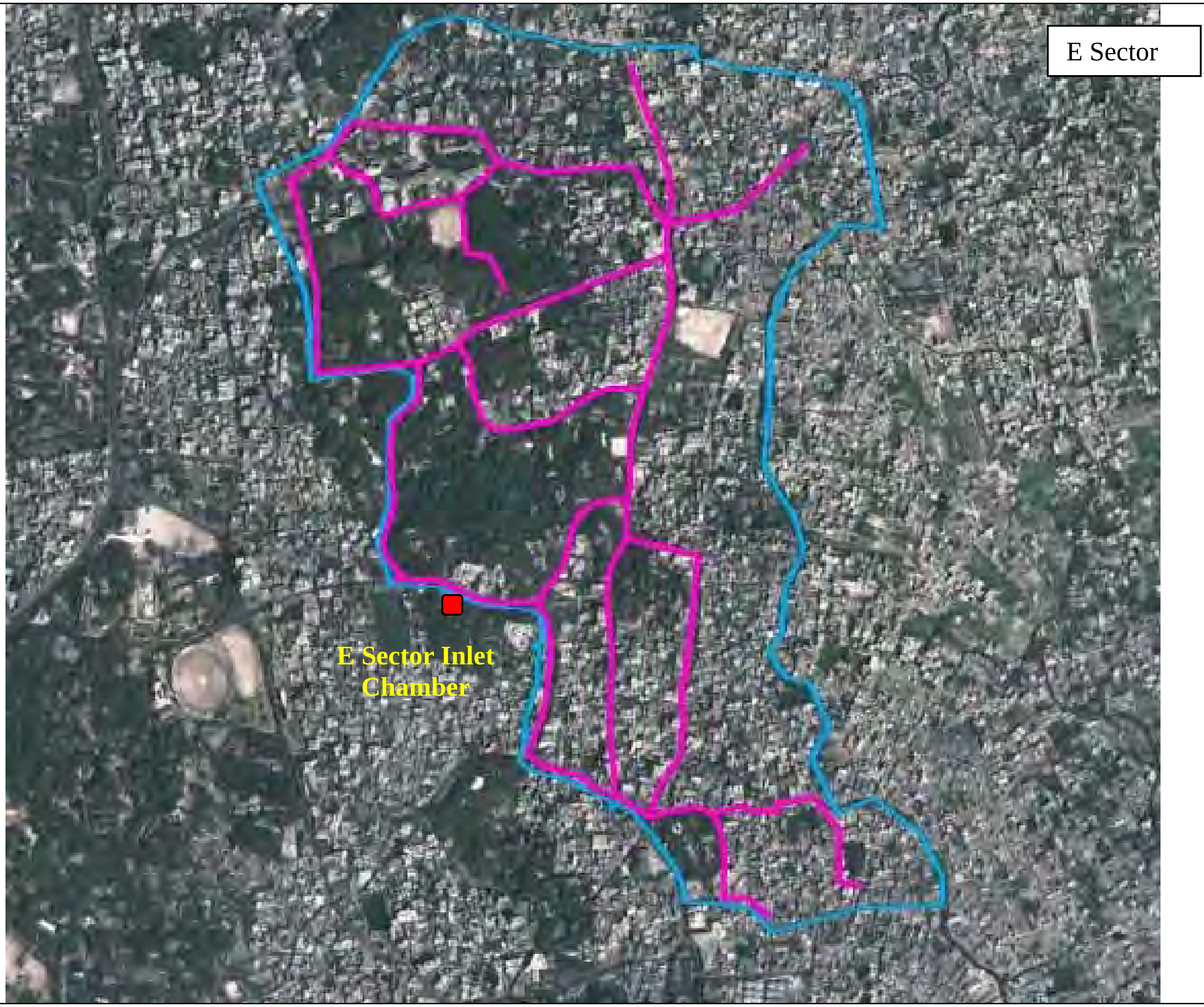


Figure 6.2.9 (5) Distribution Pipeline in Sector – E

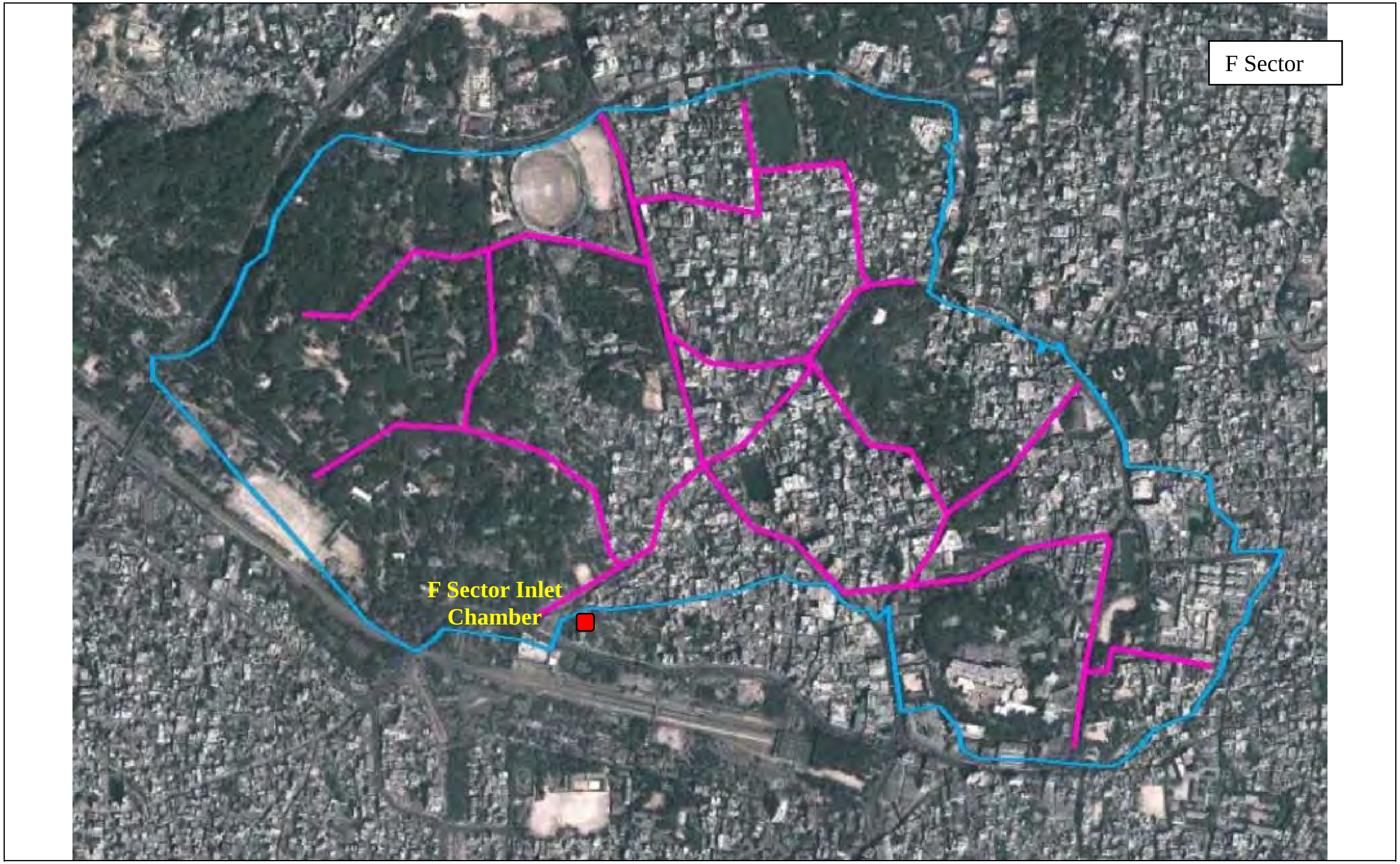


Figure 6.2.9 (6) Distribution Pipeline in Sector – F

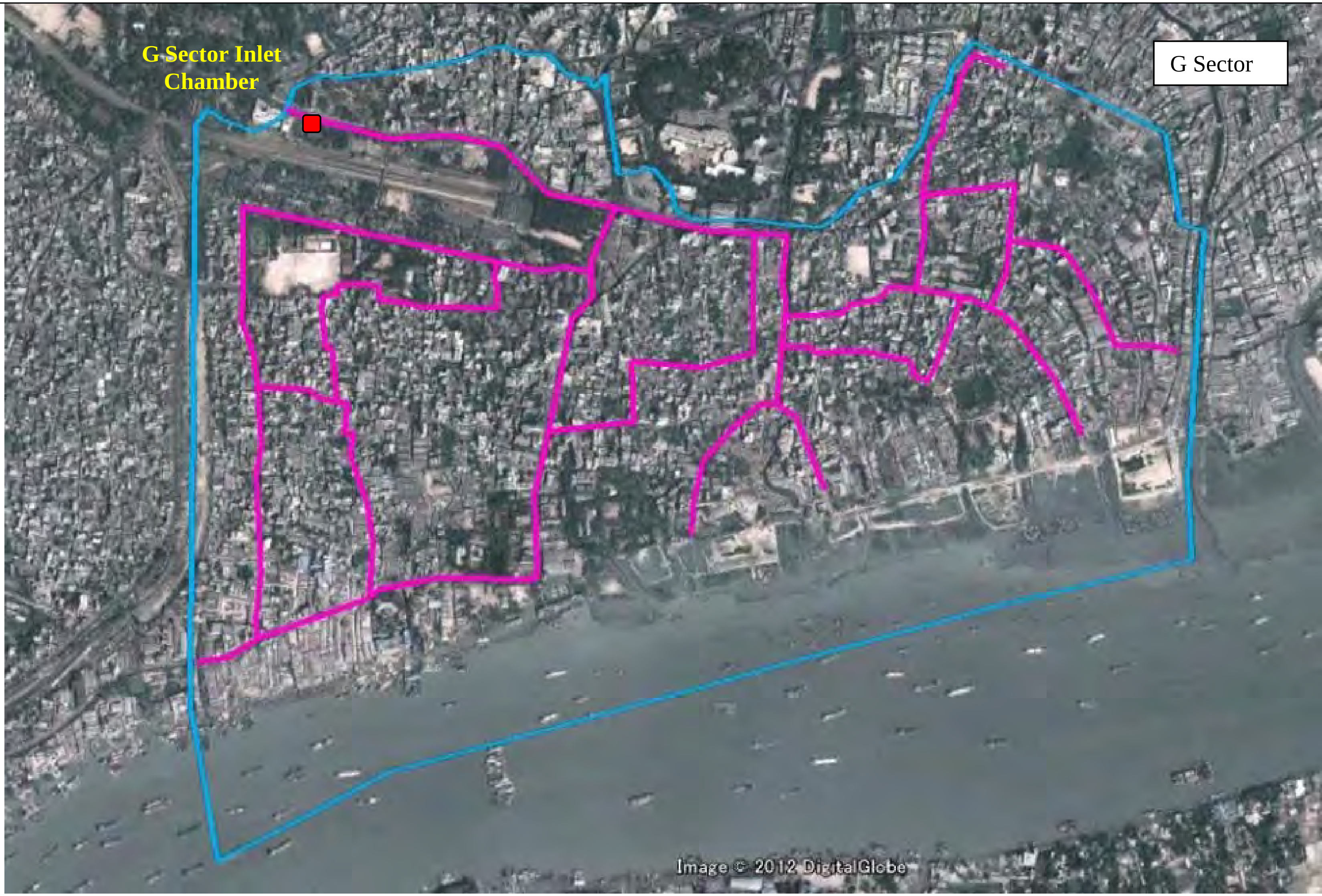


Figure 6.2.9 (7) Distribution Pipeline in Sector – G

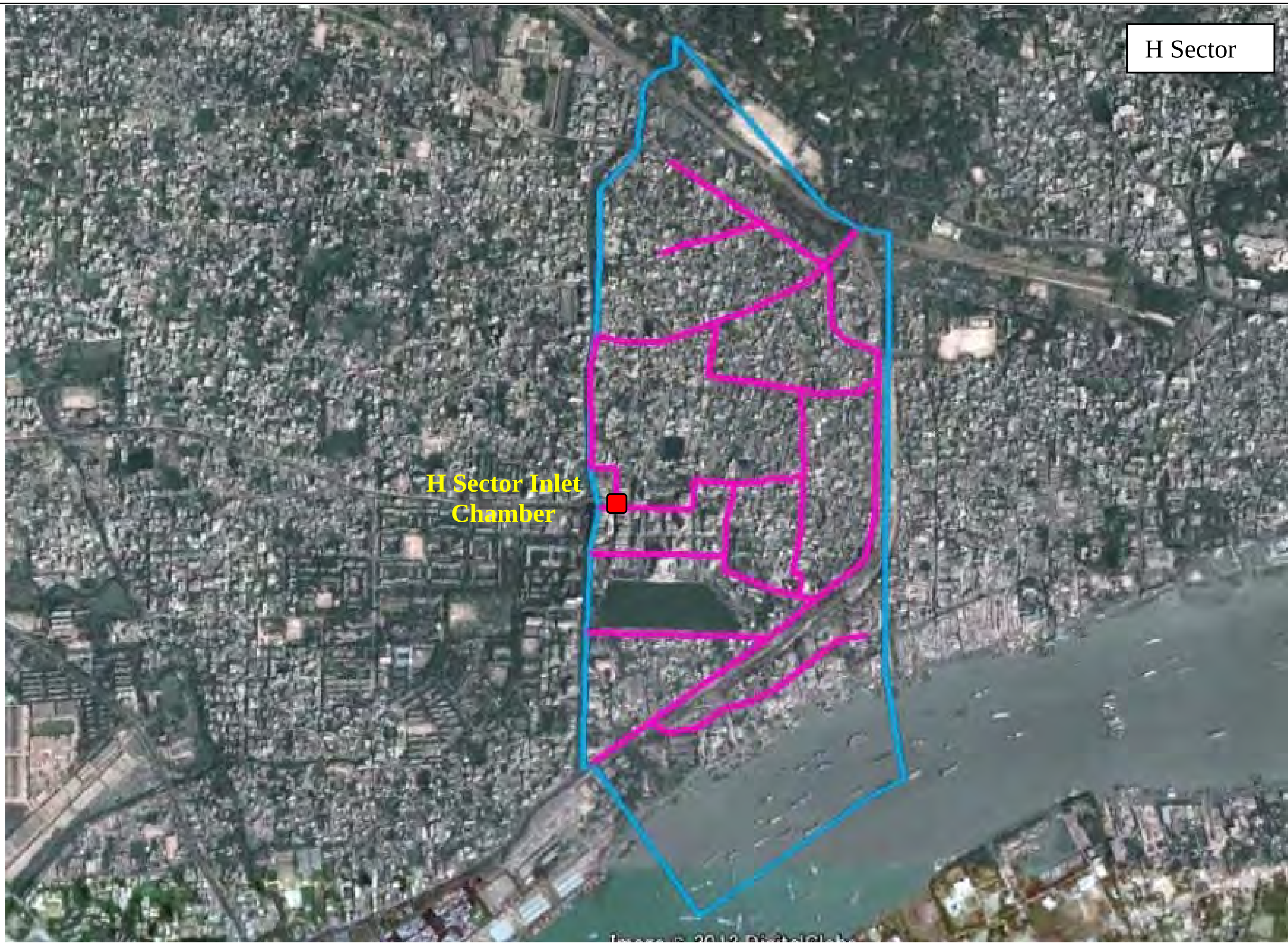


Figure 6.2.9 (8) Distribution Pipeline in Sector – H

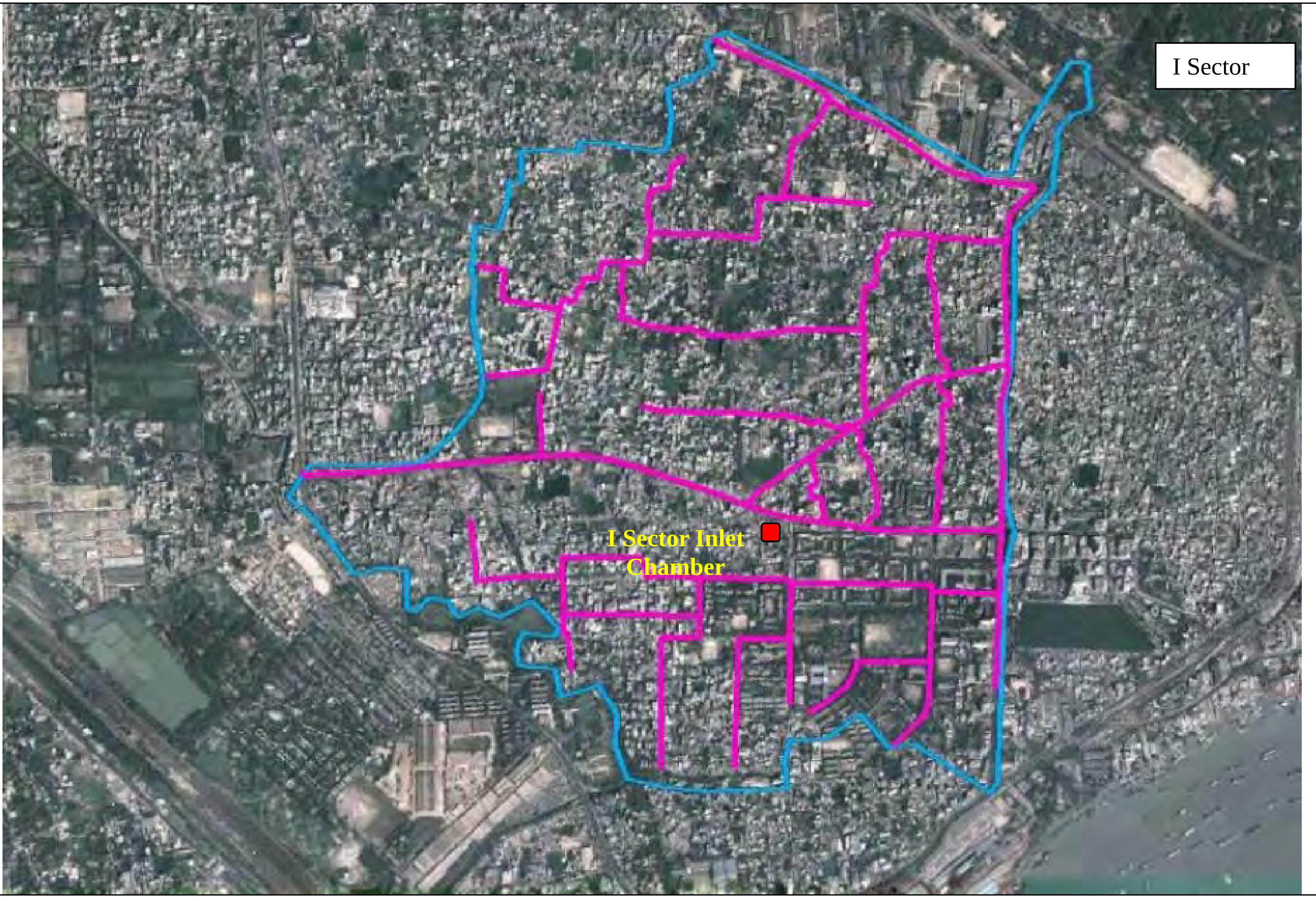


Figure 6.2.9 (9) Distribution Pipeline in Sector – I

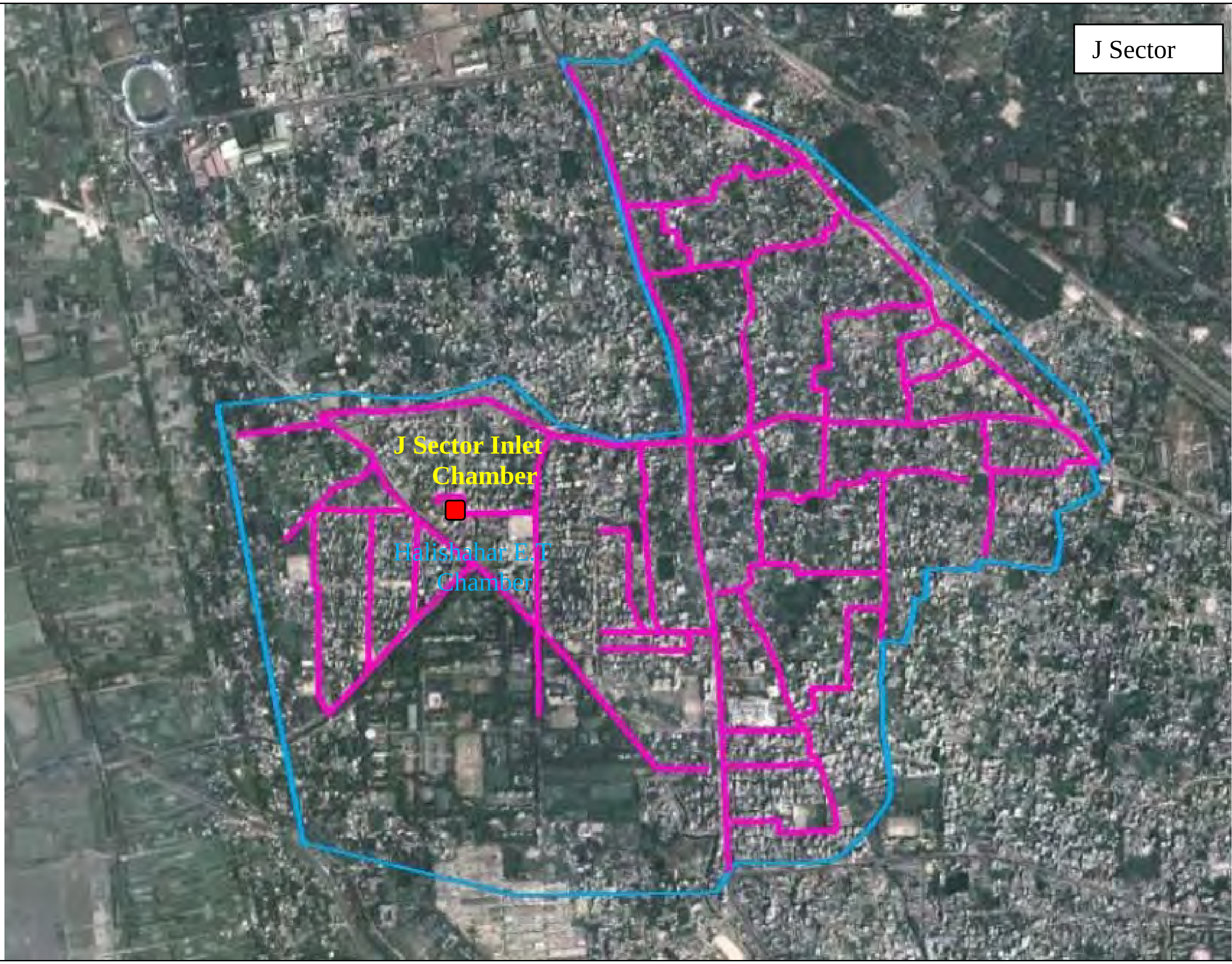


Figure 6.2.9 (10) Distribution Pipeline in Sector – J

CHAPTER 7

PRELIMINARY DESIGN OF THE WATER SUPPLY FACILITIES

CHAPTER 7 PRELIMINARY DESIGN OF THE WATER SUPPLY FACILITIES

7.1 Objectives of the Project

The objective of the Phase 2 Project is to increase sustainable access to safe water for the people in Chittagong city, by constructing water supply facilities and strengthening the capacity of CWASA, thereby contributing to the improvement of the living environment of the citizens. The scope of work for the Phase 2 Project is as follows:

(1) The expansion of Karnaphuli water treatment plant (production capacity 143,000m^3/day) and related facilities (intake, conveyance, transmission pipelines, reservoirs and distribution networks).

(2) Consulting services (engineering; D/D, construction supervision, etc.)

7.2 Necessity and Priority of the Project

(1) Limited Service Coverage

Since the completion of the Mohara WTP, no major projects have been implemented to increase the production amount and expand the distribution networks. Currently, the production capacity is about 47% of the present demand and intermittent water supply or chronic shortages of water are common for those served by CWASA.

The people not yet served by CWASA use shallow wells located all over the city area. CWASA estimates the number of private shallow wells in Chittagong at 3,000 to 4,000. The shallow well water is usually saline and/or contains high iron, aside from the problem of unsanitary condition affected by polluted water. There is also some evidence of arsenic contamination of shallow wells in the city. Under such conditions people in the city are exposed to the danger of water borne/related diseases.

CWASA does not provide adequate services to the estimated forty percent of Chittagong's population who live in slum areas. As a result of CWASA inability to supply water to the whole city, CCC has developed deep wells in selected slums areas and has procured 14 tankers / bowsers. Several NGOs are also active in the provision of water supply services to slum areas. Some slum dwellers purchase water from water vendors.

The Railway Authority developed its own water scheme to serve their staff using treated water from Foy's Lake. Some industries and individuals have also developed their own tube wells (a license from CWASA is required to construct a tube well with a riser pipe with a diameter of more than 1.5 inches).

Presently only 47% of water demand is served by CWASA (supply amount of 219,000m^3/d against demand of 470,000m^3/d). Water demand will increase drastically through the future as projected from 2015 to 2030: 592,000m^3/d, 668,000m^3/d, 798,000m^3/d and 1,000,000m^3/d for the years 2015, 2020, 2025 and 2030, respectively. The gap between demand and supply amount will increase through the future without timely provision of water supply.

Although Phase 1Project is planned to provide services from year 2015, distribution facilities planned are limited to cope with increasing demand in KSA and a higher leakage will be arisen due to planned connection of main pipes to existing distribution network. Therefore, construction of distribution pipelines for entire KSA, which is included in Phase 2 Project, shall be started immediately.

(2) Dilapidated and Inadequate Distribution Networks

The distribution networks serve about 45,000 households out of an estimated number of households of more than 600,000 in the CCC area. However, within the current water supply networks water supply is not guaranteed on a regular basis. Significant parts of the existing networks include old and dilapidated pipes that are in need of rehabilitation or replacement. CWASA operates an emergency water supply system that uses a number of trucks to deliver water in emergency situations.

Furthermore it is difficult for CWASA to accurately calculate water consumption from the billing records, due to non-working meters, lack of updated information on installed meter, etc.

Under the present arrangements of water supply, CWASA have no option but to supply customers on a case by case basis, without effective control of water supply from the WTPs to and throughout the distribution system. The exact locations of the distribution pipes have not yet been determined, except for the main distribution pipelines from the WTPs. The quantity of and breakdown of NRW in the distribution network is not known, except to some extent in areas where work has been carried out under the PANI. Furthermore, based upon the investigation carried out in the PANI rehabilitation of existing pipes is not an appropriate solution, which means that pipe replacement is required. In application of the replacement, the capacity of the system to be increased can be considered in the design for future water demands and required water pressure.

The time required to address the above issues, as well as to develop a functional and realistic hydraulic model of the existing system, which could then be used to develop an optimized and efficient water supply and distribution system for the long term, is likely to be some years. On completion of the above works several years would be required to implement the first priority project, allowing for arranging finance, design, procurement, construction, etc.

The Phase 1 Project will be completed by the year 2014, which includes construction of main/ sub-main distribution pipelines. However, the Phase 1 Project does not include lateral pipe and service connections to deliver water to the consumers since main/sub-main pipeline are planned to connect to existing distribution pipeline. In this regard, Phase 2 Project, which includes lateral pipes and service connections for the service areas to be covered by both phases, is urgent to realize the augmentation of water supply services.

(3) Non-Revenue Water (NRW)

According to CWASA, the existing NRW is 33%. Results from the investigations carried out in the pilot areas under the PANI from 2011 to 2012 showed that NRW was more than 50%. The study in PANI identified issues related to a high level of NRW, as follows.

1) Human resource development: Absence of permanent training program for NRW reduction work by CWASA staff
2) Equipment and tools: Luck of survey instruments and tools for leakage detection and repair work
3) Budgetary support: No specific budget with action plan is arranged
4) Appropriate technology: Absence of technical standards for water supply works
5) Time frame: Absence of annual work plan/physical target for NRW reduction

7.3 Project Component

7.3.1 General

The objective of the Phase 2 Project is to increase sustainable access to safe water for the people in

Chittagong city, by constructing water supply facilities and strengthening the capacity of CWASA, thereby contributing to the improvement of the living environment of the citizens.

The Phase 2 Project is the expansion of the Phase 1 Project except for the arrangements of the distribution system, although the service area to be covered by the Phase 2 Project is almost the same as the Phase 1 Project. Likewise, the capacities, locations of major facilities and manner of design thereto for the Phase 2 Project are basically the same as the Phase 1 Project.

Nevertheless, some modifications, additions and/or reductions to the Phase 1 Project are studied for the major facilities covering the civil/architectural, mechanical and electrical aspects, taking into account the issues and problems encountered during the implementation of the Phase 1 Project.

The outlines of the facilities for the Phase 2 Project by major item are; intake, conveyance pipeline, water treatment, transmission and distribution facilities. The plan of facilities which is presented firstly in each major facility is the basis for the preliminary design of water supply facilities for the Phase 2 Project to achieve the following requirements, as well as the general conditions/criteria.

(1) Minimize the possibility for and consequences of delays;
(2) Minimize the possibility for and consequences of claims;
(3) Minimize the possibility for and consequences of increases in cost;
(4) Enhance public relations and minimize disruption to the public, businesses, etc.;

The facility planning is made adopting the following general conditions/ criteria on water supply services (refer to Table 7.3.1).

Table 7.3.1 General Conditions/Criteria

Item	Conditions/Criteria
Target Year	2030
Fluctuation of water demand	
Daily Maxi demand factor:	1.15 (Daily Average demand : Daily Maximum demand = 1.00 : 1.15)
Peak hour demand factor:	1.5 (Daily Maximum demand :Peak hour demand = 1.0 : 1.5)
Capacity of distribution reservoir	
Reservoir/ Elevated Tank:	5 hours of the maximum daily water demand
Raw water quality:	Turbidity 40 NTU
Treated water quality:	Turbidity 10 NTU
Water supply pressure:	The minimum distribution pressure shall be more than 1.5kg/cm^2.
Water supply hours:	Basically, 24 hours continuous water supply should be ensured.
Water supply area:	The water shall be equitably distributed in the entire service area.

Table 7.3.2 summarizes the outline of facilities for Karnaphuli Water Supply Improvement Project by Phase and Figure 7.3.1 shows the outline of Karnaphuli Water Supply Project (Phase 2).

Table 7.3.2 Outline of Karnaphuli Water Supply Improvement Project by Phase

No.	Facility Name	Quantity		Capacity/Diameter/Detail	
		Phase 1	Phase 2	Phase 1	Phase 2
1	Intake Facility	C/A and M/E works	Mainly M /E works	150,000 m^3/d	150,000 m^3/d
2	Conveyance Facilities (Intake – WTP)				
2.1	Conveyance Pipeline	L=3.6km	L=3.6km	DN1200mm	DN1200mm
2.2	Surge Tank 1	1 no.	1 no.	427m^3	427m^3
3	Water Treatment Plant	1 no.	1 no.	143,000 m^3/d	143,000 m^3/d
4	Transmission Facilities (WTP – Nashirabad Reservoir)				
4.1	Transmission Pipeline 1	L=24.4km	L=24.4km	DN1200mm	DN1200mm
4.2	Surge Tank 2	1 no.	1 no.	213m^3	213m^3
5	Nashirabad Reservoir Facilities				
5.1	Reservoir	1 no.	1 no.	26,300m^3	24,800m^3
5.2	Elevated Tank	1 no.	-	2,200m^3	-
6	Transmission Pipeline 2 (Nashirabad – Battali Hill)	L=5.5km	-	DN1200mm /1000mm	-
7	Transmission Pipeline 3 (Nashirabad – Halishahar)	-	L=10km	-	DN1100mm
8	Halishahar Elevated Tank	-	1 no.	-	2,400m^3
9	Primary /Secondary Distribution Pipeline				
9.1	Primary Distribution pipeline at Northern, Central, and Western Area	L=42.8km	-	DN300– 1200	-
9.2	Primary Distribution Pipeline in Karnaphuli Service Area				
	1) Nashirabad ET to Sector A, B and C	-	L=1.5km	-	DN700-800mm
	2) Battali Hill Reservoir to Sectors D, E, F and G	-	L=1.3km	-	DN600-1000mm
	3) Halishahar ET to Sectors H, I and J	-	L=5.1km	-	DN600-1000mm
10	Sector Inlet Chamber (Pressure/flow Control system)	-	10 No.	-	Sectors A- J
12	Optical fiber cable	L=37km	L=20km	-	-
13	Secondary/Tertiary Distribution Pipelines in DMAs by sector 3,063 ha, Total L=about 475km				
13.1	Sector A (A=192 ha), DMA=12 Nr	-	L=31.4km	-	DN100-500mm
13.2	Sector B (A=216 ha), DMA=13 Nr	-	L=33.1km	-	DN100-700mm
13.3	Sector C (A=158 ha), DMA=10Nr	-	L=23.8km	-	DN100-800mm
13.4	Sector D (A=352 ha), DMA=22Nr	-	L=51.8km	-	DN100-500mm
13.5	Sector E (A=216 ha), DMA=13Nr	-	L=33.8km	-	DN100-500mm
13.6	Sector F (A=220 ha), DMA=14Nr	-	L=35.4km	-	DN100-600mm
13.7	Sector G (A=425 ha), DMA=26Nr	-	L=63.3km	-	DN100-800mm
13.8	Sector H (A=257 ha), DMA=16Nr	-	L=40.6km	-	DN100-800mm
13.9	Sector I (A=356 ha), DMA=22Nr	-	L=57.5km	-	DN100-700mm
13.10	Sector J (A=671 ha), DMA=42Nr	-	L=104.2km	-	DN100-400mm
14	House Connections (Served Population:1,540,200)	-	51, 360 set	-	Saddle, Service pipe and water meter

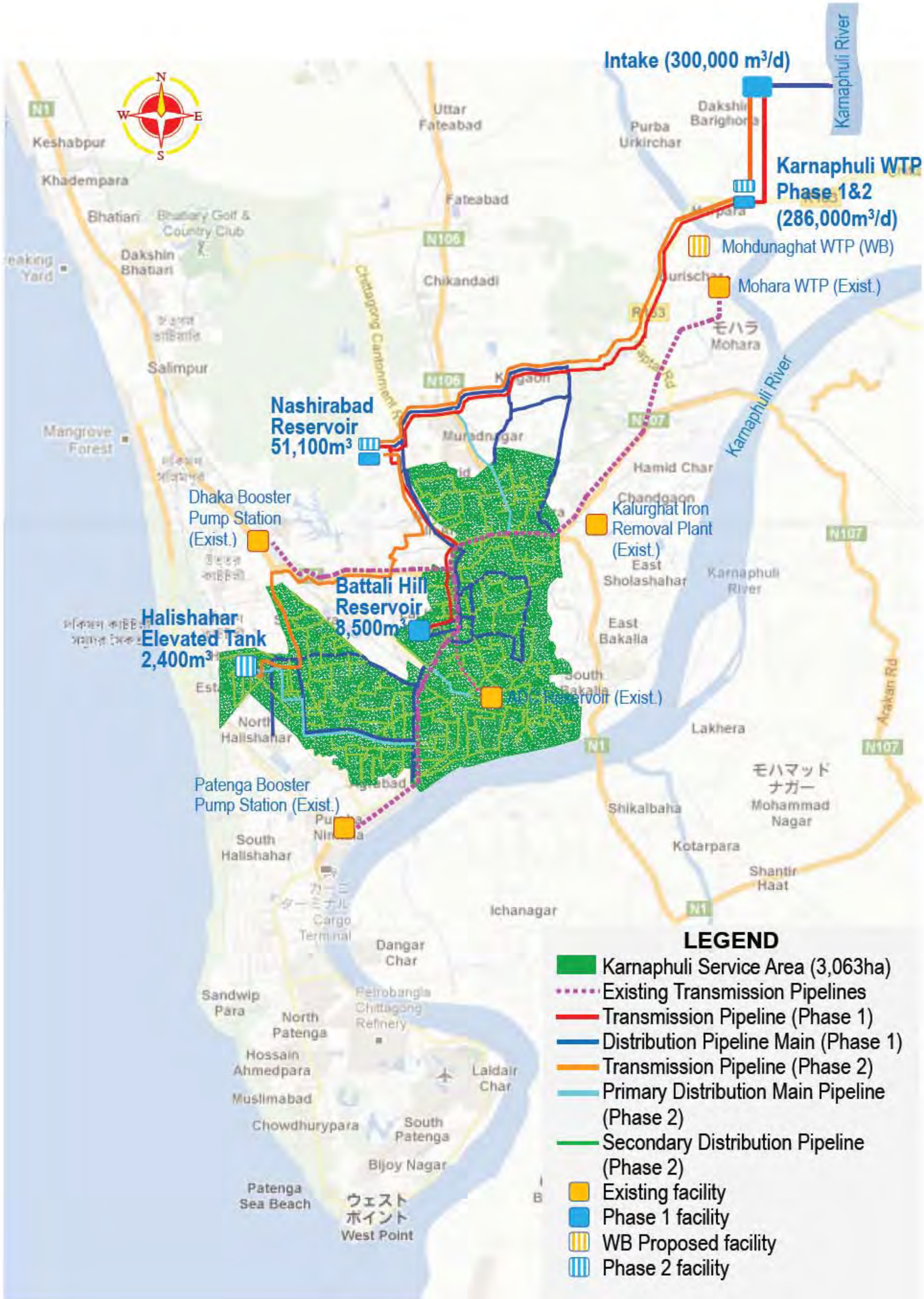


Figure 7.3.1 Location of Major Facilities for the Phase 1& 2 Project

7.4 Issues and Problems encountered by Phase 1 Project and Countermeasures

The plan of facilities for Phase 2 Project shall be prepared taking into account the lessons learned from the Phase 1 Project. There are two major issues/ problems in the Phase 1 Project, as enumerated below.

a) Land acquisition for the construction of facilities
b) Right of way for pipe laying

(1) Land acquisition

During the preparatory stage for the Phase 1 project, CWASA encountered problems on the land required for major facilities. Table 7.4.1 shows issues /problems, lessons learned and countermeasures for the implementation of Phase 2 project.

Table 7.4.1 Issues & Problems/Lessons learned and Countermeasures for Phase 2

Issues & Problems encountered by Phase 1 Project	Lessons learned from Phase 1 project	Status on land acquisition	Countermeasures for Phase 2 Project
1. Intake Facility	Boundary and shape of the land area were changed due to lack of an accurate map	Obtained for 2 Phases	Land area was confirmed and available
2. Conveyance Pipeline (surge tank)	Same problem as the site for Intake Facility	Obtained for 2 Phases	Need to confirm the boundary for Phase 2 surge tank site with CWASA
3. WTP	It took for a long time for negotiation with the land owner	Only site for Phase 1 WTP was obtained.	Due to the difficulty of obtaining additional land, the Phase 1 WTP site shall be utilized
4. Transmission Pipeline (surge tank)	Same problem as the site for Conveyance Pipeline	Obtained for 2 Phases	Need to confirm the boundary for Phase 2 surge tank site with CWASA
5. Distribution Facility (Nashirabad Reservoir)	None	Obtained for 2 Phases	Land area was confirmed and available

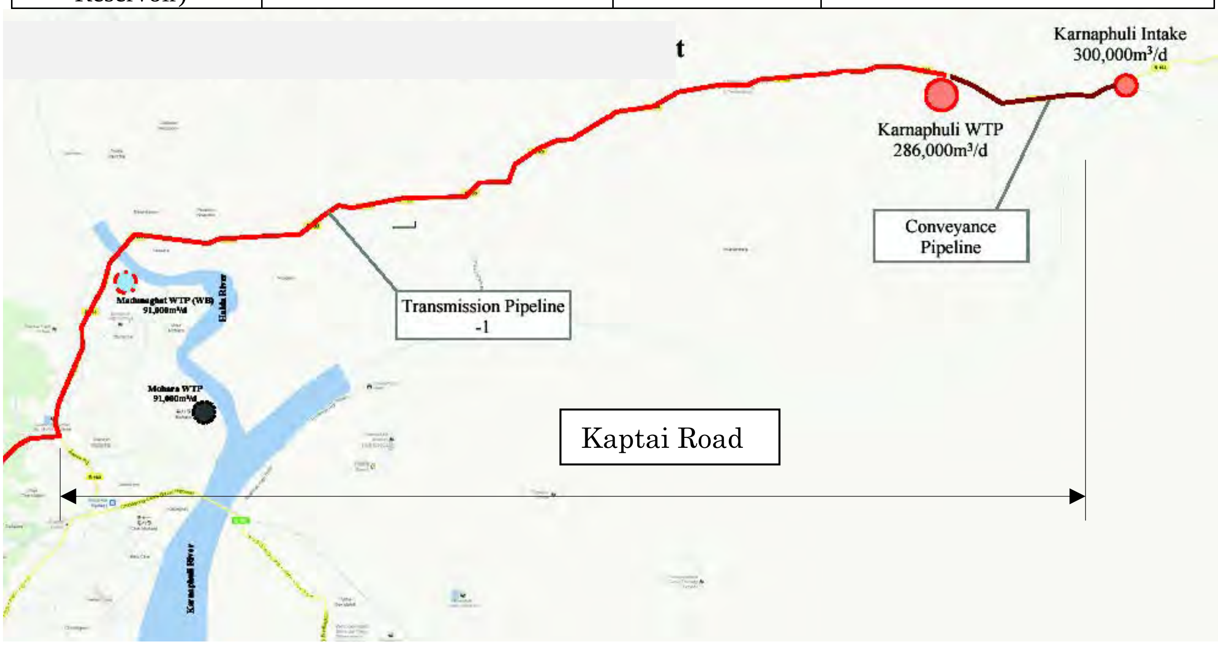


Figure 7.4.1 Location of Kaptai Road

(2) Right of way for the installation of pipelines

The permission from the Roads and Highways Department (RHD), Ministry of Communication was obtained in October, 2012 on the right of way for installation of conveyance and transmission lines along Kaptai road for the Phase 1 Project. There is a same problem for the Phase 2 Project in the construction of the same pipelines along Kaptai road. CWASA has been making all efforts to get approval from RHD for the Phase 2 before the end of January, 2013.

In order to mitigate possible problem before the determination of Phase 2 Project, the following are also requisites.

- Application of realistic construction methods
- Provision of countermeasures to mitigate traffic problems and to obtain social acceptance
- Establishment of cooperation system by concerned parties

In consideration of the above mentioned issues /problems, the plan of facilities is prepared to come up with the framework for respective facilities.

7.5 Intake Facility

The Phase 1 Project includes the majority of the civil/architectural works for both the Phase 1 and Phase 2 Projects. The scope of work includes inlet channel, pumping station, electrical building, and other buildings for a combined capacity of 300,000m^3/d. The requirements for the Phase 2 Project are mainly mechanical and electrical equipment for the intake for a capacity of 150,000m^3/d.

7.5.1 Civil Work

Yard pipes including a flow meter on the conveyance pipeline are planned.

7.5.2 Mechanical Equipment

(1) Pre-conditions for planning Phase 2

The intake facilities require various equipment including stop-logs, screens, water level gauge, conveyance pumps, flow meter and overhead crane to maintain pumps and valves. In the Phase 1 Project some equipment is provided for two phases, as summarized in Table 7.5.1.

Table 7.5.1 Mechanical Equipment at Inlet Channel

Item	Specification	Phase 1 & 2 (under Phase 1 Project)
Inflow Screen	Bar Screen W 2.0m x H 3.5 m x Opening 40mm	2 units
Sand Pump	Submersible Sand Pump 0.2m^3/min x 15m	2 units

(2) Intake Pump Facility

Four pumps (two duty and two standby) are planned for the inflow of 150,000m^3/d for the Phase 1 Project. For the Phase 2 project, two additional pumps are required, as shown in Table 7.5.2.

Table 7.5.2 Intake Pump Facilities

Item	Specification	Phase 1	Phase 2
Intake Pump	Vertical end suction volute pump $53m^3$/min x 27 m x 315kW (VVVF)	4 units Including 2 standby	2 units (duty)
Flow Control Valve	Motorized Butterfly D 1000mm x 0.75kW	1 unit	1 unit

(3) Intake Pump Control System

A variable speed control system is applied to cope with the fluctuation of water demand through the year. An additional one-way surge tank is planned to protect pipes and pump units against water hammer in the event of power failure.

7.5.3 Electrical Equipment

(1) Main Power Supply

In the Phase 1 Project it is planned to install an extension to the power supply from REB (single 33kV 50Hz) and a connecting transformer (33kV/3.3kV) at the intake facility site. The incoming power line is reliable, due it being a direct and dedicated supply from the nearest substation. However, the capacity of the transformer covers only the Phase 1 loads. Therefore, an additional transformer and connection breakers are required for the Phase 2 Project. The necessary area for the facility, including a concrete foundation, is considered and allowed for in the Phase 1 Project. The type of transformer shall be outdoor, oil immersed and natural cooling.

(2) Emergency Power Generation

One unit of standby diesel engine generator was planned for the intake pumps in the Phase 1 Project. An additional generator will be required for the Phase 2 Project and will be planned to be of the same type and with the same capacity as that provided in Phase 1.

Figure 7.5.1 shows the single line diagram to show the scope of the Phase 2 Project.

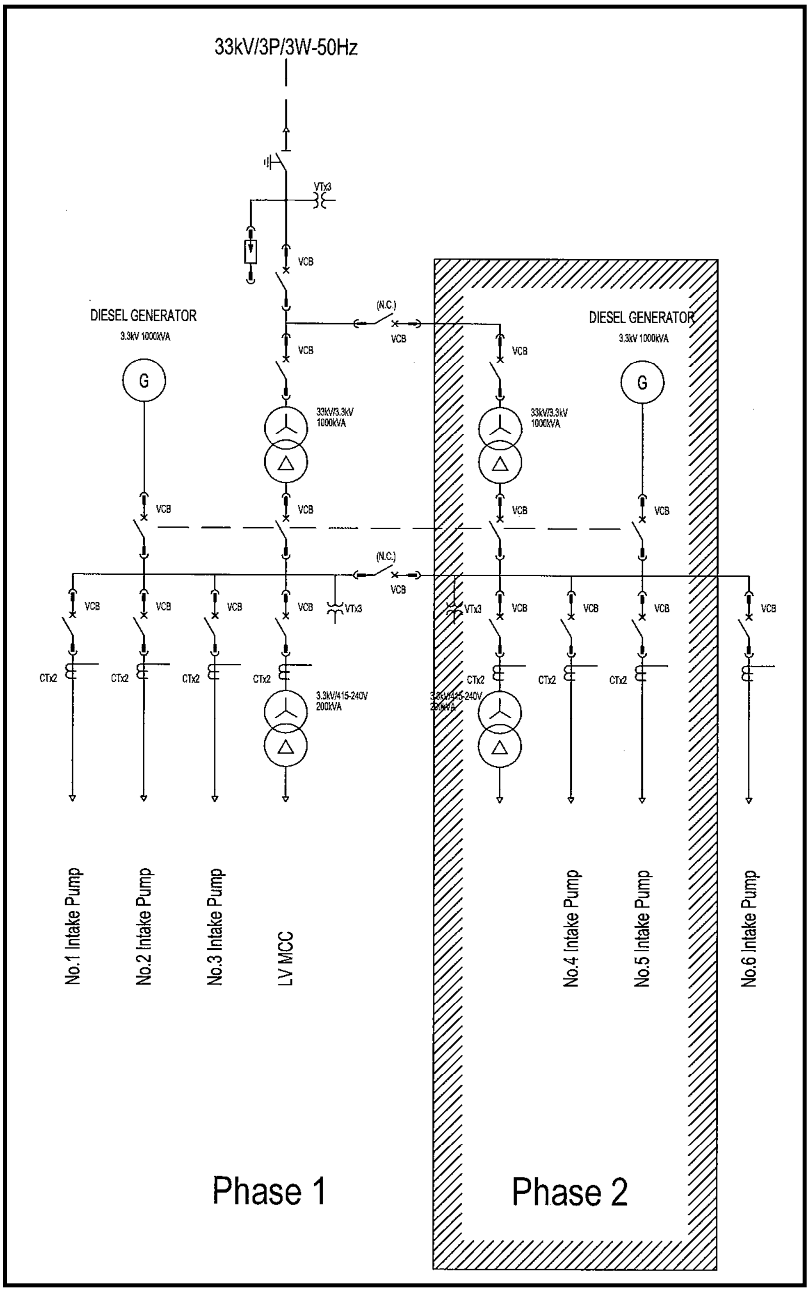


Figure 7.5.1 Single Line Diagram for Intake Pump Station

(3) Electrical Room

One electrical room was planned in the Phase 1 Project in each of the Electrical Building and Intake Pump Station. For the Phase 2 Project, 3.3kV switchgear and LV transformer, and LV distribution board shall be installed in the Electrical Building and pump starters and a motor control center shall be installed in the Pump Station. The electrical rooms planned in the Phase 1 Project will be able to accommodate additional equipment.

(4) SCADA and Instrument

A SCADA system was applied to the intake facilities in the Phase 1 Project. Under Phase 2 additional facilities shall be incorporated into the Phase 1 SCADA system using the same type of PLC. The software of the SCADA should be the same as that used in Phase 1.

Table 7.5.3 summarizes the main electrical equipment in Phase 2.

Table 7.5.3 Main Electrical Equipment in Phase 2

Equipment	Feature
33kV Switchgear	VCB
33/3.3kV Transformer	Oil type
3.3kV Switchgear	VCB
3.3kV pump starter	VFD drive
Intake MCC	400V Form 3b
Local Operation Panel	Stand type
Intake Flow Measurement	Electromagnetic
PLC/RTU	Open protocol (Profibus)
SCADA System	Modification and up-grading
Standby Generator	Diesel engine, radiator cooling

7.6 Conveyance Pipeline

A 4.5 km long conveyance pipeline from the Intake Pump Station to Pre-Sedimentation Basin in the WTP is necessary to connect the WTP with the intake facility (3.6 km between the contract boundaries of the intake facilities and WTP). It will be provided with a flow measurement device, isolation valves, air-relief valves for relief of accumulated air at high points in the pipeline, and surge-control devices for reducing transient pressure waves.

In the Phase 1 Project, three options for the design of the conveyance pipeline were considered, as shown in Table 7.6.1. Among them, Case-3 (150,000m^3/day, dia.1200mm x 1no.) was selected in the Phase 1 Project to reduce the construction cost. Figure 7.6.1 presents alignment of the pipeline.

Table 7.6.1 Section of Dia./No. of Conveyance Pipeline

		Case-1	Case-2	Case-3
Water Flow (m^3/day)		300,000	300,000	300,000
Conveyance Pipeline	Dia. (mm)	2000	1400	1200
	Length (m)	4,500	4,500	4,500
	Number of pipe	1	2	2
	Velocity (m/sec)	1.11	1.13	1.53
	Hydraulic loss (m)	19.0	21.50	27.0

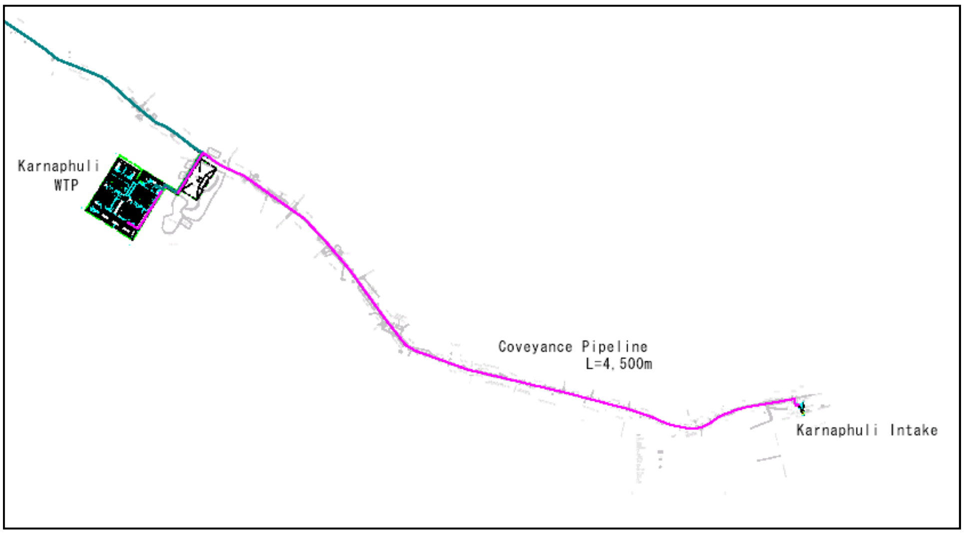


Figure 7.6.1 General Layout Plan of Conveyance Pipeline

In Phase 2, the same quantity of 150,000m^3/d as the Phase 1 Project is pumped to the WTP. On the way to the WTP, a one- way surge tank is installed to protect pipes and pump units in the event of a power failure, with the facilities being the same as in the Phase 1 Project.

The conveyance pipeline for the Phase 1 Project is arranged on the left side of the Kaptai road going towards the CCC area, with the pipeline for Phase 2 on the right side, as shown on Figure 7.6.2. The right of way for the pipelines for Phase 1 Project was approved on October 3, 2012 by RHD, Ministry of Communication. CWASA has been making efforts to get concurrence from RHD on the right of way for the Phase 2 Project by the end of November, 2012.

The location of the Surge tank for Phase 2 is arranged next to the Phase 1 tank, as also shown on Figure 7.6.2. However, the boundary of the site should be reconfirmed with the concerned agencies/persons.

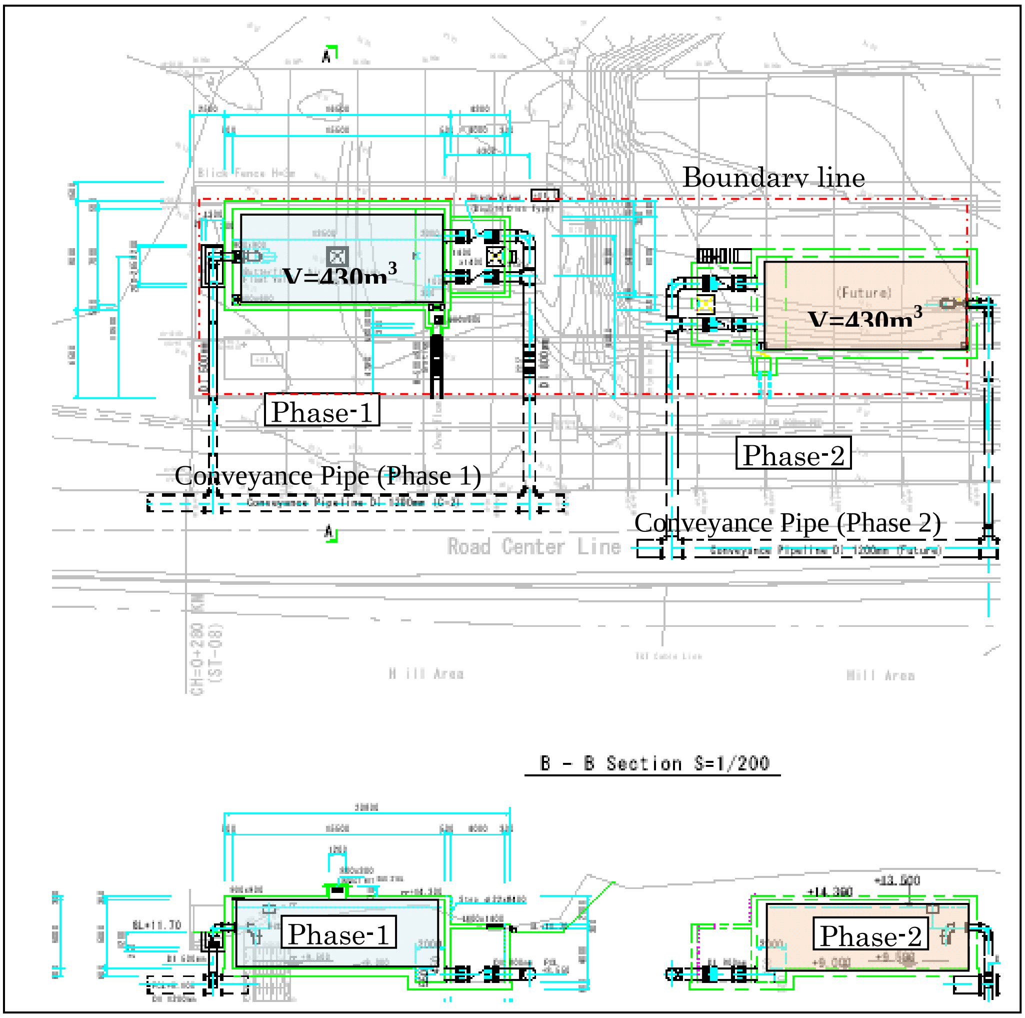


Figure 7.6.2 Installation of Surge Tanks and Alignment of Conveyance Pipelines for Two Phases

7.7 Water Treatment Plant

As experienced in Phase 1 Project, additional land acquisition for the construction of the Phase 2 WTP is very difficult. Therefore, a study was made on how to effectively utilize the area obtained for the Phase 1 Project, for both phases. The water treatment process for Phase 2 is basically the same as the process for Phase 1, which is flocculation, sedimentation, and rapid sand filtration process.

The layout of the Phase 2 works has been studied in order to facilitate construction of a parallel water treatment plant with the same capacity as Phase 1. In order to construct a parallel plant, adequate and appropriate sludge treatment has to be planned for both Phases 1 and 2, as the Phase 2 water treatment facilities have to be constructed on the site of part of the Phase 1 sludge lagoons. In addition, the capacity of the Phase 1 pre-sedimentation has to be reviewed, taking into account recent raw water quality data of Karnaphuli River.

The overall shape (rectangular) of the site is generally ideal; however between the pre-sedimentation basin and the northernmost sludge lagoon there is a cremation ground. The arrangement of yard pipes and cables will be installed outside of the site.

7.7.1 Water Treatment Process

(1) Pre-Sedimentation Basin

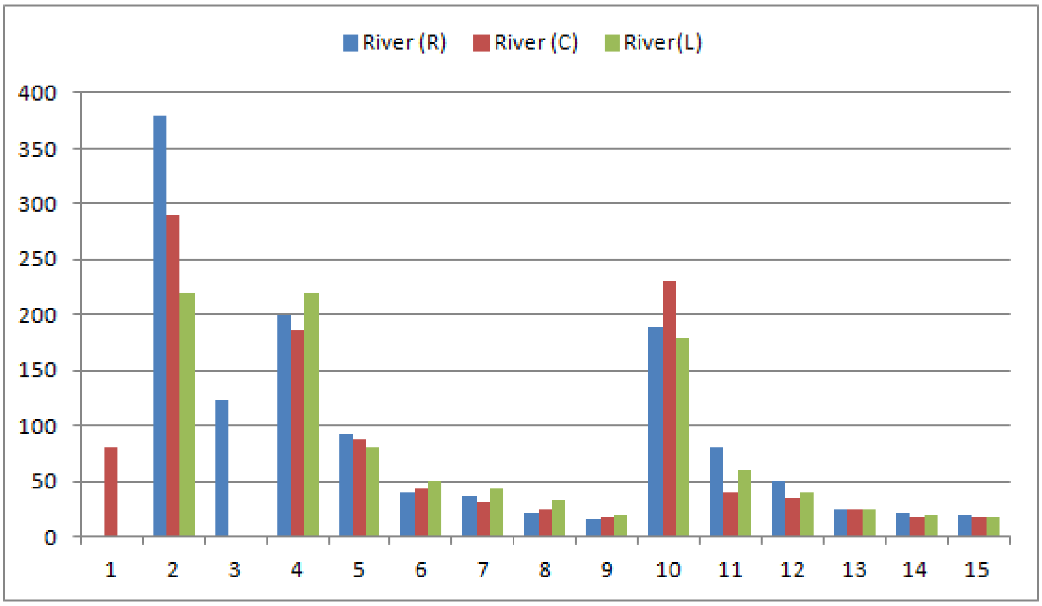
1) Design Turbidity for Karnaphuli WTP

The SAPROF study referred to the turbidity of the Halda River, which was used for the design of Mohara WTP. The design of the Phase 1 Project followed the same idea; however, the water quality (in terms of turbidity) in the Karnaphuli River is much better than in the Halda River. Table 7.7.1 shows a comparison of the water quality on the same day (13th July 2008).

Table 7.7.1 Comparison of Turbidity between Karnaphuli River and Halda River

Sampling Location	Water temperature (deg. C)	Turbidity (NTU)
Karnaphuli Intake point 20m away (surface)	23	25
Mohara Intake point (surface)	25	150

Examination of water quality at the intake point from the Karnaphuli River has been conducted from the June 17th, 2012 up to September 30th, 2012 (15 times during the rainy season) as shown in Figure 7.5.1. Turbidity in Halda River has exceeded 400NTU in the rainy season. However, turbidity in the Karnaphuli River is lower than in the Halda River and it was confirmed by the analysis in the above period that the water quality in the Karnaphuli River recovers within a few days of heavy rain. Thus, it is concluded that periods when high turbidity (more than 300 NTU) occurs are limited, even during the rainy season and that turbidity is less than 40 NTU (design turbidity for Phase 1 Project) in the majority of days in a year (refer to Supporting Report 7.7.1 for details).



Number of Sampling days

Note: R: right bank of the River, C: centre of the River and L: left bank of the River;
Water sample from 6/17 to 9/30, 2012

Figure 7.7.1 Turbidity at Godown Bridge near Intake Site

2) Process flow

Considering that turbidity in the Karnaphuli River is comparatively low, except for during some times in the rainy season and that recovery from high turbidity is very fast, the need for a Pre-Sedimentation Basin may be considered for limited periods. In this connection, the Pre-Sedimentation basin planned in the Phase 1 project may be commonly used for both Phase 1 and 2 in the case where the inflow has a high turbidity.

The following process flow is planned, taking into account the need for economical and realistic treatment of sludge from Phases 1 and 2.

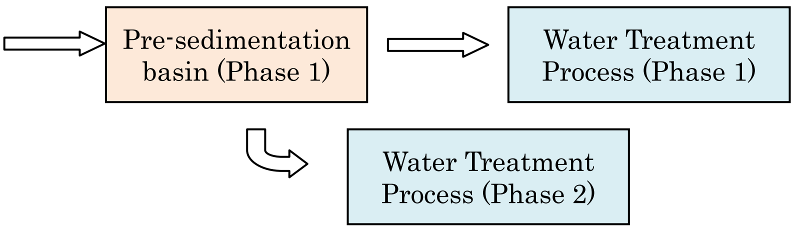


Figure 7.7.2 Water Treatment Flow Diagram

7.7.2 Sludge Treatment Process

(1) Generation of sludge in the water treatment process

Sludge is generated during the process of water treatment. Historically in Chittagong, sludge has been directly discharged into a water body. The major sources of sludge at the WTP are the pre-sedimentation basin, sedimentation basin and sand filter.

1) Sludge generated at pre-sedimentation basin

The sludge (mainly silt) is deposited by gravity in the pre-sedimentation basins. In case of Mohara WTP, the accumulated sludge is removed from the pre-sedimentation basin once a year in the dry season. The removed sludge is utilized for backfill/limited agriculture landfill.

2) Sludge generated at sedimentation basin

In the Phase 1 Project (Q=150,000m^3/d), lagoons were selected for the treatment of sludge generated in the sedimentation basins, as shown in Figure 7.7.3. Sludge flows into a lagoon by gravity and is accumulated for a few months. Upon filling of the lagoon with sludge, sludge from the sedimentation basin is transferred to the next lagoon.

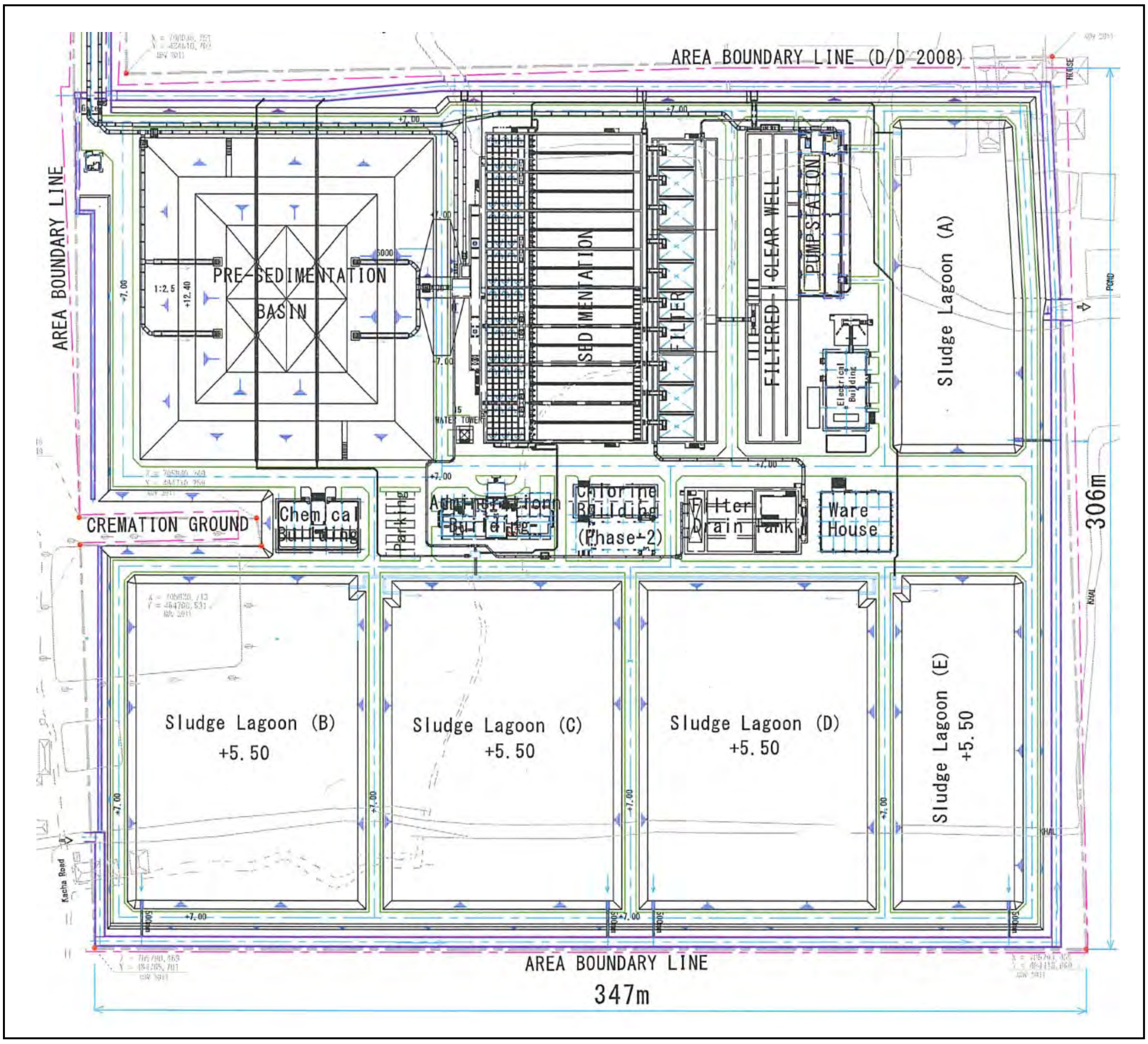


Figure 7.7.3 General Layout Plan of Phase 1

Alternation of feeding the sludge lagoon is planned to be carried out throughout the year. Then, thickened sludge in the lagoons is removed during the dry season. However, the area planned for the lagoons in Phase 1 has to be used for the water treatment facilities for Phase 2 because of the difficulty of additional land acquisition. In this regard, alternative sludge treatment processes are studied in order to accommodate the sludge treatment facilities for both phases within the area obtained in the Phase 1 Project.

Environmental considerations on the discharge of treated water are also another concern for the study of sludge treatment: Suspended Solids (SS) shall be less than 150mg/l in the case of discharge to inland surface waters, in accordance with the "Standards for of Schedule-10 (Discharge from industries/projects) of the Environmental Conservation Rules, 1997".

3) Wastewater generated in the process of backwashing Sand Filters

Wastewater generated from the backwashing process in the Sand Filters flows into the filter drain tank. The SS value is usually high when backwashing starts and decreases at the end of the cycle. The size of floc in the wastewater is small particles, which are wrapped and chemical jointed with Alum and suspended solids.

The wastewater, about 5% of the 300,000 m^3/d (the total amount of Phase 1 and 2), is returned by pumping to the sedimentation basin for recycling use.

(2) Alternative sludge treatment methods

The dried sludge shall be properly disposed of according to the prevailing laws and regulations in Bangladesh. However, there are no standards at present for the disposal of sludge generated at the WTP. In case of Mohara WTP, dried sludge from the pre-sedimentation basin is removed manually once a year in the dry season during 4 months from November to February, in which drying periods are 1 or 1.5 months, as stated above and as shown in the following photos (Figure 7.7.4).

Figure 7.7.4 Pictures on Removal of Sludge at Mohara WTP (18/1/ 2012)

The removed sludge is transported by residents living near to the WTP to fill in low land or is auctioned to sell to Brick factories at about 20 Taka/m^3, according to CWASA. These practices shall also be adopted for the reuse of the sludge from Karnaphuli WTP as well as disposal at the landfill site.

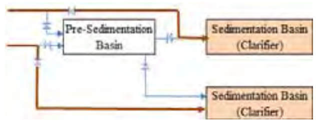
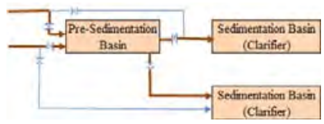
Alternative sludge treatment methods are studied for the total sludge to be generated from Phases 1 and 2, as follows:

1) Projection of seasonal sludge volume

Due to the seasonal differences in the turbidity of inflow water from the Karnaphuli River, sludge volumes in the dry and rainy seasons are projected.

In days of heavy rain, turbidity of water to the Sedimentation Basin, after passing the Pre-Sedimentation Basin is assumed at about 100NTU, because Alum will be coagulated in the Pre-Sedimentation Basin when turbidity of the raw water is as high as 200NTU or 300NTU. Under such assumptions, the sludge volume is 11.673 t DS/d (2,334m^3/d; turbidity in raw water = 40NTU, water content = 0.5%) in the dry season and 28.243 t DS/d (5,650m^3/d; turbidity in raw water = 100NTU, water content = 0.5%) in days of heavy rainy (refer to Table 7.7.2).

Table 7.7.2 Projection of Sludge Volume by Season

Items	Dry season	High Turbidity(Heavy rain)
Process Flow		
Capacity of WTP	Q= 300,000m^3/d	Q= 300,000m^3/d
Turbidity of inflow water to Sedimentation Basin (Clarifier)	T=40 NTU	T=100 NTU (after Pre-Sedimentation Basin)
Alum Dosing, $Al_2(SO_4)_3$ $16H_2O$	E=21 mg/l	E=30 mg/l
Sludge quantity	Q・(T+αx E) x 10^{-6} x 90% DS/d (α=0.154) =11.673 t DS/d =2,334 m^3/d (w=0.5%) =390m^3/d(w=3%) after thickener	Q・(T+αx E) x 10^{-6} x 90% DS/d, (α=0.154) =28.247 t DS/d =5,650 m^3/d (w=0.5%) = 470m^3/d (w=6%) after thickener (in case of 2 trains)

2) Study on Sludge Treatment Process and disposal

Under the above mentioned seasonal sludge generation, alternative sludge treatment processes are studied, as follows:

a) Alternative-1: Sedimentation Basin-Lagoon - Disposal
b) Alternative-2: Sedimentation Basin-Gravity type Sludge Thickener-Sludge Drying - Disposal
c) Alternative-3: Sedimentation Basin-Gravity type Sludge Thickener-Mechanical Dewatering-Disposal

In the case of the design of the sludge thickeners in Alternatives 2 and 3, the process flow diagrams shown in Figure 7.7.5 are recommended, taking into account the different estimated sludge volumes in the dry and rainy season (days of heavy rain).

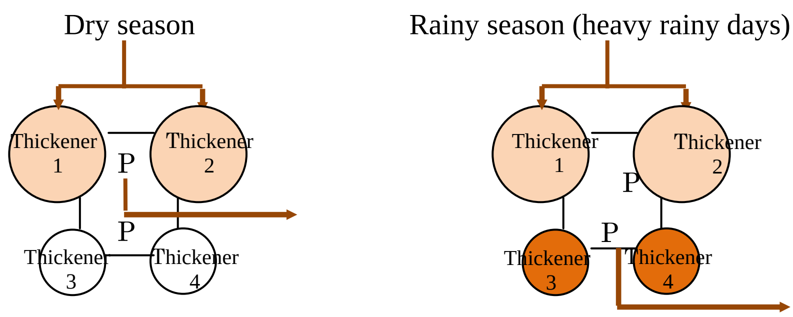


Figure 7.7.5 Sludge Thickening Process

Alternative plans of sludge treatment process after completion of Phase-2 Project are summarised as follows:

a) Alternative-1; Sedimentation Basin -Lagoon - Disposal

The sludge generated at Sedimentation Basin is pumped to a lagoon, but capacity of a lagoon is limited to storage for about 1.3 days (water content=0.5%) in the case of the dry season. Therefore, there is a high possibility that the supernatant from the lagoon has a high SS. To obtain SS in the supernatant of less than 150mg/l, sludge would need to be fed into the same lagoon for about one (1) month. During sludge drying in a lagoon, the sludge from Sedimentation Basin is pumped to another lagoon. Accumulation and drying of the sludge is practiced such that the lagoons are used on a cyclical basis. Dried sludge is utilized for land filling of low areas or recycling use for making bricks /construction materials.

b) Alternative-2; Sedimentation Basin – Gravity type Thickener - Sludge Drying - Disposal

The sludge from Sedimentation Basin flows into a sludge receiving tank and is pumped to the sludge thickeners. The thickened sludge (water content = from 99.5% to 94% (or 97%) depending upon the season, as shown in Table 7.5.3 and is pumped to a sludge drying bed until the sludge accumulates up to a certain depth, following which the next bed is fed with sludge. Dried sludge from the drying bed is managed in the same manner as alternative-1.

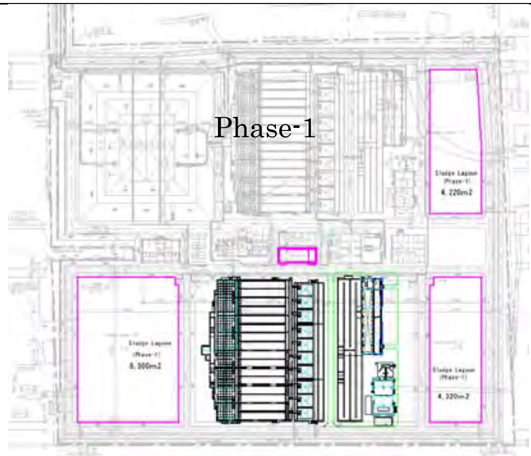
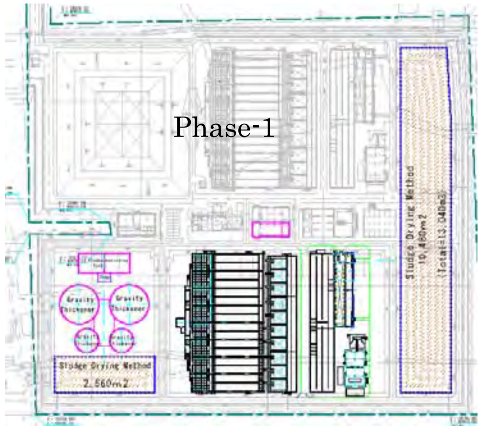
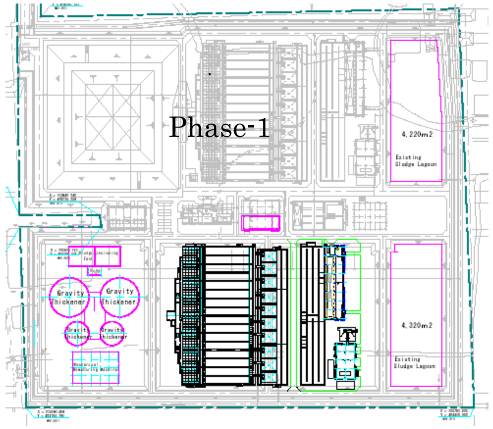
c) Alternative-3; Sedimentation Basin – Gravity type Thickener - Mechanical Dewatering - Disposal

The sludge treatment process is same as for alternative-2 up to and including sludge thickening. The thickened sludge is pumped to a mechanical dewatering process and the water content of dewatered sludge is planned to be about 75%. Sludge cake is managed in the same manner as alterneative-1.

Table 7.7.3 shows the summary of the comparison on the alternative sludge treatment processes. Alternative 2 is recommended because of the following reasons.

a) In Alternative 1 it is difficult to maintain a SS concentration of less than 150 mg/l in the supernatant without acquiring additional land to provide an increased sludge lagoon volume.
b) Alternatives 2 and 3 both meet the condition that the SS of supernatant from sludge treatment process should be less than 150mg/l according to the discharge regulation (Standard for Schedule-10).
c) The construction and operation and maintenance costs of Alternative 2 are considerably lower than those of Alternative 3.

Table 7.7.3 Summary of Comparison on Alternative Sludge Treatment Process

Item	Alternative-1 Lagoon		Alternative-2 Gravity Thickener + Sludge Drying		Alternative-3 Gravity Thickener + Mechanical Dewatering	
General Layout Plan						
Outline of Major Facilities	1) Lagoon (Phase-1); A:4,220m^2, B:8,500m^2, E:4,320m^2 Total=17,040m^2 2)Lagoon Capacity; (in case of a Lagoon) 4,220m^{2}x0.7m/2,334m^3/d=1.3day 11,673kg/d x 60d/4,220m^2 =166kg/m^2 (Dry season)		1) Gravity Thickener with sludge recieving tank Normal NTU;11,673kg/d / 15kg/m^2/d =780m^2 High NTU ;28,247kg/d /15kg/m^2/d =1,900m^2 →Dia.30&18m x 2no. (standby-1no in case of normal NTU) 2) In case of high turbidity, 2-stage thickening is used (water content: 94%) 3) Sludge Drying Method 11,673kg/dx 60day/60kg/m^2/d =11,673m^2		1) Gravity Thickener with sludge recieving tank Normal NTU;11,673kg/d / 15kg/m^2/d =780m^2 High NTU ;28,247kg/d /15kg/m^2/d =1,900m^2 →Dia.30&18m x 2no. (stanby-1no in case of normal NTU) 2) Mechanical Dewatering in case of centrifugal type 30kW x 3 units 4) Lagoon;(for emergency) A:4,220m^2, E:4,320m^2	
Discharge of SS to public water body (agricultural channel)	There is a possibilty to discharge SS with more than 150mg/l due to limited retension time (1.3 day) and high sludge load to Lagoon, specially in case of high tubidity in days of heavy rainy.	×	Easy control in discharging SS from WTP.	○	Easy control in discharging SS from WTP and also there are sludge lagoons for emergency use.	◎

Item	Alternative-1 Lagoon		Alternative-2 Gravity Thickener + Sludge Drying		Alternative-3 Gravity Thickener + Mechanical Dewatering	
Sludge treatment for Phase 1 WTP during construction of Phase-2 WTP	Existing Lagoon can be operated as temporary sludge treatment for Phase-1	○	At least, half size facility of Sludge Drying Method should be constructed in first stage of Phase-2 Project	△	Existing Lagoon will be operated for temporary sludge treatment for Phase-1 treatment	○
Operation & maintenance	Very easy but frequent overflow of supernant from Lagoon to nearby canal	×	Need frequent O&M	○	Difficult	×
Construction Cost	Constructed by Phase-1	◎	1) Sludge receiving tank; 920,000 US$ 2) Gravity thickener ; 3,623,000 US$ 3) Sludge drying Method 11,550m^2 x 400US$/m^2 = 4,600,000US$ **Total 9,143,000 US$** (**100**)	△	1) Sludge receiving tank; 920,000 US$ 2) Gravity thickener; 3,623,000 US$ 3) Mechanical Dewatering C&A: 35m x 24m x 3,000US$/m^2 = 2,520,000 US$ M&E = 7,000,000 US$ **Total 14,063,000 US$** **(154)**	×
O & M Cost for sludge treatment	1) Sludge removal ; 4 times/year 2) 10 persons/time/month 3) 4 x 10 x 150 US$/M = 6,000 US$ **Total 6,000 US$ /year** **(100)**	◎	**65,000 US$/year** **(1080)**	△	**200,000 US$/year** **(3,300)**	×
Recommendation	Not recommended due to a high possibility of supernatant with SS more than 150mg/l due to high sludge load to the lagoon	×	Recommended as lower construction and O&M costs than Alternative-3	○	Not recommended due to high construction and O &M Cost	△

Note) ◎;fairly good, ○;good, △;not bad, ×;bad

7.7.3 Civil/Architectural design

(1) Buildings & facilities

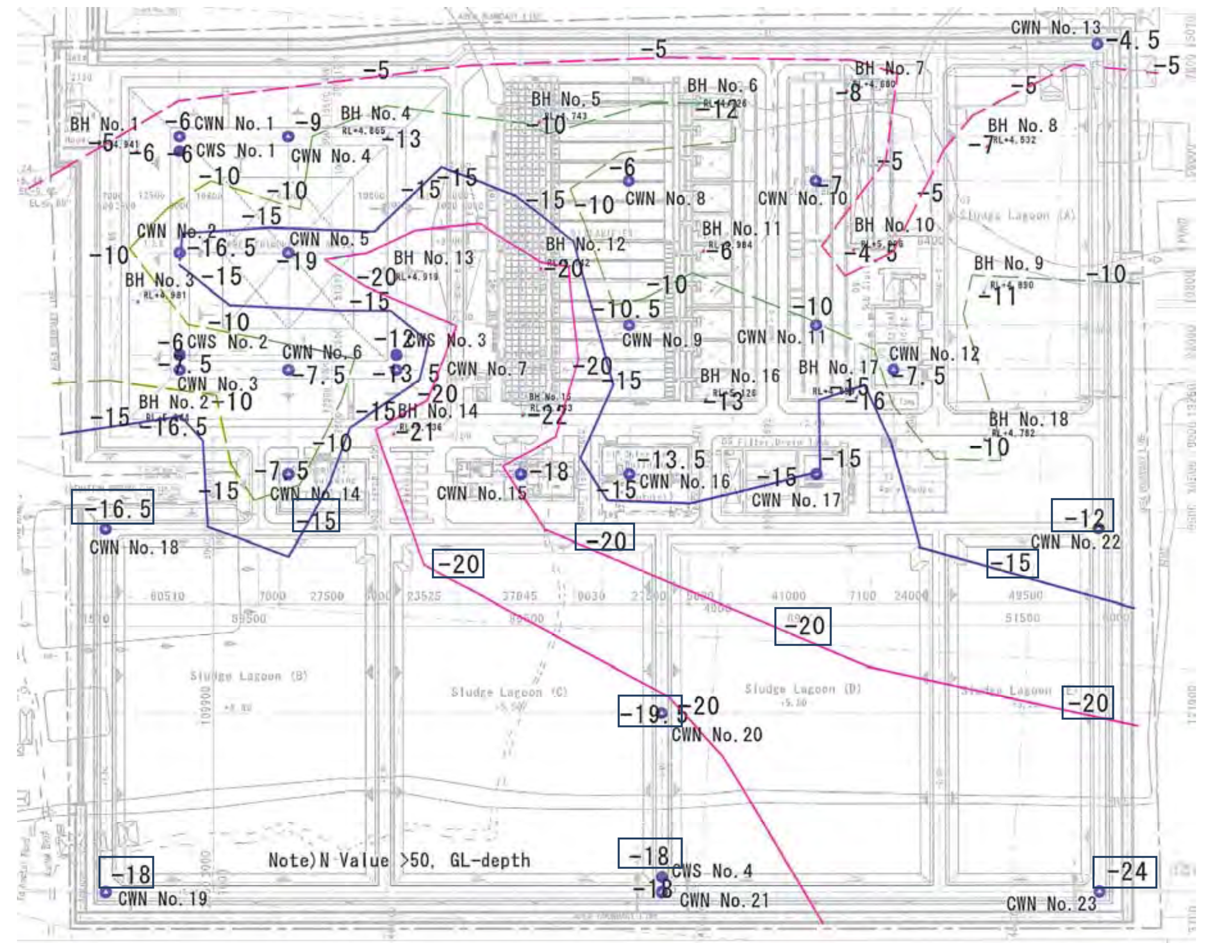
Table 7.7.4 shows the outline of the facilities in Phase 1 and Phase 2. The Phase 2 Project includes sludge receiving tank, thickeners and sludge drying beds for sludge treatment.

Table 7.7.4 Outline of the Facilities in Phase 1 and Phase 2 Projects

Facilities	Phase 1	Phase 2	Notes
Pre-Sedimentation Basin	For 150,000m^3/d	-	Common to Phases 1 & 2
Clarifier (Sedimentation Basin)	1) Mixing Chamber; W3.0m x L13.6m x D4.7m x 2 tanks 2) Flocculation Tank; W1.9m x L 63.1m x D4.0m x 8 channels 3) Sedimentation; W12.8m x L39.0m x D4.0m x 8 tanks	1) Mixing Chamber; W3.0m x L13.6m x D4.7m x 2 tanks 2) Flocculation Tank; W1.9m x L63.1m x D4.0m x 8 channels 3) Sedimentation; W12.8m x L39.0m x D4.0m x 8 tanks	
Filter	W7.6m x L12.2m x 10 tanks	W7.6m x L12.2m x 10 tanks	
Filter Drain Tank	W10.0m x L39.0m x D3m x 2 tanks	-	
Clear Well Reservoir	W4.0m x D4.0m x Total L413.7m	W4.0m x D4.0m x Total-L 413.7m	
Sludge Lagoon	A:V=3,669m3, H=0.7m B:V=5,384m3, H=0.7m C:V=5,492m3, H=0.7m D:V=5,492m3, H=0.7m E:V=5,384m3, H=0.7m	-	
Sludge Treatment	-	- Sludge receiving Tank; W15.0m x L20.0m x D4.0m x 2no. - Thickening Tank; Dia. 30m x D4.0m x 2 No. Dia. 18m x D4.0m x 2No. - Sludge drying bed; about 11,000m^2	
Sub-Station	W10.8m x L11.7m	-	
Electrical Building	W14m x L26m	-	
Generator Building	-	New building required.	
Chemical Building	W16.5m x L27.5m	-	
Chlorine Building	W9.5m x L27.5m	W9.5m x L27.5m	
Administration Building	W11.8m x L38m	-	
Warehouse	W20.5m x L24m	-	
Guard House	W5.0m x L5.0m	-	
Water Tower	W2.9m x L2.9m x D3.0m	-	
Yard piping	Conveyance Pipe: DN1200mm Transmission Pipe: DN1200mm Connecting pipe between facilities	Conveyance Pipe: DN1200mm Transmission Pipe: DN1200mm Connecting pipe between facilities	
Site works	Fence, road, earth filling, drainage etc.	Road	

(2) Soil Conditions

Soil investigation was conducted at the WTP site in 2012 and the information on the bearing layer for planning the pile foundation was collected. The bearing layer for the construction of WTP in Phase 2 is shown in Figure 7.7.6. About 20m long concrete piles will be required in the sedimentation basin area.



Note) Length of Piles for Phase 2 will be longer than Phase 1

Figure 7.7.6 Soil Investigation Results in 2012

7.7.4 Mechanical Equipment

(1) Design Conditions

Table 7.7.5 shows the major mechanical design conditions for the water treatment and sludge treatment processes.

Table 7.7.5 Mechanical Design Condition for Phase 2 Project

Facility Name	Design Condition of Phase 2		Reference
Water Treatment Plant (WTP) 1) Receiving Well/ Mixing Chamber/ Flocculation Facility 2) Sedimentation Basin Facility 3) Filter Facility	150,000 m^3/ day Design average turbidity 40 NTU Design maximum turbidity 100 NTU		Phase 1 is 150,000 m^3/day
4) Clear Well /Transmission Pump Facility	143,000 m^3/ day		Phase 1 is 143,000 m^3/day
5) Filter Drain Tank Facility			All work including phase 2 is under construction.
6) Chemical Facility	150,000 m^3/ day		Civil work including phase 2 is under construction.
	Alum	Average dosage rate 21 mg/l Maximum dosage rate 30 mg/l	
	Lime	Average dosage rate 5 mg/l Maximum dosage rate 15 mg/l	
7) Chlorine Facility	150,000 m^3/ day		Phase 1 is 150,000 m^3/day
	Pre chlorine	Average dosage rate 3 mg/l Maximum dosage rate 5 mg/l	
	Post chlorine	Average dosage rate 1 mg/l Maximum dosage rate 1.5 mg/l	
8) Sludge Treatment Facility	300,000 m^3/ day		
	Inlet sludge concentration and volume	approx. 0.5 % dry season 2,334m^3/d Rainy season 5,650m^3/d	
	Thickened sludge concentration and volume	approx. 3.0 % dry season 390m^3/d Heavy rainy day 950m^3/d	Total two thickeners, including each one stage thickener during dry season
	Thickened sludge concentration and volume	approx. 6.0 % Heavy rainy day 470m^3/d	Total four thickeners, including two sets of two thickeners connected in series during rainy season

Note: The number and specification of mechanical equipment for Phase 2 WTP is basically the same as for the Phase 1 WTP.

(2) Major Equipment

Table 7.7.6 shows the major Mechanical Equipment for the Phase 2 Project, as well as equipment provided in Phase 1.

Table 7.7.6 Major Mechanical Equipment for Phase 2 Project

Item	Specification	Phase 1 (under construction)	Phase 2
a. Receiving Well/ Mixing Chamber/ Flocculation facility			
Flash Mixer:	Turbine Mixer D 1.0m x 8 blades x 11kW	2 units	2 units
Inlet Gate	Manual Sluice W 0.6m x H 0.6m	8 units	8 units
b. Sedimentation Basin			
Sludge Collector	Submerged Car-scraper (rope pulling) W5.75m x L36.3m x 0.75kW	8 units	8 units
De-sludge Valve	Motorized Eccentric D-200 x 0.4kW	32 units	32 units
c. Filter Facility			
Inflow Valve	Motorized Butterfly D-600 x 0.2kW	10 units	10 units
Filtrated & Backwash Valve	Manual Butterfly D-600	10 units	10 units
Surface Wash Valve	Motorized Butterfly D-300 x 0.2kW	10 units	10 units
Wash Waste Gate	Motorized Rectangular Butterfly W0.9m x H0.9m x 0.75kW	10 units	10 units
d. Filter Drain Tank			
Wash Waste Pump:	Submersible Sewage 14m3/min x 16 m x 55kW	4 units including 2 standby	-
e. Clear Well/ Transmission Pump Facility			
Transmission Pump	Horizontal double suction volute 34m3/min x 81 m x 630kW (two are VVVF/ each phase)	5 units including 2 standby	5 units including 2 standby
f. Chemical and Chlorine Facility			
Alum Facility			
Alum Mixer	Double Impeller Turbine Mixer 3.7 kW	2 units	2 units
Alum Pump	Diaphragm 280-850 L/ hr x 0.75kW	4 units including 2 standby	4 units including 2 standby
Lime Facility			
Lime Mixer	Double Impeller Turbine Mixer 3.7 kW	2 units	2 units
Lime Pump	Diaphragm 170-860 L/ hr x 0.75kW	3 units including 2 standby	3 units including 2 standby
g. Chlorination Facility			
Chlorine cylinder	Cylindrical Convexed Container 1000 kg	18 units	18 units
Chlorinator	Self-Stand Vacuum 40kg/ hr	3 units including 1 standby	3 units including 1 standby
h. Sludge Treatment Facility			
Sludge Receiving Tank			
Sludge Mixer	Submersible Mixer 5.5kW	-	6 units including 2 in stock
De-sludge Pump	2.0 m^3/min x 15kW	-	4 units including 2 standby
Sludge Thickener			
Thickener 1	Gravity Thickener Dia. 30m x 1.5kW	-	2 units
Thickener 2	Gravity Thickener Dia. 18m x 1.5kW	-	2 units
Thickened Sludge Pump 1 group	Non-clog centrifugal 0.41 m^3/min x 7.5 kW	-	4 units including 2 standby
Thickened Sludge Pump 2 group	Non-clog centrifugal 1.0 m^3/min x 11kW	-	3 units including 2 standby
i. Supernatant Tank Facility			
Supernatant Pump	Non-Clog Submersible 1.8 m^3/min x 15kW	-	4 units including 2 standby

(3) Sludge Treatment Facility

The sludge treatment facilities require various equipment including sludge mixers, gates, de-sludge pumps, thickened sludge pumps, thickeners, and other necessary items. Sludge from the sedimentation basin, which is used for both phase 1 and 2, is transferred to the sludge receiving tank by gravity. Four sludge mixers (with an additional two in stock) will be provided in the tanks to prevent the inlet sludge from settling and sludge is transferred to the sludge thickeners by de-sludge pumps. It is planned that one duty pump out of the total of four pumps will be operated during the dry season and two duty pumps during the rainy season.

A total of four thickeners (D30m x2, D18 x 2) are planned. Two thickeners will be operated during the dry season. During days with heavy rain/rainy season, a total of four thickeners, two systems each with two thickeners connected in series will be operated. During the dry season, sludge with about 0.5 % concentration from sludge receiving tanks is thickened up to about 3 % concentration in the gravity thickener, and thickened sludge is transferred to the sludge drying bed by a thickened sludge pump. During days with heavy rain/rainy season, the thickened sludge concentration is increased up to about 6% due to two stage thickeners being connected in series. Thickened sludge is transferred to the sludge drying bed using a thickened sludge pump (refer to Figure 7.7.7 for schematic operation flow of sludge treatment).

7.7.5 Electrical Equipment

(1) Main Power Supply

In the Phase 1 Project expansion of the main power supply with a single 33kV 50Hz by REB and connecting to 33kV/3.3kV transformer is planned. The incoming line is reliable due to it being a direct and dedicated supply from the nearest substation. However, the capacity of transformer allows for only the Phase 1 needs.

An additional transformer and connection breakers are required for Phase 2. The necessary space, including concrete foundation is considered and allowed for in the Phase 1 Project. The transformer shall be of the outdoor, oil immersed, and natural cooling type.

(2) Emergency Power Generation

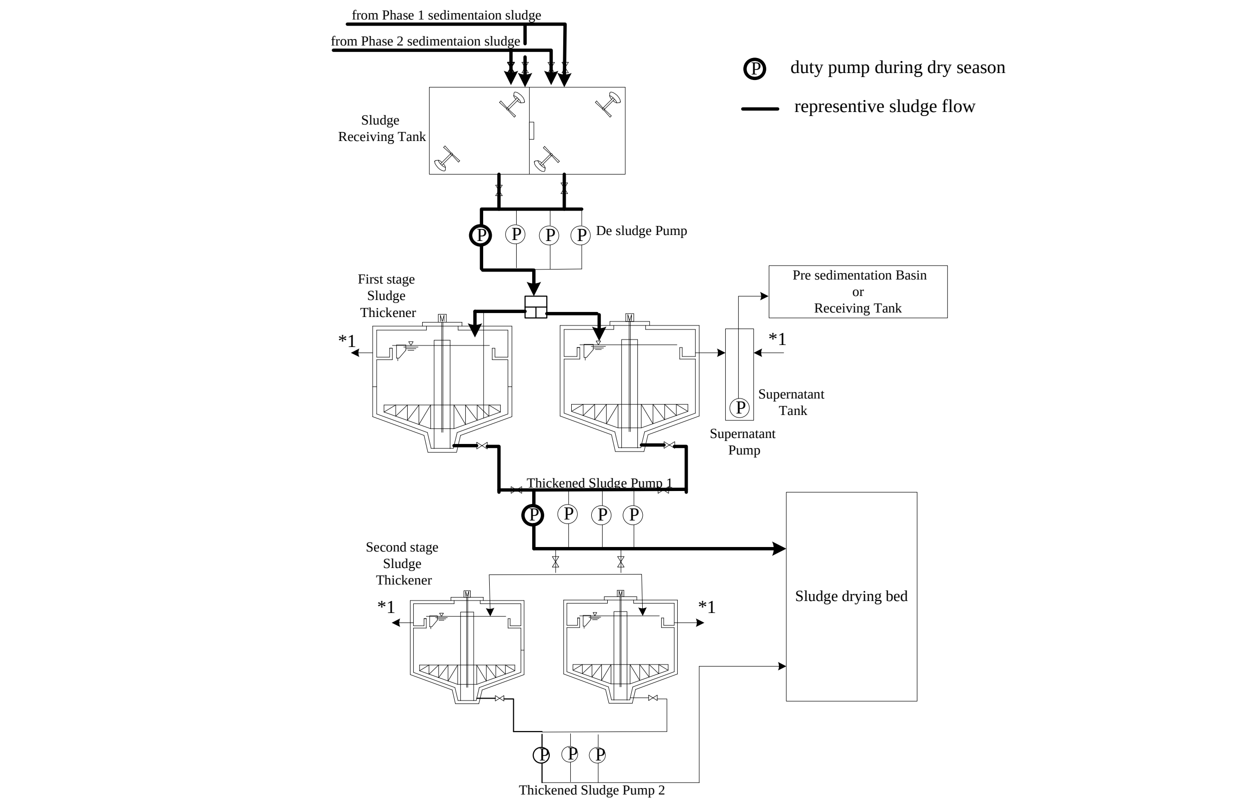
An additional generator will be required for the Phase 2 WTP. The capacity and type of generator will be the same as that in Phase 1. A new generator building will be required for the additional generator.

Figure 7.7.8 shows the single line diagram to show the scope of the Phase 2 Project.

(3) Electrical Room

Four electrical rooms will be required for the Phase 2 project, located in the Substation, Filter, Transmission Pump Station and Chemical Building. In the Phase 2 project, 3.3kV switchgear, LV transformer and LV distribution board shall be installed in the Substation; and pump starters and motor control centres shall be installed in the other electrical rooms. It is possible to accommodate additional equipment in the Phase 1 Substation and Chemical Building. However, for the Filter and Pump Station, new electrical rooms, which are similar to the Phase 1 works, will be required.

Dry Season



Rainy season (heavy rain day)

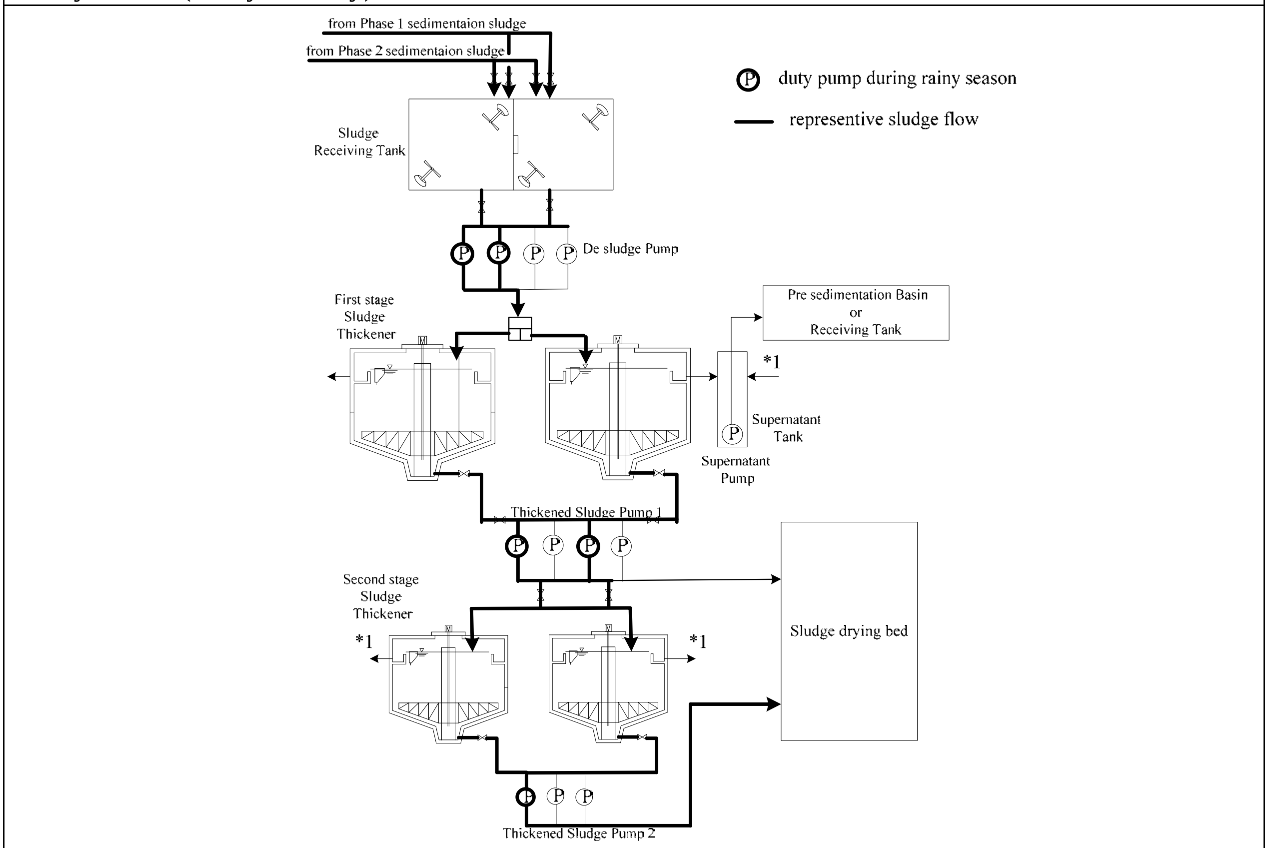


Figure 7.7.7 Schematic Operation Flow of Sludge Treatment

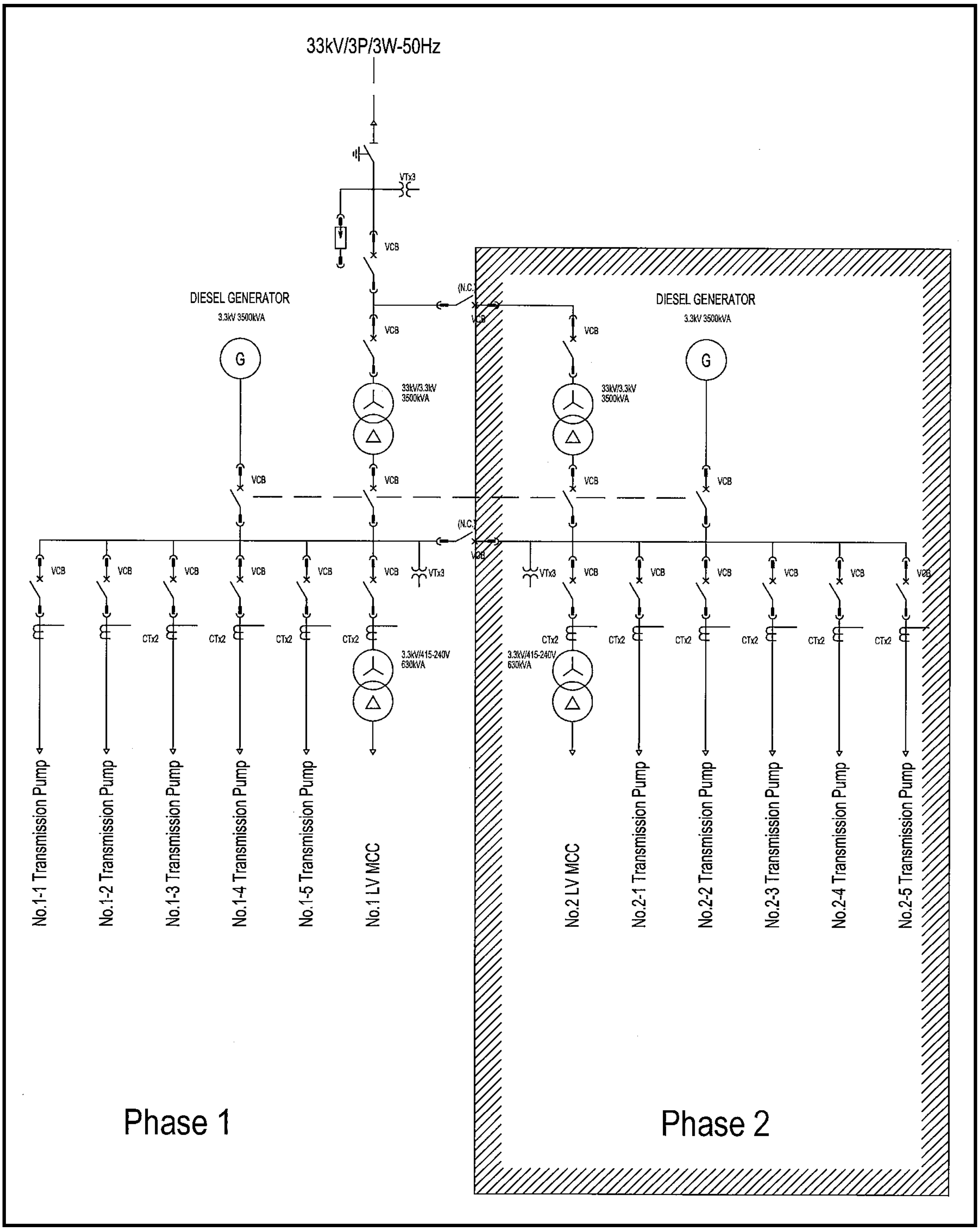


Figure 7.7.8 Single Line Diagram for Karnaphuli WTP

(4) SCADA and Instrumentation

A SCADA system for the WTP facilities is included in Phase 1. Additional facilities should be provided in Phase 2 and these should be compatible with and incorporated into the Phase 1 SCADA system, using the same type of PLC as Phase 1 (Profibus protocol). The software of the SCADA should be same as that of the Phase 1 Project.

Table 7.7.7 shows the main electrical equipment required for Phase 2 Project.

Table 7.7.7 Major Electrical Equipment required for Phase 2 Project

Equipment	Features
33kV Switchgear	VCB
33/3.3kV Transformer	Oil type
3.3kV Switchgear	VCB
3.3kV pump starter	VFD drive
WTP MCC	400V Form 3b
Chemical MCC	400V Form 3b
Local Operation Panel	Stand type
Intake Flow Measurement	Electromagnetic type
Filter Level Measurement	Ultrasonic type
Residual Chlorine Measurement	Polarograph Type
Clear Water Level Measurement	Submersible type
Transmission Flow Measurement	Electromagnetic type
PLC/RTU	Open protocol (Profibus)
SCADA System	Modification and up-grading
Standby Generator	Diesel engine, radiator cooling

Figure 7.7.9 shows the Instrumentation Flow Diagram in the WTP.

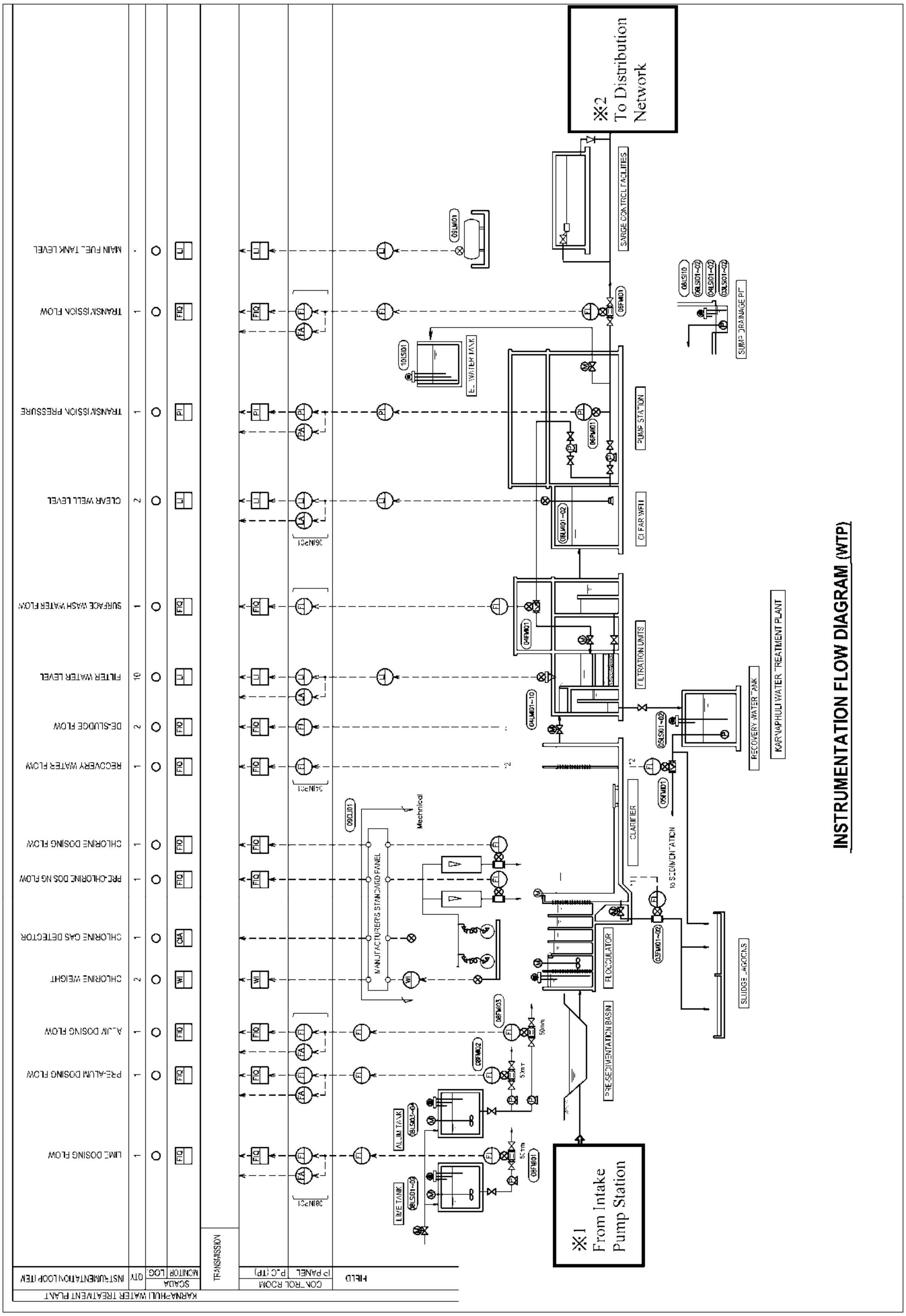


Figure 7.7.9 Instrumentation Flow Diagram in Karnaphuli WTP

7.8 Transmission Pipeline

(1) Outline of Transmission Pipeline

Transmission pipelines are planned for the two phases, as shown in Table 7.8.1.

Table 7.8.1 Outline of Transmission Pipeline

Pipeline Route		Diameter (mm)	Length (m)	Project	
Starting point	**End point**			**Phase 1**	**Phase 2**
Karnaphuli WTP	Nashirabad Reservoir	1200	24,400	x	x
Nashirabad Reservoir	Nashirabad Elevated Tank	1000	100	x	-
	Battali Hill Reservoir	1200 1000	5,000	x	-
	Halishahar Elevated Tank	1100	10,000	-	x

Note: x- included

(2) Transmission Pipeline from WTP to Nashirabad Reservoir

The road section from the WTP to Halda River (Madunaghat bridge) is out of Chittagong City Cooperation or CWASA's jurisdiction area. In this section the transmission pipeline from the WTP to Nashirabad Reservoir is planned along Kaptai road for both the Phase 1 and Phase 2 Projects, as shown in Figure 7.8.1.

The right of way for the Phase 1 pipelines was approved on October 3, 2012 by RHD, Ministry of Communication. The following are issues and problems in case of "off the road" construction being required, in the case that concurrence from RHD to construct the pipeline in the road is not obtained for the Phase 2 Project.

1) Social issues/problems: To work off the roadway will require the removal of Mosques, Graveyards, big houses, hundreds of trees, demolition of stores, filling in of ponds, removal of power poles, etc.
2) Technical issues/problems: The contractor would have to restrict his working periods to the dry season, which will be costly and extend the period of execution. The excavation will require sheet piling to prevent the soft soil from caving in. Additional restraining joints for the pipe are necessary due to the soft soil conditions. Dewatering of the trench will be required, as the water table is high.
3) Government sector targets and policy response: The Government sector objective in the National Strategy of supplying drinking water to the entire population by 2011 will be adversely affected in terms of service coverage and will result in sanitation problems and complaints from people.

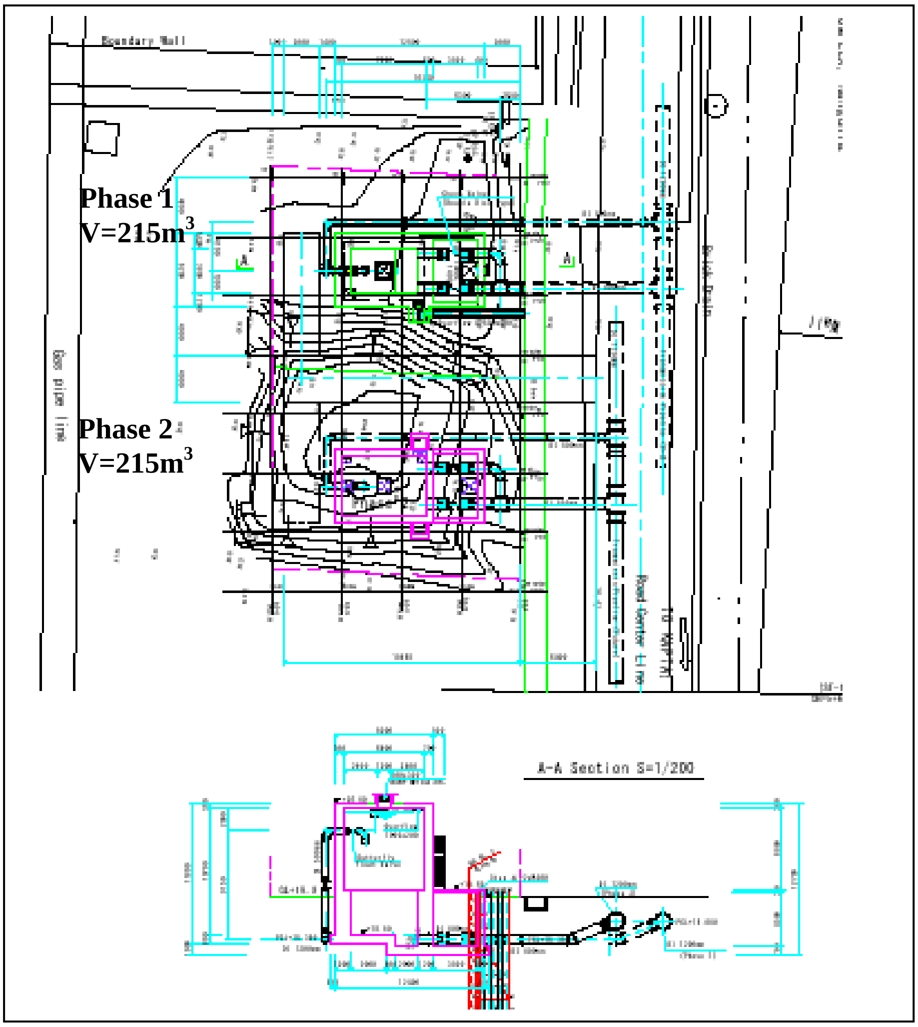


Figure 7.8.1 Location of Surge Tank and Transmission Pipelines

Concurrence from RHD on the right of way for the Phase 2 is urgent and the construction plan shall consider realistic and acceptable construction methods, adequate traffic control and public communication. Some faucet systems along the transmission pipeline shall be provided for the residents to mitigate complaints, as shown in Figure 7.8.2 and it is proposed that systems are provided at five locations, as shown in Figure 7.8.3. The faucets will be used by the people including not only the residents near the faucet systems, but also travelers. However, associations consisting of the residents near the faucet systems shall be established for the adequate use and O&M of the facilities under the leadership of CWASA. CWASA shall have a continuous talk with the associations before construction of the facilities.

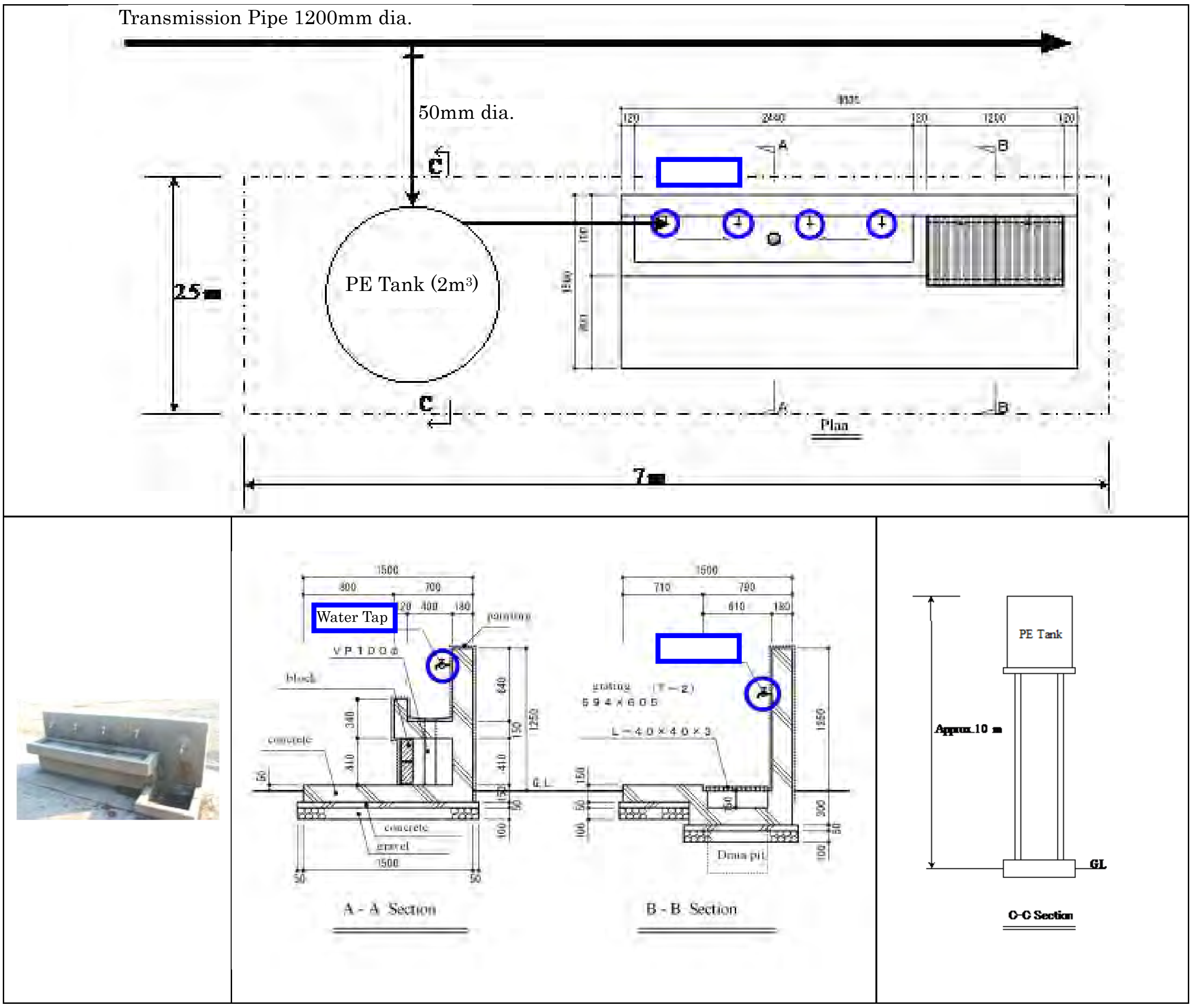


Figure 7.8.2 Faucet for Residents

Figure 7.8.3 Proposed Location of Faucet Systems

Regarding the Halda River crossing, the supports for the water bridge are provided in the Phase 1 Project, as shown in Figure 7.8.4. Only steel pipes will be required for the Phase 2 Project.

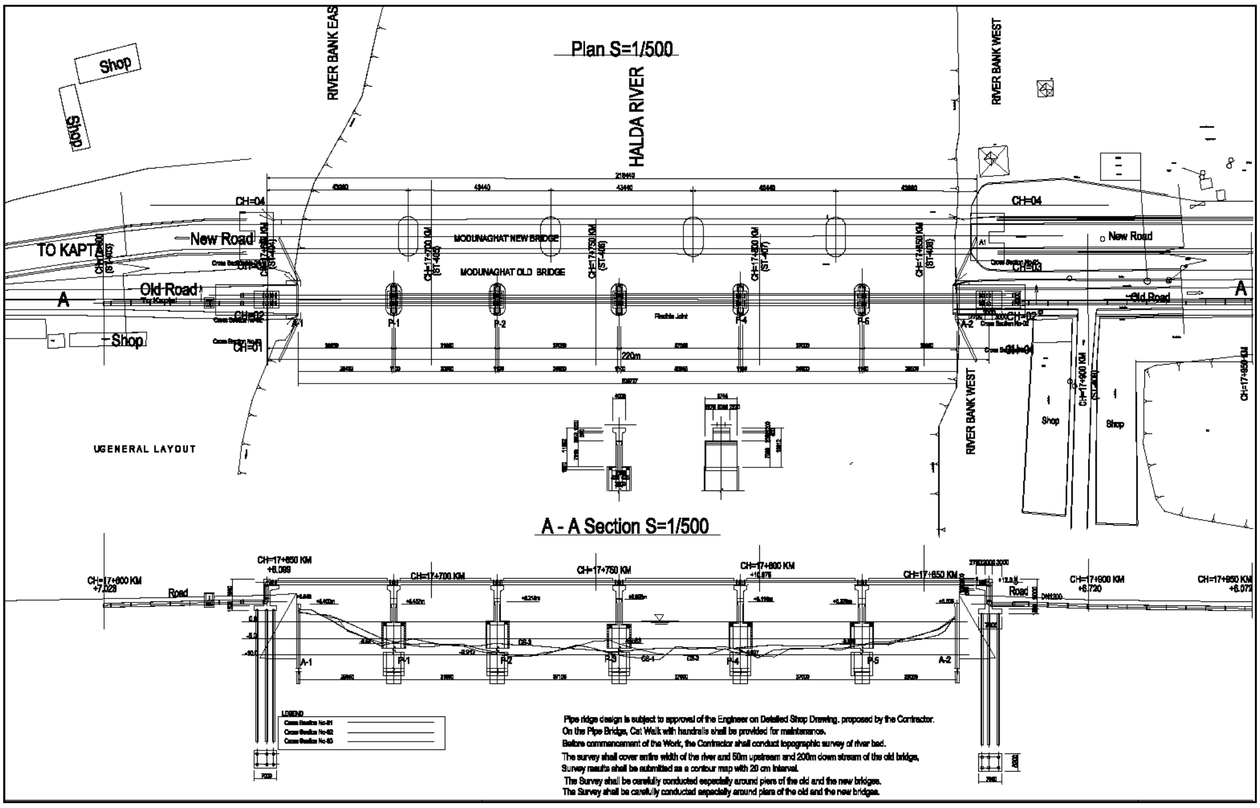


Figure 7.8.4 Water Bridge at Halda River Crossing

(3) Transmission Pipeline from Nashirabad Reservoir to Elevated Tank/Reservoir

As shown in Table 7.8.1 there are two transmission pipelines from Nashirabad Reservoir in Phase 1. These are to:

- Elevated Tank at Nashirabad Site
- Battali Hill Reservoir

A pipeline from the Nashirabad Reservoir to Halishahar Elevated Tank is proposed for the Phase 2 Project to supply the western area of the Karnaphuli service area. Figure 7.8.5 shows the transmission pipeline route and site conditions of this route are included in Supporting Report 7.8.1.

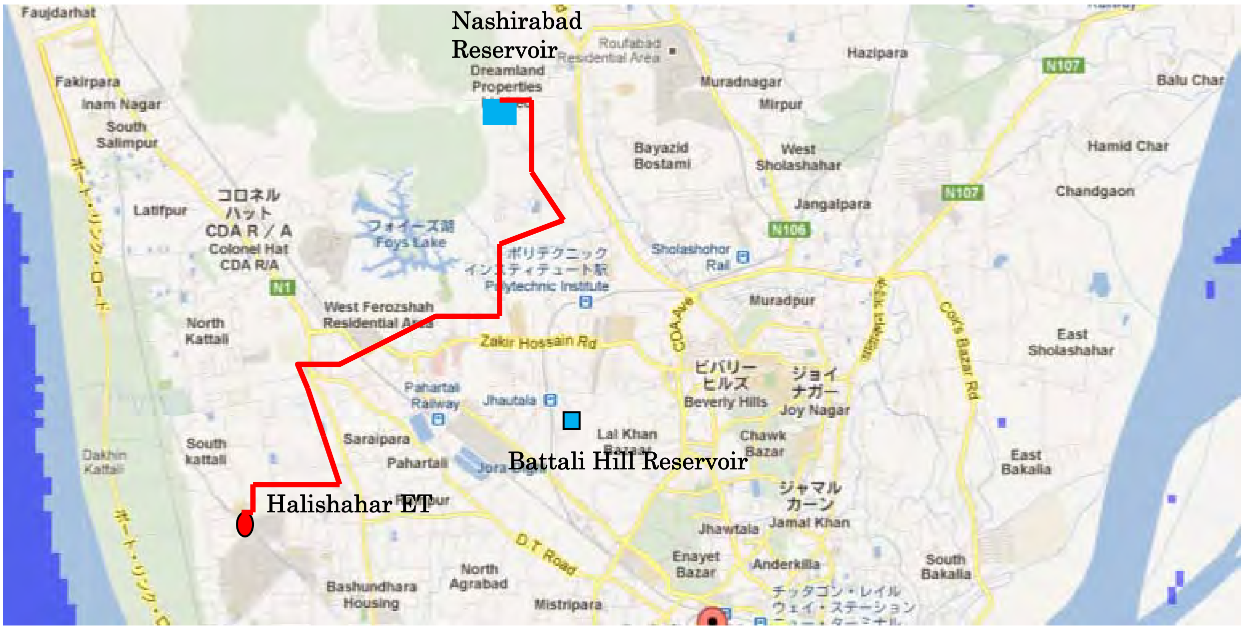


Figure 7.8.5 Transmission Pipeline Route from Nashirabad to Halishahar

7.9 Distribution Facilities

(1) Outline of Distribution System

The distribution system covers ten (10) Sectors and is divided into three (3) sub-systems, the northern, central and western areas. These areas are served by the Elevated Tank at Nashirabad site, Battali Hill Reservoir, and Halishahar Elevated Tank respectively, as shown in Figure 7.9.1.

(2) Nashirabad Reservoir

1) Civil Works

Nashirabad Reservoir with a capacity of 26,300m^3 is planned for the Phase 1 Project to achieve the function of storage of water to cater for the peak hour demand in the Karnaphuli service area. In the Phase 2 Project, augmentation of the reservoir up to a capacity of 51,100m^3 is needed, in accordance with the distribution plan in Chapter 6. Thus, a reservoir with a capacity of 24,800m^3 (= 51,100 – 26,300) is required in Phase 2, the location of which is shown in Figure 7.9.2. Figure 7.9.3 shows the Hydraulic Profile from Nashirabad Reservoir to the other Reservoir/Elevated Tank.

2) Mechanical Equipment

Table 7.9.1 shows the outline of mechanical equipment at the Pump Station at Nashirabad Reservoir.

Table 7.9.1 Distribution Reservoir Facility (Nashirabad Pump Station)

Facility Name	Design condition of Phase 2
For Nashirabad Elevated Tank	117,450 m^3/day (78,300m^3/day x 1.5)
For Battali Hill Reservoir	153,600 m^3/day (128,000m^3/day x 1.2)
For Halishahar Elevated Tank	119,550 m^3/day (79,700m^3/day x 1.5)

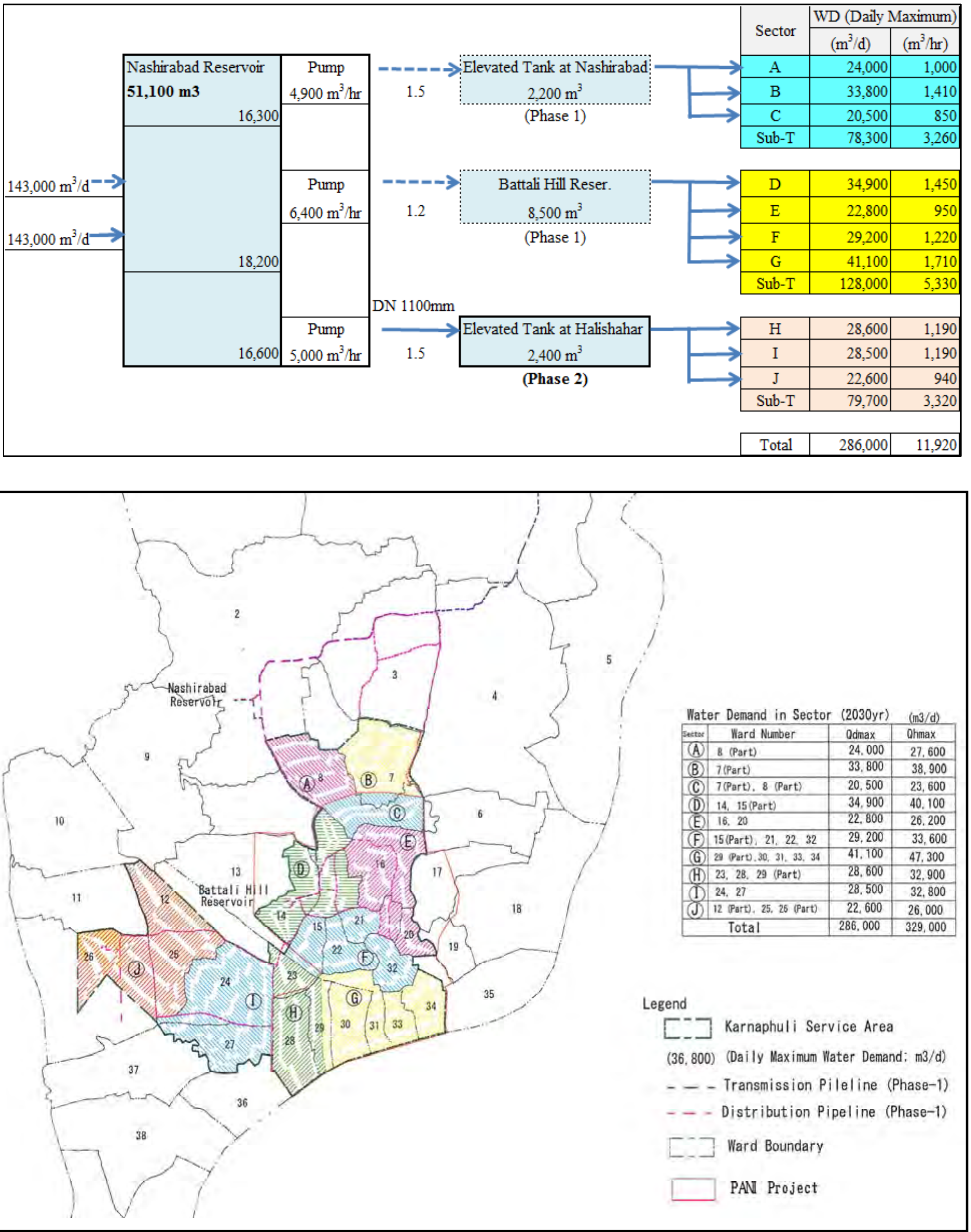


Figure 7.9.1 Schematic Plan of Distribution System and Locations of Sectors

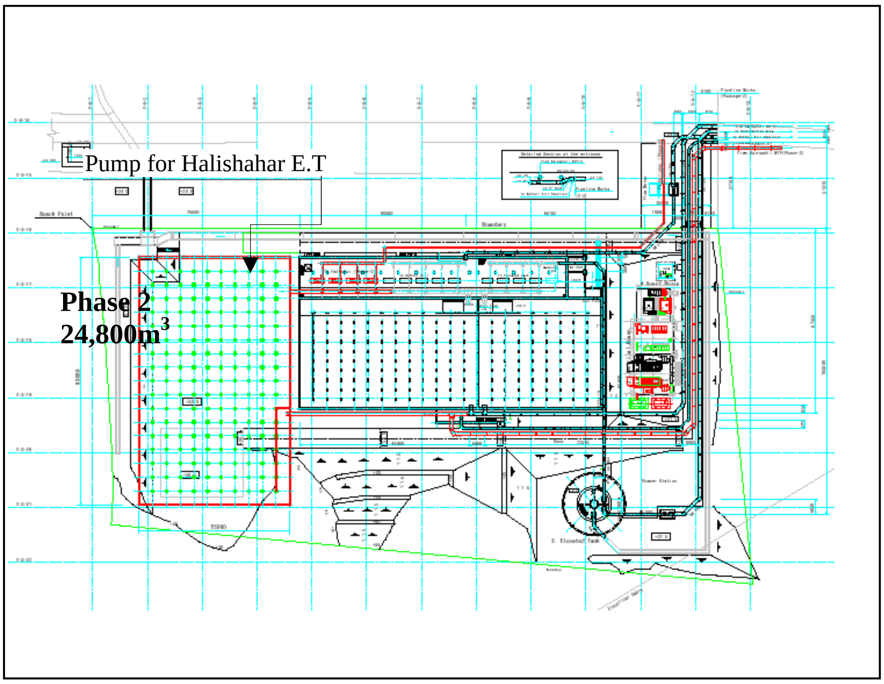


Figure 7.9.2 General Layout Plan of Nashirabad Reservoir for Phase 2 Project

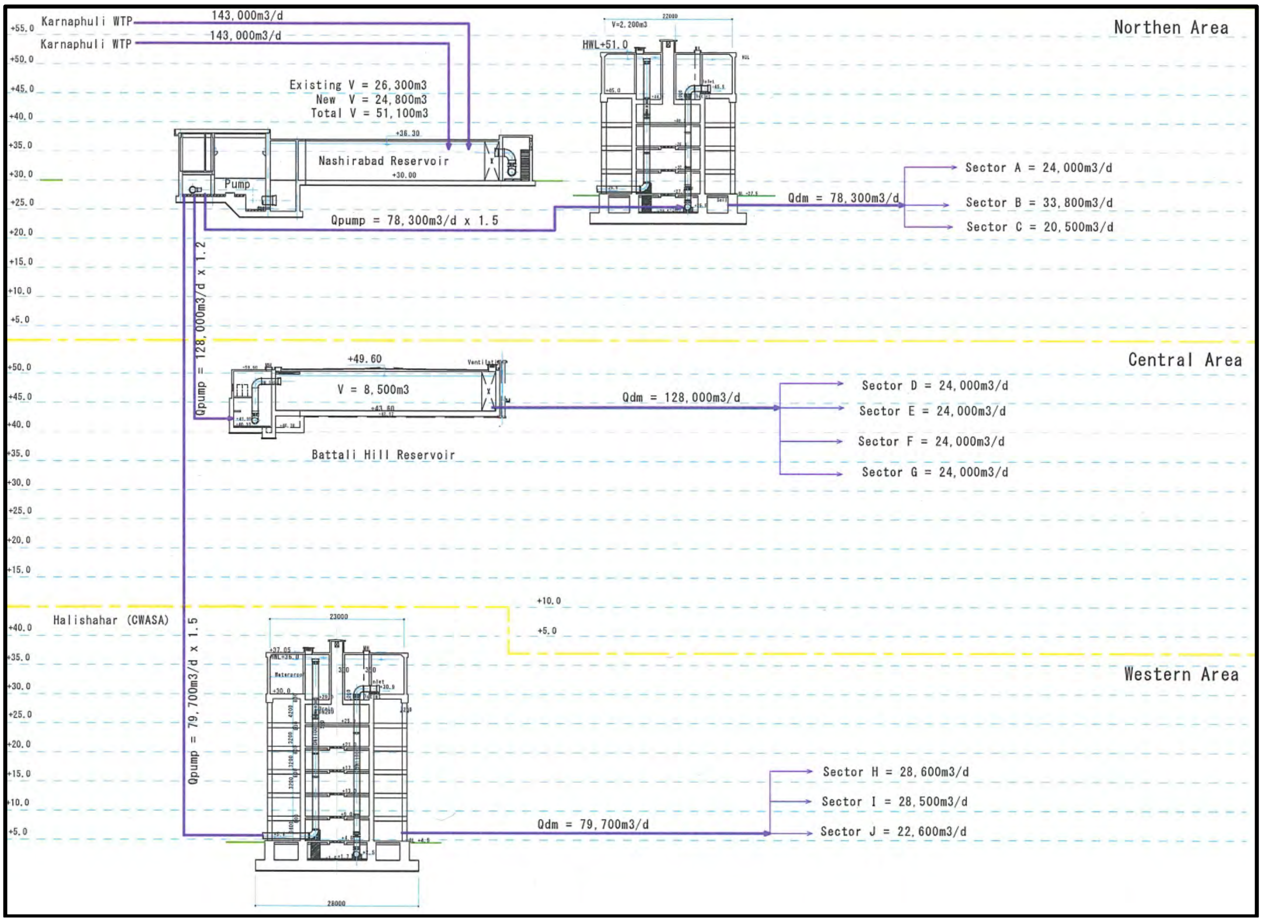


Figure 7.9.3 Hydraulic Profile from Nashirabad Reservoir to Other Reservoir/Elevated Tank

Additional mechanical equipment for Phase 2 at Nashirabad Elevated Tank is not necessary, since it will be equipped under the Phase 1 Project. Regarding the transmission pumps to Battali Hill Reservoir, the five pumps which are planned in phase 1 cannot be used in Phase 2 because both the pump flow capacity and hydraulic head are to be increased in accordance with the planned distribution area in Phase 2. Thus, five new pumps shall be installed to meet the planned capacity for Phase 2. Fortunately, all pumps planned for Battali Hill in Phase 1 will be able to be used as the pumps for transmission of water to Halishahar Elevated Tank. The five transmission pumps planned for Battali Hill in Phase 1, which include one standby and one in stock, are arranged as transmission pumps to Halishahar Elevated Tank. The required equipment at Nashirabad Pump station is summarized in Table 7.9.2.

Table 7.9.2 Transmission Pumps to be installed at Nashirabad Pump Station

Item	Specification	Phase 1	Phase 2
Transmission Pump to Nashirabad ET	Horizontal double suction volute $54m^3$/min x 26 m x 315kW	4 units including 2 standby	-
Transmission Pump to Battali Hill	Horizontal double suction volute $29m^3$/min x 33 m x 220kW	5 units including 2 standby	(all pumps will be relocated to supply Halishahar Elevated Tank)
Transmission Pump to Battali Hill	Horizontal double suction volute $36m^3$/min x 38 m x 320kW	-	5 units including 2 standby (proposed)
Transmission Pump to Halishahar	Horizontal double suction volute $28m^3$/min x 28 m x 220kW	-	5 units including 1 standby and 1 stock (re-installed Battali Hill pumps of phase 1)

3) Electrical Equipment

a) Main Power Supply

The main power supply for Phase 1 is double (duty-standby), 11kV, 50Hz, supplied by PDB connecting to a 11kV/3.3kV transformer. The incoming line is reliable due to the dual incoming power supply. However, the capacity of the transformer only covers the Phase 1 needs.

An additional transformer and connection breakers are required for the Phase 2 project. The necessary space including concrete foundation work is considered and allowed for in the Phase 1 Project. The transformer shall be of the outdoor, oil immersed, and natural cooling type.

b) Emergency Power Generation

Standby diesel engine generator capacity to operate all of the duty transmission pumps is provided in the Phase 1 Project. An additional generator set is required for the additional transmission pumps. The capacity and type of generator shall be the same as for Phase 1. The additional generator sets can be accommodated in the building provided in the Phase 1 Project. Figure 7.7.4 shows the single line diagram to show the scope of the Phase 2 Project.

c) Electrical Room

Two electrical rooms were planned in the Phase 1 project, one in the Electrical Building and other in the Transmission Pump Station. In the Phase 2 project, 3.3kV switchgear and LV transformer and LV distribution board shall be installed in the Electrical Building, and pump starters and motor control centre shall be installed in the Pump Station. Both electrical rooms are able to accommodate additional equipment without expansion work.

d) SCADA and Instrumentation

A SCADA system at Nashirabad Reservoir is included in Phase 1. The system is connecting to the SCADA system at the WTP by optical cable and it is possible to conduct comprehensive monitoring from the intake to distribution system. Additional facilities in Phase 2 should be incorporated into the Phase 1 SCADA system using same type of PLC. The software of the SCADA system should also be the same as that of Phase 1.

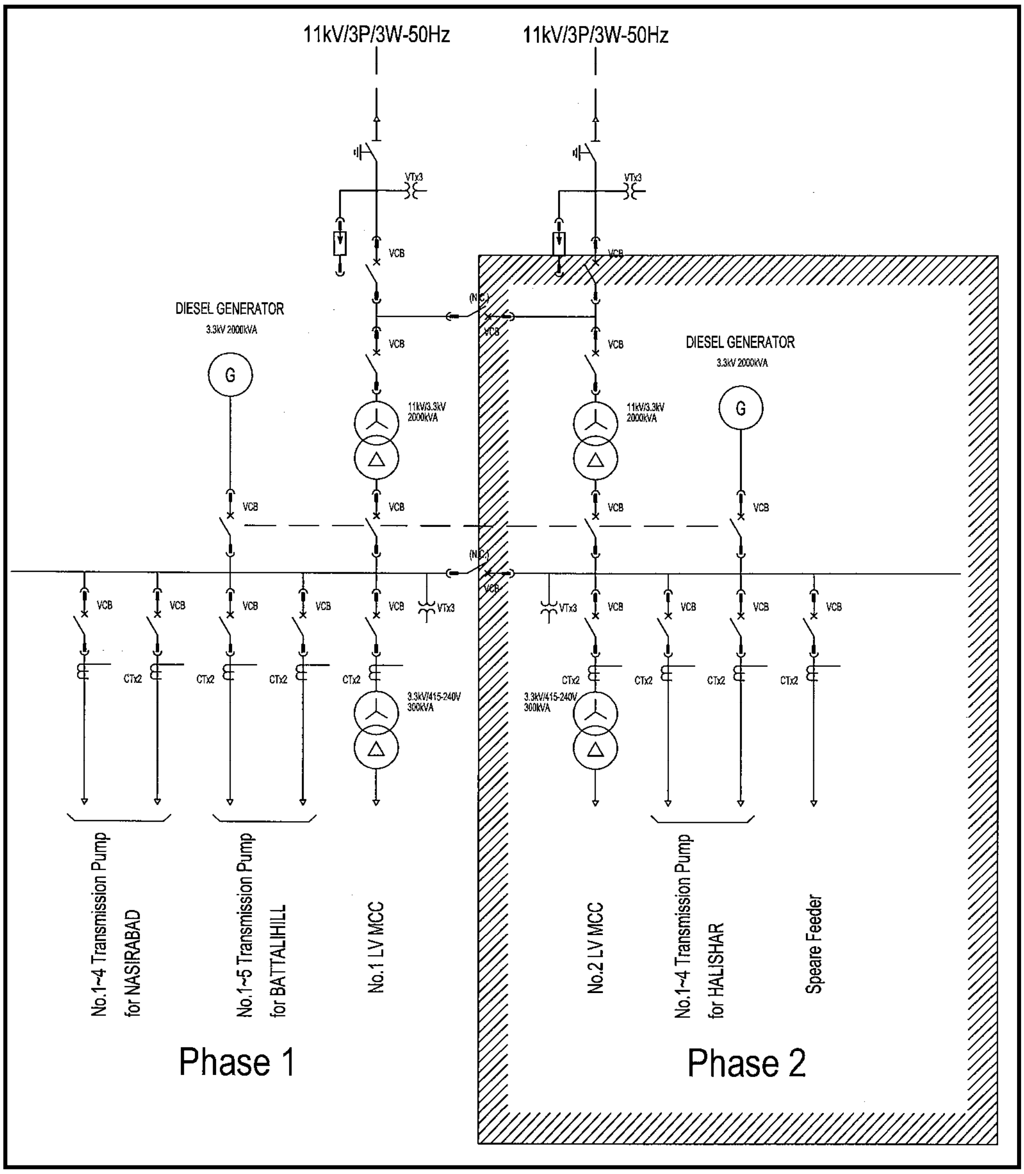


Figure 7.9.4 Single Line Diagram for Nashirabad Reservoir

Table 7.9.3 summarizes the major electrical equipment for Phase 2 Project.

Table 7.9.3 Summary of Major Electrical Equipment

Equipment	Feature
33/3.3kV Transformer	Oil
3.3kV Switchgear	VCB
3.3kV pump starter	VFD drive
Transmission MCC	400V Form 3b
Local Operation Panel	Stand type
Reservoir Level Measurement	Submersible type
Distribution Flow Measurement	Electromagnetic
PLC/RTU	Open protocol (Profibus)
SCADA System	Modification and up-grading
Standby Generator	Diesel engine, radiator cooling

(3) Battali Hill Reservoir

Battali Hill Reservoir with a capacity of 8,500m^3 is constructed in the Phase 1 Project (Refer to General Layout of the Reservoir in Figure 7.9.5). The inlet pipe diameter to the reservoir is from DN1000mm to DN1200mm because of the very narrow access road to the reservoir. Two distribution pipelines are connected to the reservoir in Phase 1 (DN 500mm and the exiting DN900mm). The water levels in the reservoir are LWL +43.6 m and HWL +49.6m. The Inlet Chamber for Sector D will be constructed at DN500mm in Phase 1.

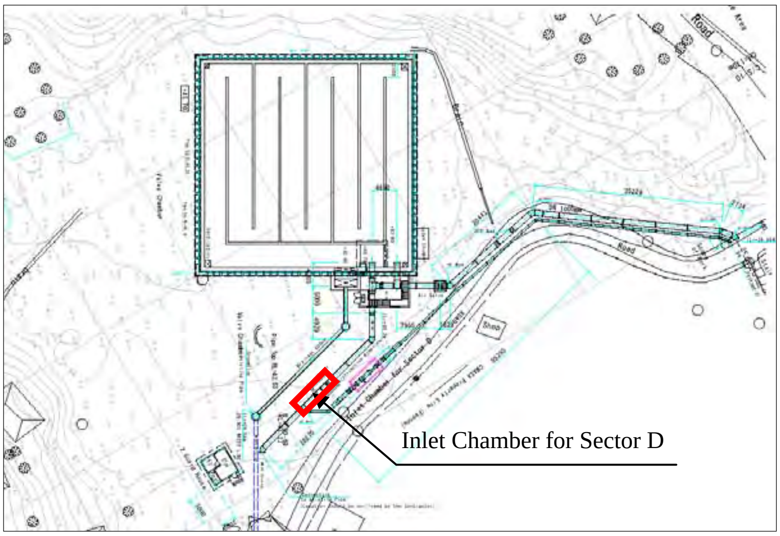


Figure 7.9.5 General Layout Plan of Battali Hill Reservoir

(4) Elevated tank at Nashirabad site

An Elevated Tank at Nashirabad site with a capacity of 2,200m^3 is constructed in the Phase 1 Project. The planned water levels in the tanks are LWL +45.0m and HWL +51.0m. Figure 7.9.6 shows the general layout of the Elevated Tank.

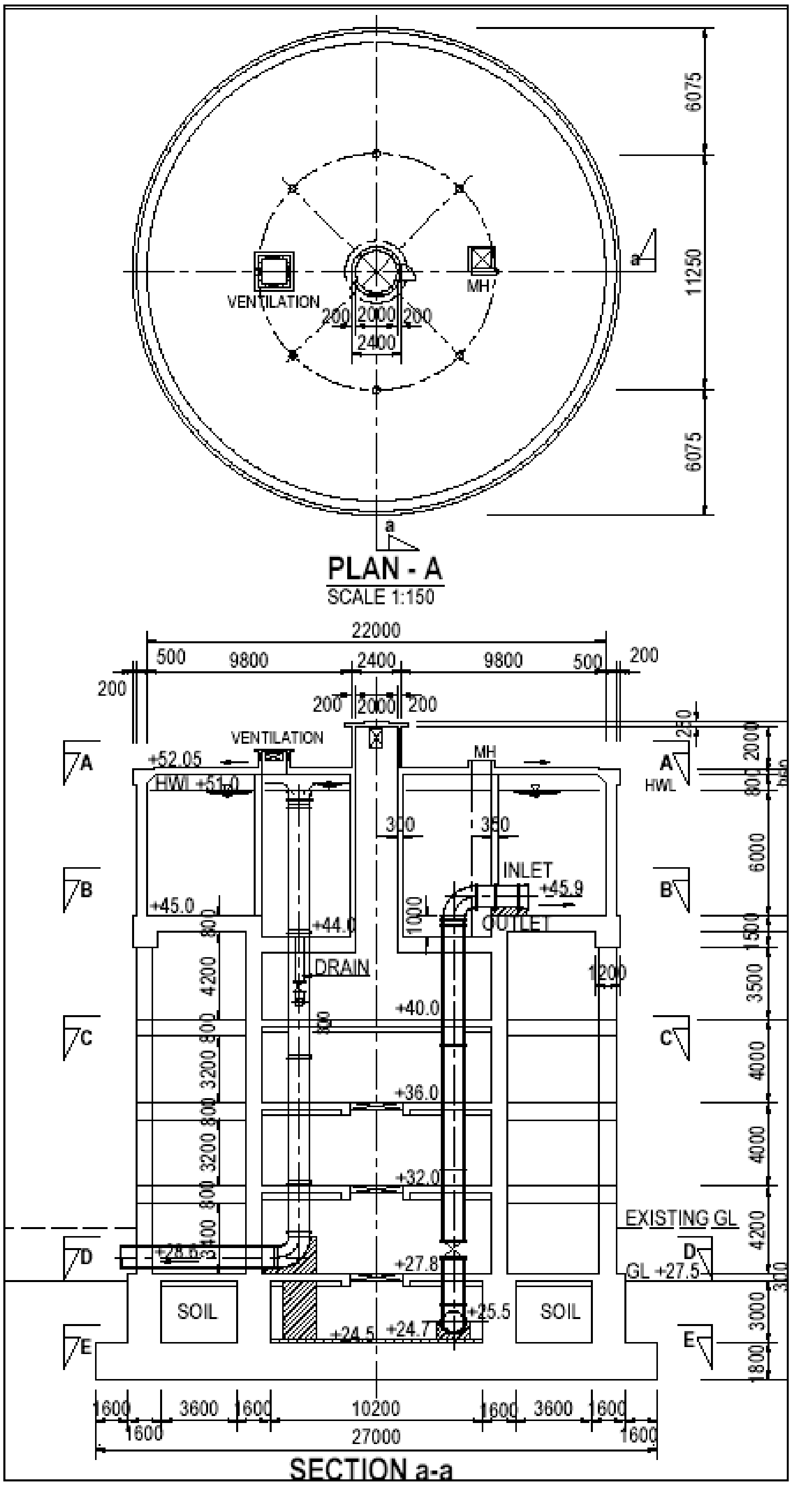


Figure 7.9.6 General Layout of Nashirabad E.T.

(5) Elevated tank in Halishahar

Halishahar Elevated Tank (capacity 2,400m^3) will be constructed in the Phase 2 Project and it will be located on CWASA owned property, as shown in Figure 7.9.7.

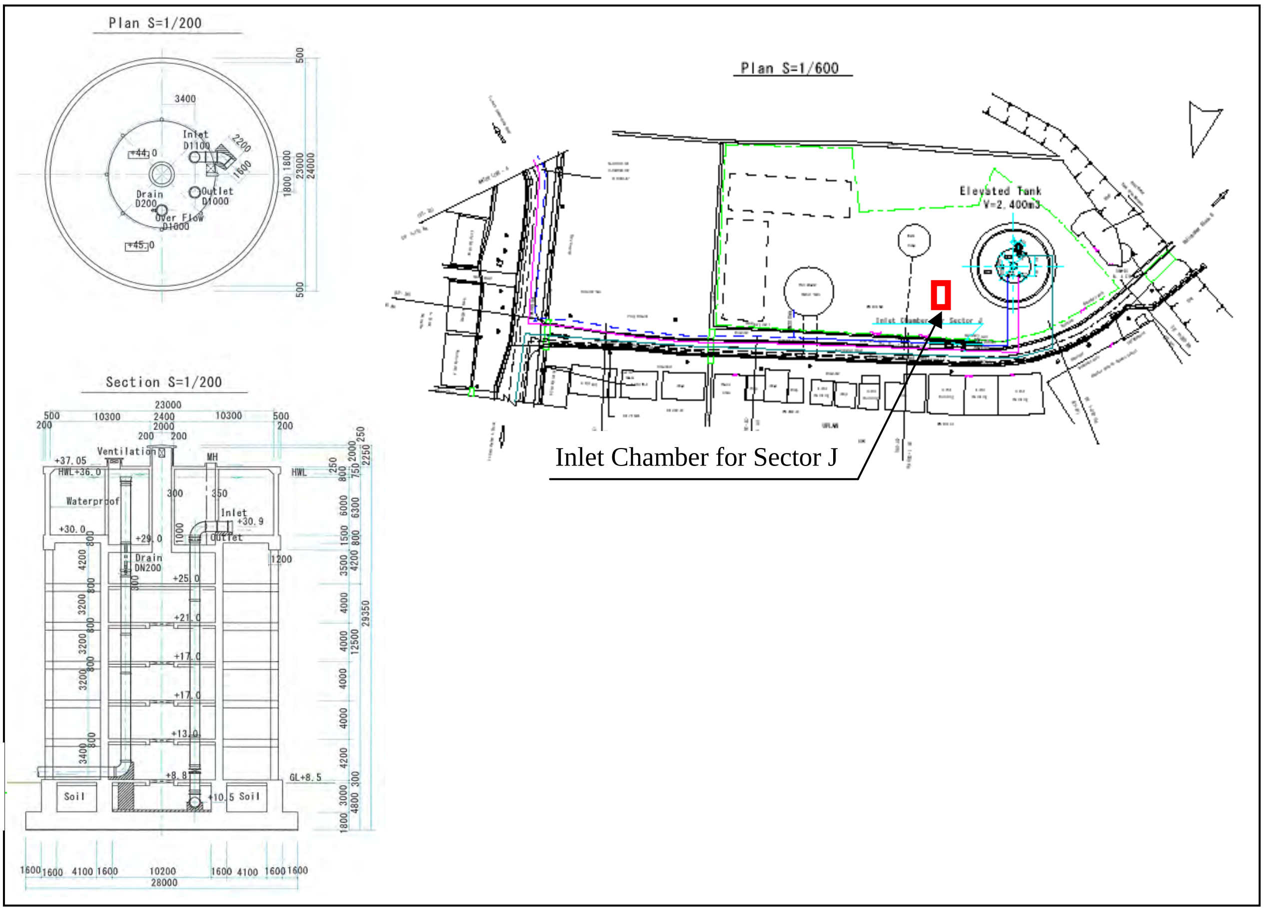


Figure 7.9.7 General Layout Plan of Halishahar Elevated Tank

7.10 Distribution Pipeline

(1) Distribution pipelines in Phase 1

Water (143,000m^3/d) produced from Karnaphuli WTP is planned to be distributed mainly to the Fatehabad, Nashirabad, Agrabad, Madarbari, Kotowari, and Halishahar areas via Nashirabad Elevated Tank and Battali Hill Reservoir by connecting with the existing pipes to meet the water demands in 2010, as shown in Figure 7.10.1.

(2) Distribution pipelines in Phase 2

Water from the three (3) main distribution facilities, namely the Elevated Tank at Nashirabad site, Battali Hill Reservoir and Halishahar Elevated Tank, is distributed to ten (10) sectors (A to J), as shown in Figures 6.2.6 and 6.2.7. Furthermore, water is supplied to District Metered Areas (DMAs), as described in Chapter 6.

Table 7.10.1 shows the approximate length of distribution pipelines for the Phase 2 Project, from the distribution reservoir/elevated tank to the sector inlet valve, from the sector valve to the DMAs, and within the DMAs in the Karnaphuli Service Area.

Water delivery to the slum areas in KSA will be arranged through discussions between CWASA and communities established by the people in each slum area (about 50 groups exist in CCC area). Depending on the request from communities, service connections or faucets will be installed for them, extending from the main pipes to be constructed in the Phase 2 Project.

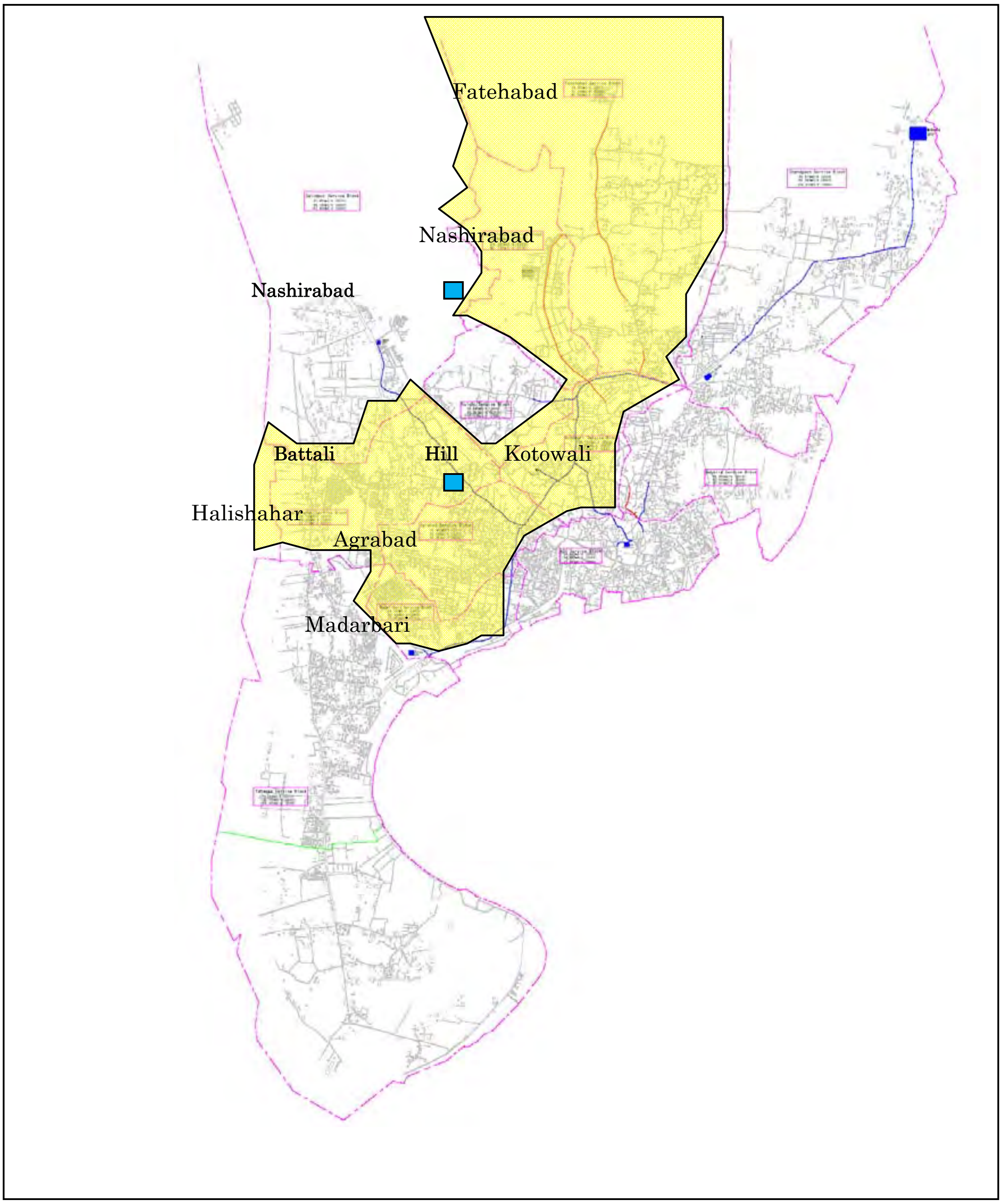


Figure 7.10.1 Water Supply Area in Phase 1

Table 7.10.1 Length of Distribution Pipeline in KSA

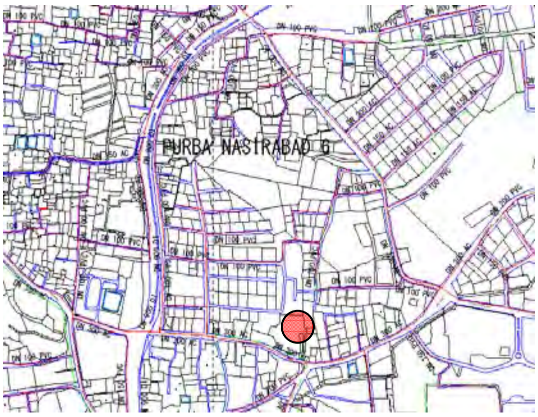
Unit: m

	Upstream to Sector Valve					Downstream of Sector Valve to DMA							DMA
Dia. (mm)	1000	900	800	700	600	800	700	600	500	400	300	200	150/100
Length	5,367	2	2,428	91	44	1,058	668	4,776	2,968	5,056	18,05	74,883	367,560
Breakdown													
A Sector						0	0	0	167	0	2,161	5,989	23,040
B Sector	0	0	1,417	74	0	0	161	867	816	385	918	4,065	25,920
C Sector						105	0	0	216	1,472	1,094	2,001	18,960
D Sector						0	0	0	833	167	2,662	5,866	42,240
E Sector	1,185	2	86	0	44	0	0	0	692	127	660	6,444	25,920
F Sector						0	0	559	0	0	3,007	5,468	26,400
G Sector						893	0	1,240	244	427	3,211	6,305	51,000
H Sector						60	0	1,581	0	1,162	1,798	5,168	30,840
I Sector	4,182	0	925	17	0	0	507	529	0	1,046	1,354	11,382	42,720
J Sector						0	0	0	0	270	1,189	22,194	80,520
Sub -total	7,932					107,464							367,560
Total	482,956 →483km												

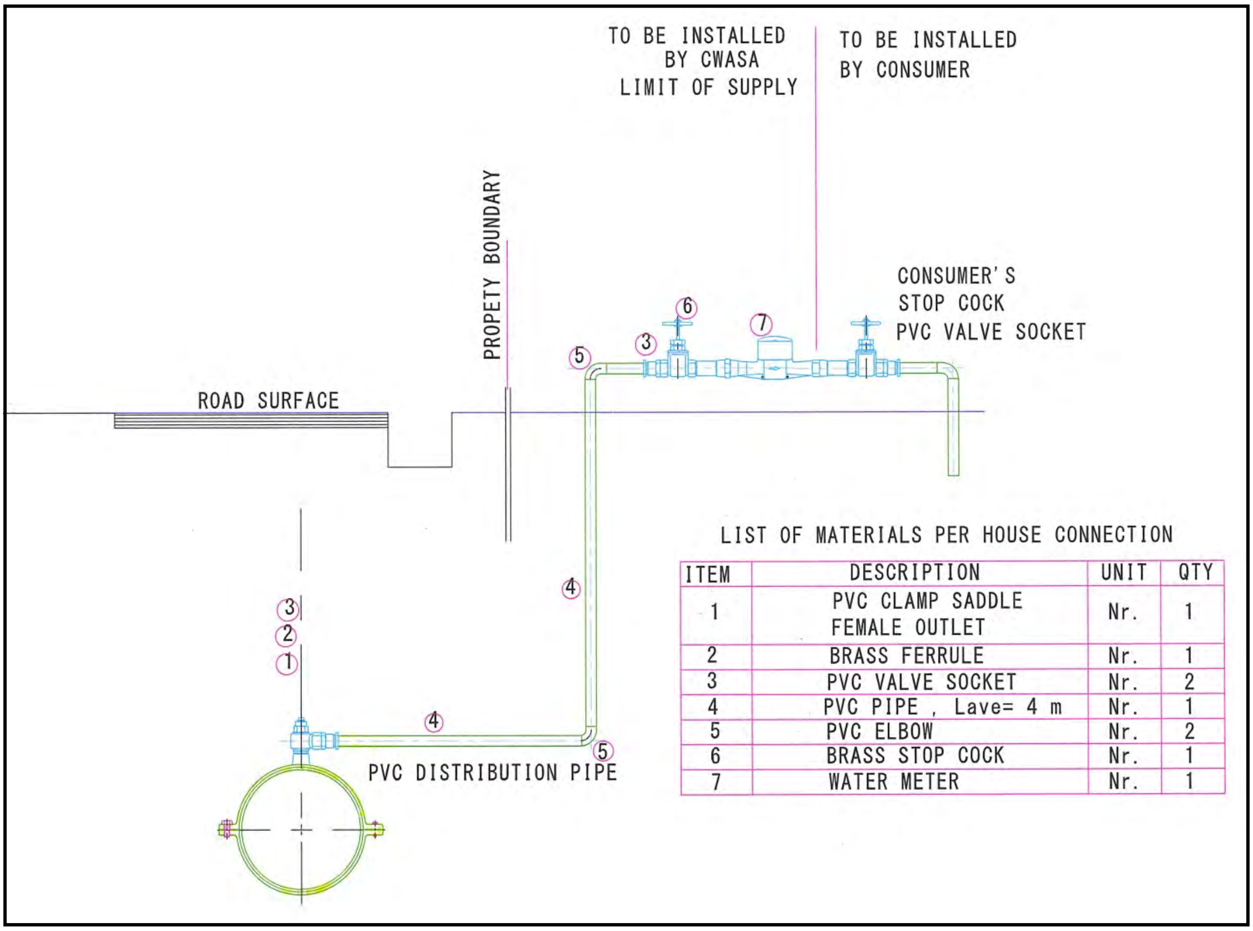
Note: Pipe length in DMA is calculated in assumption of 120m/ha,
The total amount may not be the same as the sum, due to the round off.

(3) Service Connections

In the present situation, service pipes are sometimes laid in U shape drainage channels, as shown in the following Photo, which may result in supplied water being polluted and also reduce the capacity of the drainage channels. Therefore, new distribution pipes in the DMAs should be laid in the road near to housing, businesses, etc. and the length of the service connection pipes should be minimized, as shown in Figure 7.10.2.

Location of Photo	Example of Present Service Connection Pipe
	

Photograph on Existing Service Connections, where is without distribution pipeline



ITEM	DESCRIPTION	UNIT	QTY
1	PVC CLAMP SADDLE FEMALE OUTLET	Nr.	1
2	BRASS FERRULE	Nr.	1
3	PVC VALVE SOCKET	Nr.	2
4	PVC PIPE , Lave= 4 m	Nr.	1
5	PVC ELBOW	Nr.	2
6	BRASS STOP COCK	Nr.	1
7	WATER METER	Nr.	1

Figure 7.10.2 Proposed Service Connection

7.11 Water Distribution Control System

(1) General

For the purpose of enhancing equitable distribution, the Karnaphuli Service Area is divided into at 10 numbers of hydraulically independent 'Sectors'. Each Sector will have only one inlet which is provided with a flow meter, a pressure gauge and a pressure regulating valve. Flow and pressure measurement data will be transmitted through the SCADA system to the Central Control Room, which is located at the Karnaphuli WTP for monitoring and recording purposes on a 24/7 basis. Pressure regulating valves will automatically adjust the pressure at the outlet to match a set point, which can be changed by operators in the Central Control Room. The set points for each Sector will be initially determined based on hydraulic analyses, but will be changed later by taking actual pressure conditions within each Sector into consideration.

For the effective control of non-revenue water, each Sector will be further divided into a number of small District Metered Areas (DMAs). On average, each DMA will be sized to accommodate approximately 2 to 3 kilometers of distribution pipes. DMAs will be so designed that whenever it is necessary they can be hydraulically isolated from the rest of the distribution network by closing 3 to 4 valves at known locations. In principle, each DMA will have only one inlet which is provided with proper arrangements for the measurement of minimum night flows.

(2) Control/monitoring of Sector

1) Monitoring and flow/pressure control

a) Control and monitoring of each distribution sector

A flow meter, pressure gages (primary and secondary) and a pressure regulating valve will be installed in each distribution sector and they will be monitored and controlled at the Karnaphuli WTP utilizing the SCADA System which was adopted in Phase 1 project.

b) Method of monitoring and control

Auto Monitor and Auto Control will be adopted.

Monitor: Flow and pressure data will be transmitted to the Control Room of the Karnaphuli WTP through dedicated fiber-optic cables.

Control: A pressure regulating valve is controlled automatically by PLC to keep certain pressure.

c) Distribution system

Treated water at Karnaphuli WTP is transmitted to Nashirabad Reservoir at first and then reserved at Nashirabad Reservoir, then transmitted to the service reservoirs by transmission pumps. Water in the service reservoir is distributed to each distribution sector by gravity. The number of sectors is ten and the pipe size ranges from 500mm to 800mm, so the valve chamber will be relatively large due to the requirement to install an electromagnetic flow meter and a pressure regulating valve. A valve chamber shall be newly constructed under the road.

Figure 7.11.1 shows the schematic flow for Monitoring and Control of the water supply system. Monitoring of entire water supply system will be made and required control will be provided from the intake to the distribution system. The Instrumentation Flow Diagram for the entire water supply system is shown in Figure 7.11.2.

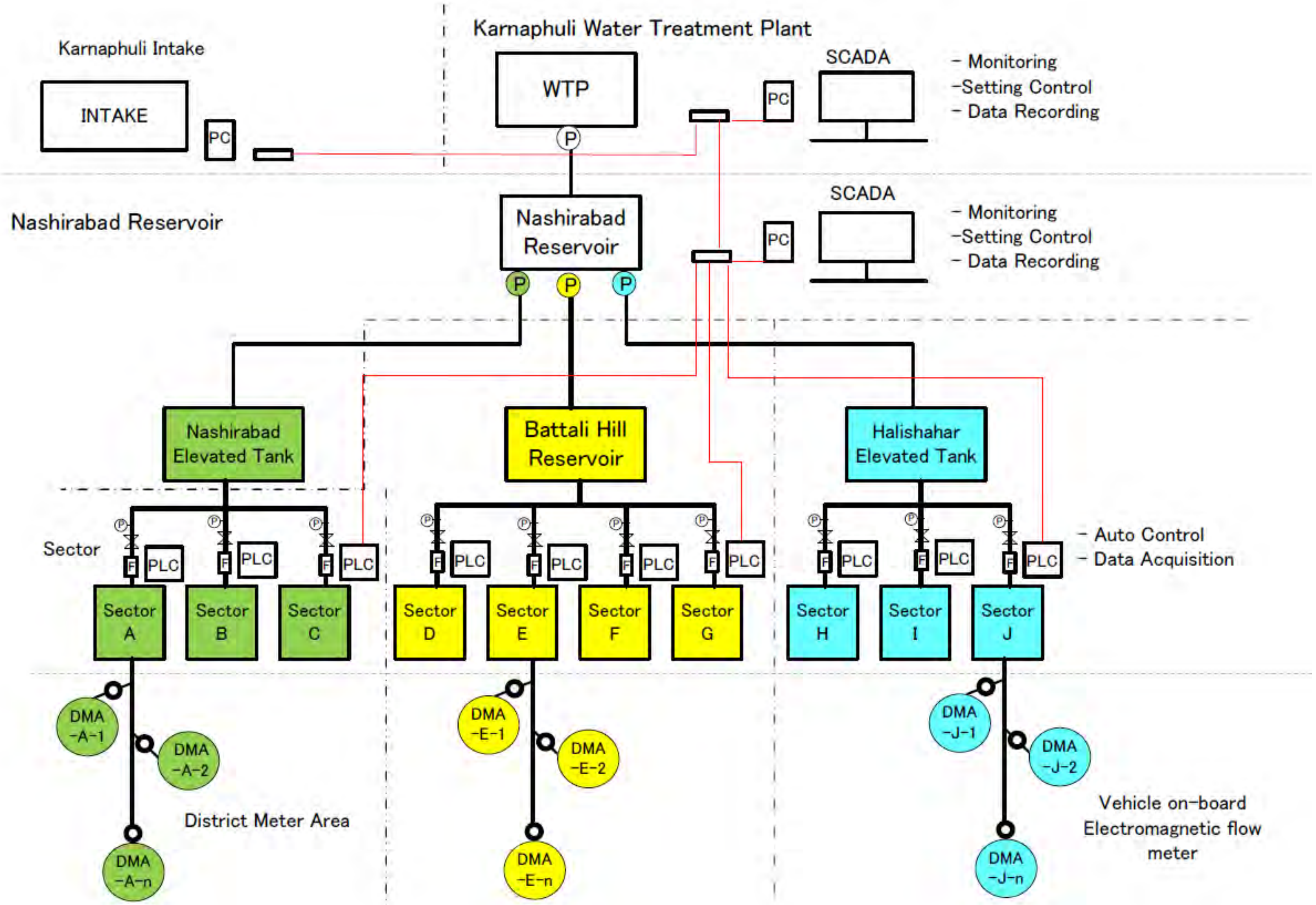


Figure 7.11.1 Schematic Flow of Water Supply and Distribution Control System

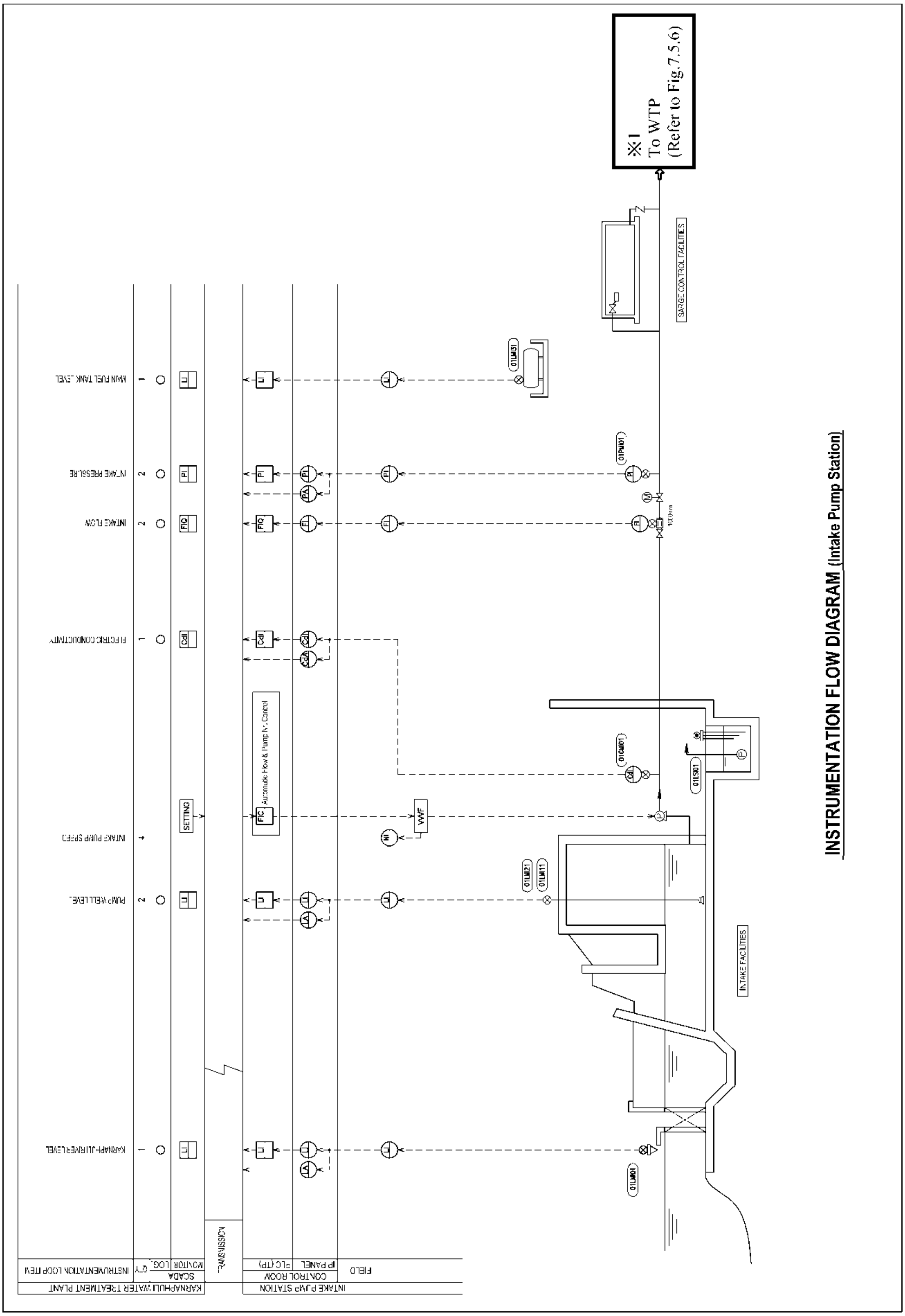


Figure 7.11.2 (1) Instrumentation Flow Diagram for Water Supply System

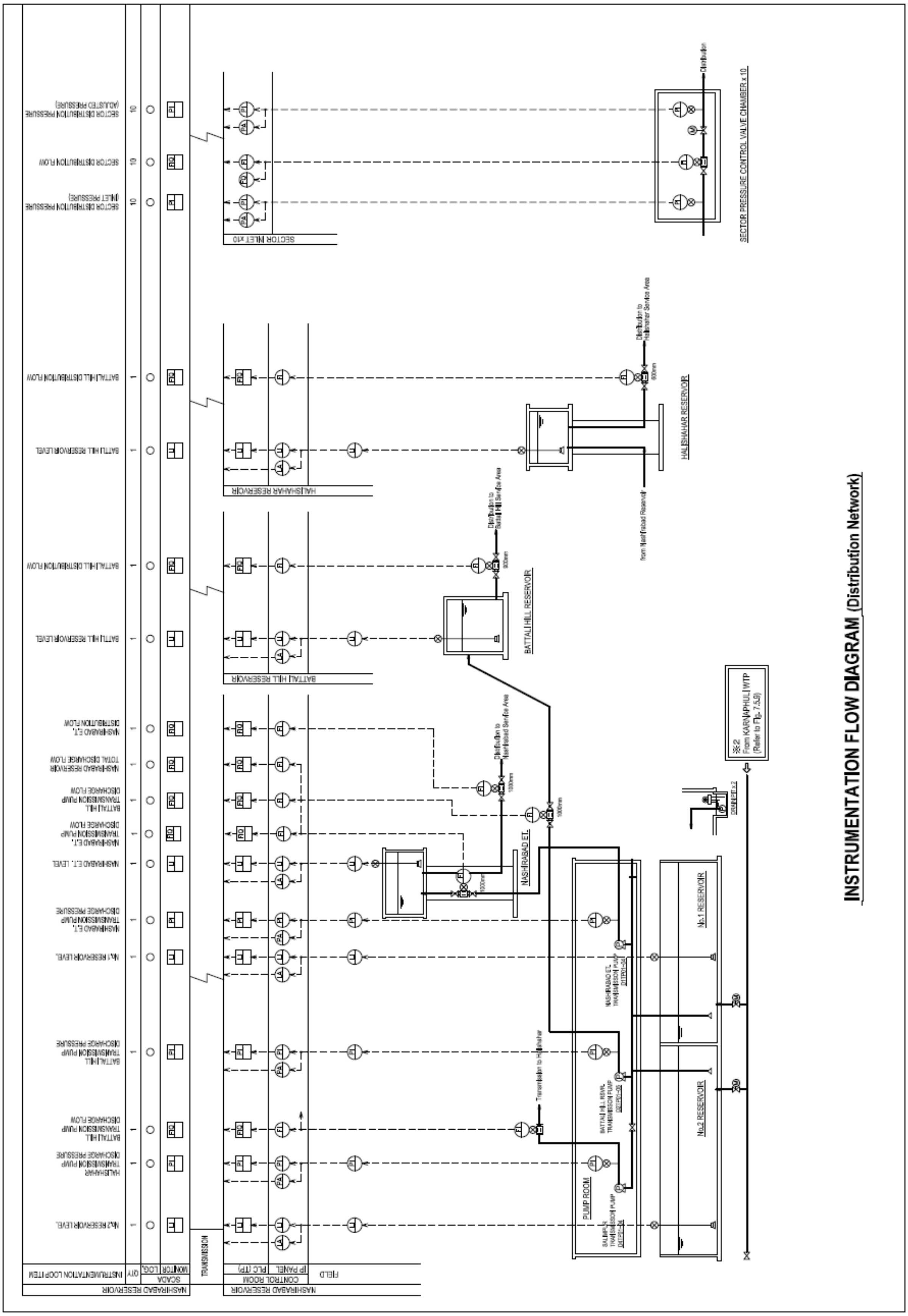


Figure 7.11.2 (2) Instrumentation Flow Diagram for Water Supply System

(3) Measurement point at the inlet of sector and the district metered area

The required size of a valve chamber at the inlet to a sector will be 2m x 6.2m x 2.5m depth and all chambers shall be located in/adjacent to a main road. In addition, an area of 1m x 2.5m for a control panel will be required on the ground near each valve chamber.

In Chittagong city, main roads in low lying areas are always inundated in heavy rain, which might cause problems for equipment such as the flow meter and pressure gauge inside the sector inlet chamber. In this connection, design of sector inlet chamber should be carefully prepared by considering the following:

- To prevent the rain water inflow to the chamber
  For example, Level of manhole slab shall be higher than ground level or to use the sealed manhole cover.
- To select waterproof equipment etc.
- To prepare the ventilation

Table 7.11.1 shows a summary of the Sector Inlet Chamber at each Sector regarding the possibility of inundation and necessity for special countermeasures such as the provision of water sealed manhole/water proof equipment, etc.

Table 7.11.1 Summary of Sector Inlet Chamber to each Sector

	Location	Pipe (mm)	G.L (m)	Possibility of inundation	Necessity for Special Countermeasures
Sector A	Baizid Bostami Road	DN700	+15.0	No	No
Sector B	CDA Avenue	DN800	+4.5	Yes	Yes
Sector C	Ditto	DN700	+4.5	Yes	Yes
Sector D	Battali Hill Reservoir Site	DN500	+45.0	No	No
Sector E	S.S Khaled RD	DN500	+17.0	No	No
Sector F	Tigerpass RD	DN600	+15.0	No	No
Sector G	Ditto	DN800	+13.0	No	No
Sector H	Agrabad	DN800	+7.0	Yes	Yes
Sector I	Halishahar RD	DN700	+3.0	Yes	Yes
Sector J	Halishahar Elevated Tank Site	DN700	+3.0	Yes	Yes (Manhole level of Chamber should be higher than G.L)

Figure 7.11.3 shows the location of a sector inlet chamber and DMA inlet chamber in one sector, as well as typical details of the chambers.

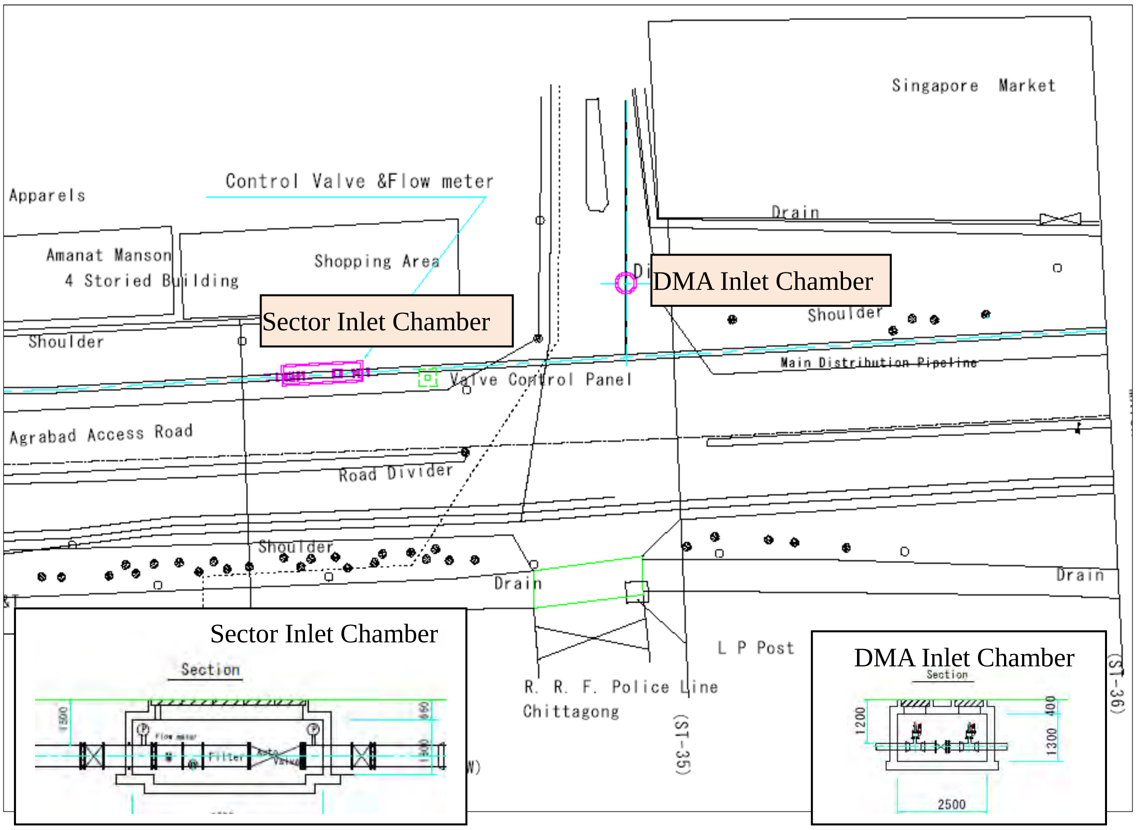


Figure 7.11.3 Location of the Manholes at Sector Inlet and the District Metered Area

To measure the flow to each DMA, measuring man-hole will be installed as shown in the above figure. The most suitable measurement method(s) will be determined when the distribution pipelines are designed. At the moment, the number of DMA is estimated at about 190 assuming that one DMA covers about 3-4km of distribution pipeline or about 16 ha. The flow meter shall be a vehicle on-board electromagnetic flow meter type considering high accuracy and easy measuring.

Figure 7.11.4 shows the location of Sector Inlet Chambers for Sectors A to Sector J.

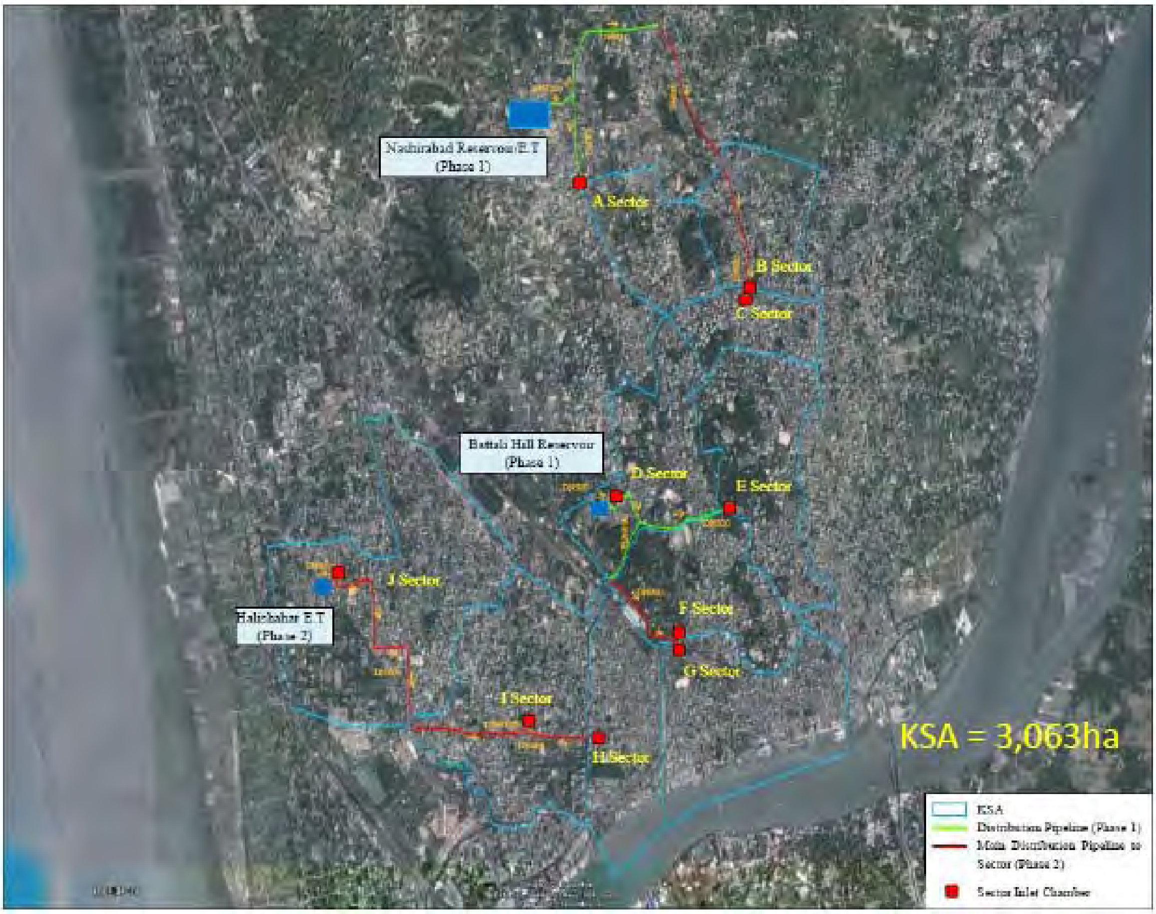


Figure 7.11.4 Location of Sector Inlet Chamber

CHAPTER 8

CONSTRUCTION PLAN OF WATER SUPPLY FACILITIES

CHAPTER 8 CONSTRUCTION PLAN OF WATER SUPPLY FACILITIES

8.1 General

The construction plan for the Phase 2 Project is planned considering environmental and social impacts and security problems during the construction work. Major problems are construction boundary, access road, stock yard, safety/security countermeasures. The required arrangements for construction methods are also included for important items of work. However, those items common to the Phase 1 Project are basically omitted.

The following sub-sections present the plan for the construction of the major water supply facilities.

8.2 Intake/Conveyance Facilities

8.2.1 Intake Facility

The access road which is connected from the existing road to the construction site shall be maintained for CWASA staff and the contractor for the Phase 2 Project, as shown in Figure 8.2.1.

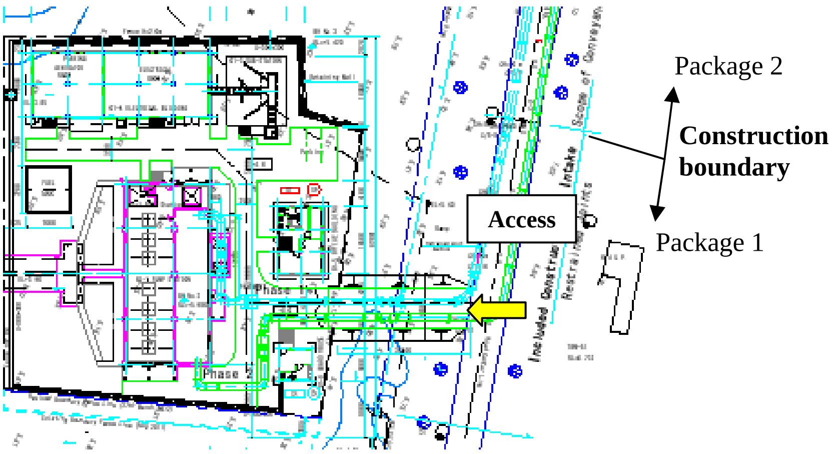


Figure 8.2.1 Access Road to Intake Site from Existing road

(Refer to Package in Chapter 11)

Civil and Architectural facilities with a capacity of 300,000m^3/d are constructed in Phase 1; therefore, only two units of intake pumps with a total capacity of 150,000m^3/d and related electrical equipment will be installed in this phase. The construction boundary of the yard piping as well as the conveyance pipe will be clearly demarcated, as shown in Figure 8.2.1.

Connections to the Phase 1 facilities (for example electrical works) shall be carried out such that the facilities operate continuously (except for short term interruptions to the power supply). In case that the power supply has to be interrupted, the standby generator provided under Phase 1 shall be utilized. It is considered that interruptions would be approximately 1 hour duration and that the works could be undertaken with one interruption to the supply.

8.2.2 Conveyance Pipeline

The conveyance pipeline from the Intake to the WTP (DN1200mm and 3.6km in length) will be installed in the Kaptai Road using open-cut method of construction. The pipeline will be laid in the opposite side of the road to the Phase 1 pipeline with appropriate traffic control during pipe laying. Sheet piles are recommended to support the trench and minimise the working width. Figure 8.2.2 shows the manner of traffic control where the opposite half side of the road to that for the construction works is used for two-way traffic, carefully observing the traffic conditions.

Figure 8.2.2 Traffic Control on Kaptai Road

8.2.3 Surge Tank 1

Surge Tank 1 will be constructed next to the Phase 1 Surge Tank within the land obtained in Phase 1. The facility level of the surge tank for Phase 2 shall be reviewed in the detailed design stage in order to reduce the construction cost for excavation and provision of retaining walls, as shown in Figure 8.2.3.

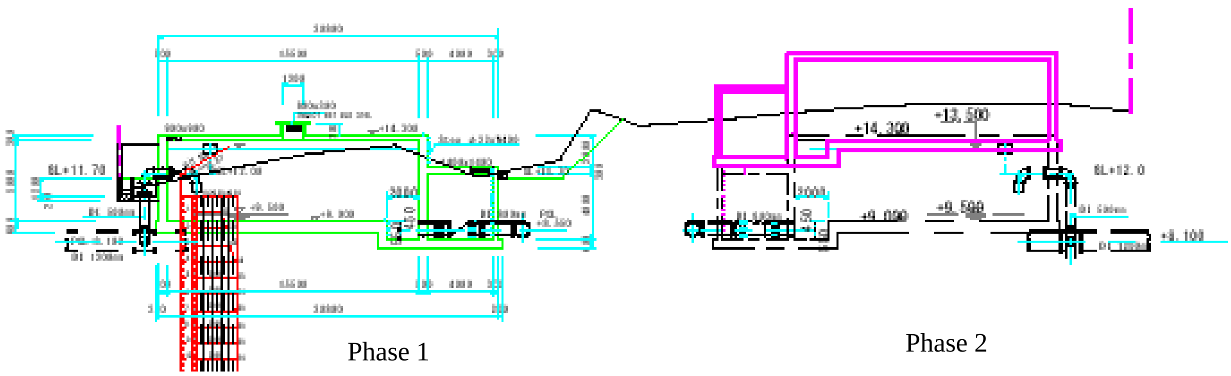


Figure 8.2.3 Surge Tank

8.3 Water Treatment Facilities

8.3.1 General

The access road from the existing road and the construction yard for the construction of the Phase 2 WTP are assured in Phase 1, as shown in figure 8.3.1. This access road shall be maintained for CWASA staff and the contractor. Due to limited open space in the WTP Site, especially taking into account of the need of the area for sludge treatment facilities for Phase 1 during construction of Phase 2 WTP, the Construction Yard shall include the area allocated for CWASA staff quarters, as shown in Figure 8.3.1. The Contractor shall also be allowed to use the site where the Phase 2 WTP is to be constructed including for offices and storage of materials subject to access being provided to CWASA staff for operation and maintenance of the sludge lagoons and other facilities.

The construction boundary of Conveyance/Transmission pipelines as well as yard pipes shall be clearly demarcated before construction.

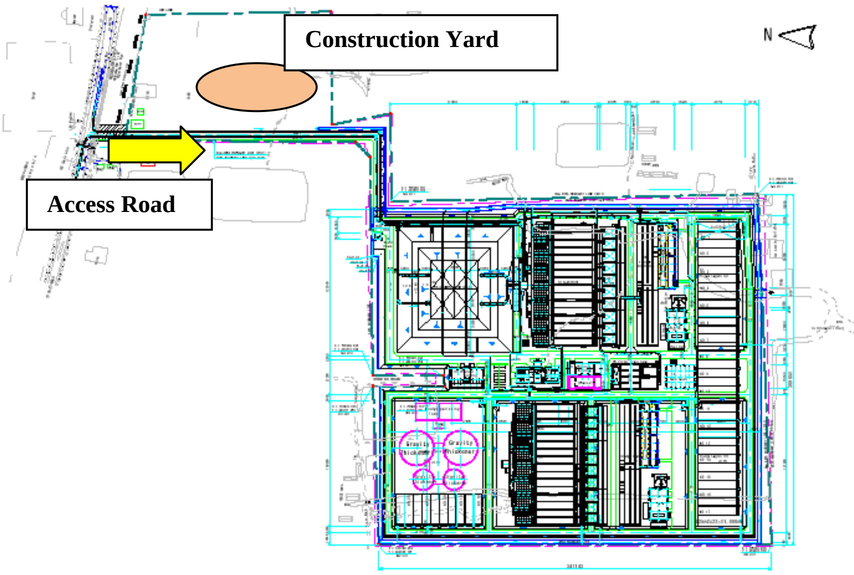


Figure 8.3.1 Access Road to WTP Site

The construction of water and sludge treatment facilities shall be made under the following conditions.

1) The Phase 2 facilities have to be constructed on the location of the sludge lagoons constructed in Phase 1 without interrupting sludge treatment.
2) The sludge treatment process will be changed from sludge lagoons to gravity thickeners and drying beds.

Excavated soil at the WTP construction site should be kept properly on site to prevent pollution of the Karnaphuli River. Provision of temporary sedimentation basins is one of the countermeasures to be used, as also discussed in 8.3.3. The EMP refers to the need for protection of inland waters.

Connections to the Phase 1 facilities (for example pre-sedimentation basin, sludge treatment, electrical works), shall be carried out such that the Phase 1 WTP operates continuously (except for short term interruptions to the power supply) and without adversely affecting the treated water quality. In the case when the power supply has to be interrupted the standby generator which is provided under Phase 1 shall be utilized, such that interruptions are short. It is considered that interruptions would be approximately 1 hour duration and that the works could be undertaken with one interruption to the supply.

8.3.2 Construction of Phase 2 Facilities considering Treatment of Phase 1 sludge

Due to the restriction of land area for WTP, Phase 2 facilities are planned on the site of sludge lagoon to be constructed in Phase 1 project. To secure treatment capacity for Phase 1 sludge, a staged construction plan of the Phase 2 facilities has to be considered.

Phase 2 water treatment facilities with capacity of 150,000m^3/d and sludge treatment facilities with capacity of 300,000m^3/d, that is total capacity of Phase 1 and Phase 2, are constructed as follows:

Construction of phase 2 facilities is planned in three stages as follows:

(1) First Stage

4 Sludge Thickener tanks and 5 units of Sludge Drying Bed will be constructed in the open space next to pre-sedimentation basin. This open space can be assured to be available at the commencement of the

contract period by not constructing one stand-by sludge lagoon (called as B lagoon in Phase 1), which is originally designed in this location. After the first stage, sludge from Phase 1 will be treated by the above facilities and one lagoon (called as A lagoon in Phase 1). Other lagoons will be abandoned in order to provide space for the construction area for next stage of the work.

(2) Second Stage

All of Phase 2 water treatment facilities and 9 units of Sludge drying bed are constructed in the area as shown in Figure 8.3.2. After the completion of this stage, sludge is treated by 4 sludge thickeners and 14 units of Sludge drying bed.

(3) Third Stage

8 units of Sludge Drying Bed will be constructed in this stage. With completion of this stage, the capacity of the WTP is the proposed capacity of 300,000m^3/d, corresponding to the total capacity of Phase 1 and Phase 2. Sludge is treated by thickeners and sludge drying beds.

The construction plan of the Phase 2 facilities in each stage is summarized in Figure 8.3.2.

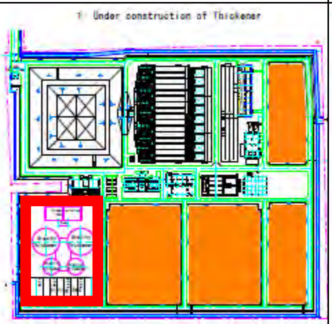
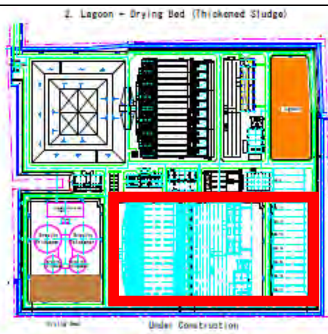
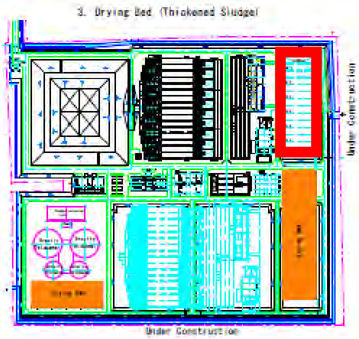
Stage	First Stage	Second Stage	Third Stage
Facility to be constructed	4 Sludge Thickener tanks 5 unit of Sludge Drying Bed	Water Treatment Facilities 9 unit of Sludge Drying Bed	8 unit of Sludge Drying Bed
Alignment of facilities **Construction area**			

Figure 8.3.2 Staged Construction of Phase 2 Facilities

Water treatment facilities and sludge thickeners will be constructed with foundation piles, the same as for the Phase 1 facilities. The sludge drying bed walls be constructed above the lagoon bottom, without breaking the bottom bricks of the Phase 1 lagoons. Low-noise and low-vibration piling machines shall be used to minimize complaints from residents living in the vicinity of the WTP site. Dirty water which is generated from excavation, piling and other works shall be properly treated so as not to pollute public water bodies, including the stream adjacent to the site and the Karnaphuli River.

Supernatant from the lagoons and leachate from the sludge drying beds shall be carefully discharged to the above stream (as is planned in Phase 1), such that discharge from the site meets the prevailing standard, including that for Suspended Solids of 150mg/L.

8.3.3 Countermeasures to Protect Soil Runoff from Construction Site during Heavy Rain

During the construction period, surface soil at the construction site may be washed away by heavy rain, causing pollution of the Karnaphuli River. To prevent soil runoff during heavy rain, a sedimentation tank/pit shall be constructed at the lowest corner of construction site. It is desirable to install floating curtain in the tank in order to quicken deposition of soil and also to reduce soil run off to the river.

8.4 Transmission Facilities

8.4.1 Transmission Pipeline

(1) From WTP to Nashirabad Reservoir

The transmission pipeline with DN1200mm and 24.4km in length will be installed in the Kaptai road in the opposite side of the Phase 1 pipeline. The profile of the Phase 2 pipeline is almost the same as that of Phase 1. In case open cut method is inapplicable at obstacles such as crossing drainage/waterway, special crossing method shall be adopted as shown in Figure 8.4.1.

(2) From Nashirabad reservoir to Halishahar Elevated Tank

The transmission pipeline with DN1100mm and 10km in length will be installed from Nashirabad Reservoir to Halishahar Elevated Tank. Traffic control including detour plan and resident's cooperation are required due to existing narrow roads. A new optical fiber cable is also planned along this pipeline route.

8.4.2 Halda River Crossing

Pipe supporting platforms have been already prepared both for Phase 1 and 2 as described in Chapter 7.

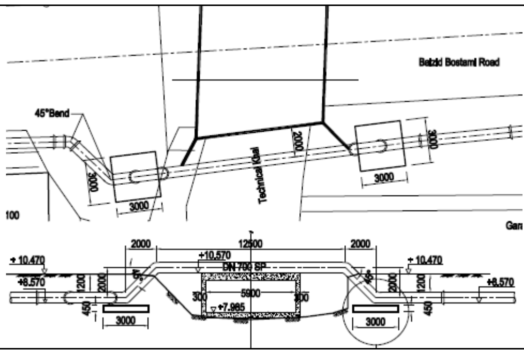
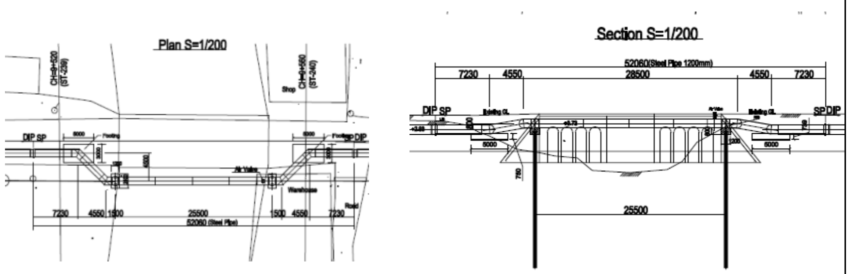
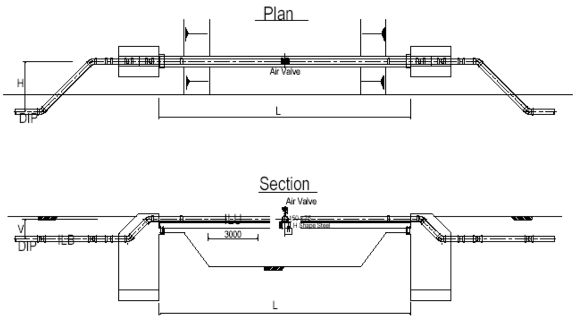
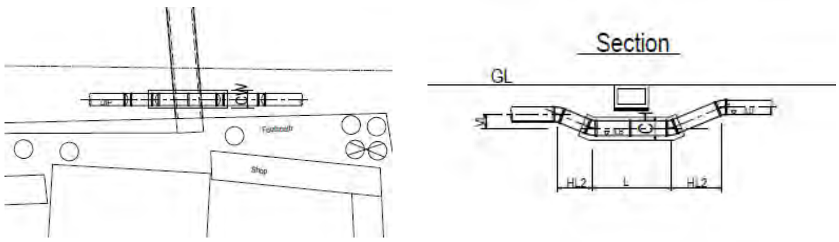
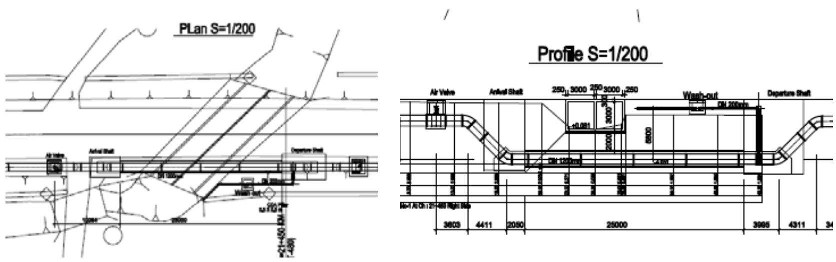
Over Passing	Without pile	
	With pile	
	With H shape Steel	
Under Passing	Open Cut Method	
	Pipe Jacking Method	

Figure 8.4.1 Special Crossing Method to the Obstacles

8.5 Distribution Facilities

8.5.1 Reservoir/ Elevated Tank

(1) Nashirabad Reservoir

The construction boundary between yard piping and the transmission pipeline is clearly demarcated. Expansion of the Nashirabad reservoir with a capacity of 24,800m^3 in Phase 2 project augments the capacity up to 51,100 m^3. Pile foundations will be required for the reservoir due to it being located in the filling area next to the Phase 1 Reservoir (refer to Supporting Report 8.5.1 Results of Boring Test). In this regard, low-noise and low-vibration type of piling machine will be required to minimize complaints from residents living in the vicinity of the site. The access road to this construction site is ensured in Phase 1, as shown in Figure 8.5.1.

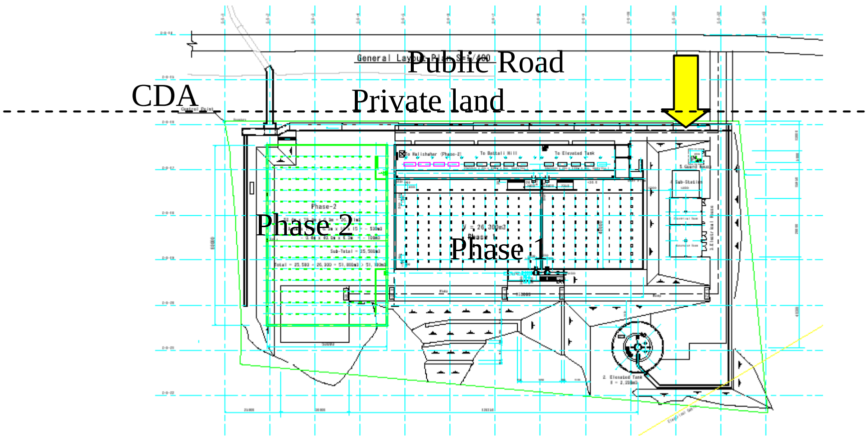


Figure 8.5.1 Access Road to Nashirabad Reservoir

(2) Battali Hill Reservoir

This reservoir with a capacity of 8,500m^3 is constructed in Phase 1. A Sector Inlet Chamber for Sector D will be constructed at the outlet of distribution main pipe to be constructed in Phase 1 in the Battali Hill Reservoir site (refer to Figure 8.5.2). The pipe will be used for the distribution of water after Phase 1 of the Project is complete. Therefore, the inlet chamber must be constructed in the nighttime in order to ensure a continuous water supply to residents in the daytime.

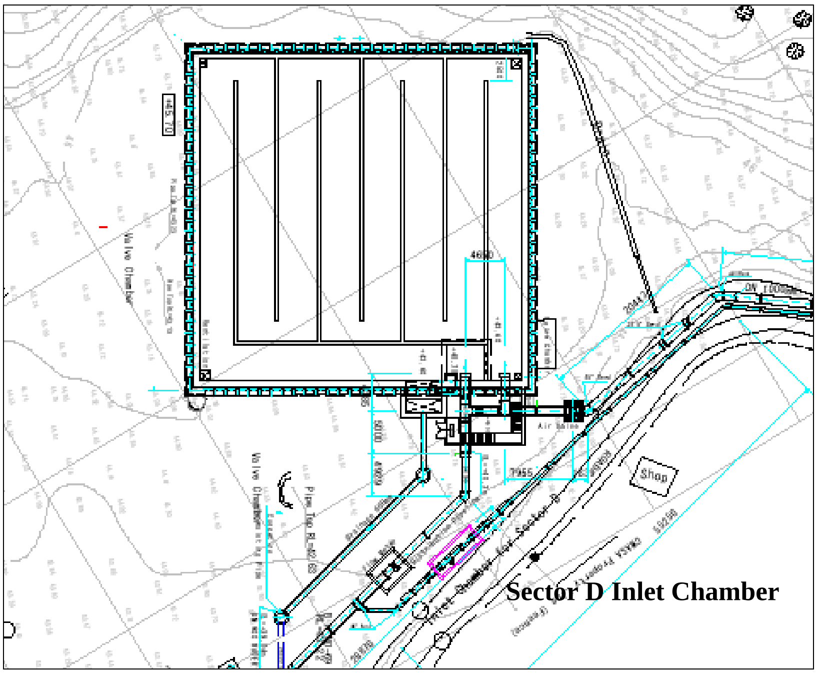


Figure 8.5.2 Location of Sector D Inlet Chamber

(3) Halishahar Elevated Tank

The access road to this elevated tank with a capacity of 2,400m^3 is ensured, as shown in Figure 8.5.3. Pile foundations to the tank will be required based on the soil investigations. (Boring test results are included in Supporting Report 8.5.1). Countermeasures to prevent public nuisance, with regard to noise and vibration, shall be taken as for other sites during the construction period. As the elevated tank is high at about 30m above ground level, a safe temporary work plan such as that used for the construction of Nashirabad Elevated Tank shall be prepared.

Figure 8.5.3 Access Road to Halishahar Elevated Tank

8.5.2 Distribution Pipeline

(1) Stock yard for pipe materials

Nearly 9,000m^2 of stock yard for pipe materials are assured in the CWASA property near Bayazid Bostami Road, as shown in Figure 8.5.4.

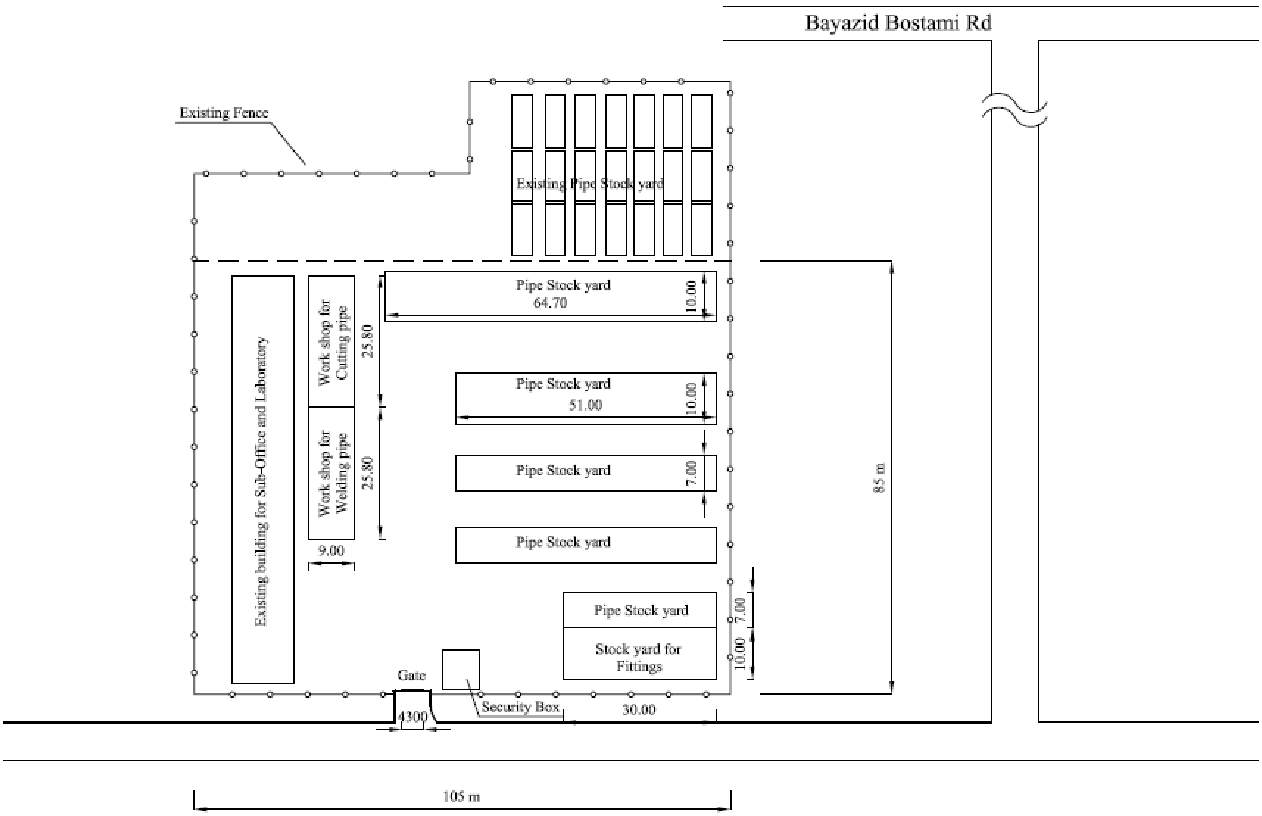


Figure 8.5.4 Stock Yard for Pipe Materials

(2) Removal and disposal of Asbestos Cement pipe (AC pipe)

During construction, the contractor may encounter AC pipes, for which removal and disposal shall be properly and safely carried out. There is a high probability of breaking buried AC pipe during construction, as detailed information on the location of existing AC pipes is not available. If construction machine break AC pipes, broken pieces shall be treated carefully so that direct contact with the pipes does not occur and exposure to airborne asbestos fibers is in accordance with the prevailing standards and legislation with regard to Permissible Exposure Levels. Broken pieces of pipe shall be packed safely and collected to storage areas, prior to final disposal from the site. Workers shall be equipped with eye-protection glasses, masks and rubber/leather gloves. In case broken pipe is an operational pipe, repair/replacement of the pipe is the responsibility of the contractor. An operations manual for removal, replacement and disposal shall be prepared prior to construction.

Regarding the right of way of the road, in the city where distribution networks will be installed, this is under the control of CCC, which is not the case for Kaptai Road. CWASA will be responsible for obtaining approval from CCC for the construction of distribution pipes after completion of D/D of the facilities.

(3) Primary distribution pipeline from distribution reservoir to Sector Inlet Chamber

Primary distribution pipelines are from distribution reservoirs to Sector Inlet Chambers and the total length of these pipelines is 7.9km. The secondary distribution pipeline, which is connected at the inlet chamber, is the main pipeline in the respective sectors.

An optical fiber cable is planned along primary distribution pipeline route to monitor and control each sector.

Traffic control or traffic diversions shall be considered during the construction period. Generation of noise, vibration by excavation machine should be minimized by appropriate countermeasures, and also subsidence or collapse of land should be prevented during installation works.

(4) Secondary Pipe from Sector Inlet Chamber to DMA Inlet Chamber

Secondary distribution pipeline is from the Sector Inlet Chamber to DMA Inlet Chambers. The same countermeasures as for primary distribution pipelines shall be taken for safety of construction and mitigation of environmental impacts such as noise and vibration. Service connections are not connected to this pipeline in principle.

(5) Tertiary Distribution Pipeline

The construction method for pipe laying with the diameter less than 400mm may be determined in consideration of alternatives; open-cut or trench less methods, during detailed design stage.

Customers shall be informed in advance of the timing and duration of the works, such that they can make arrangements to store water and informed of progress and delays to the works (if any, for example due to unforeseen conditions). Works shall be coordinated with replacement of meters, if the existing meter is used.

In the case where existing AC pipes are to be abandoned, the detailed design shall consider alternative methods for abandoning the pipes (e.g. leaving the pipes in the ground, removal and safe disposal, etc). The preferred solution is to leave existing AC pipes in the ground.

The Bidding Documents shall include (i) clear responsibilities for locating existing pipes, which are to be abandoned, (ii) safe working procedures for demolition/disposal of AC pipes, and (iii) provisions for unforeseen conditions, such that delays (including disruptions to the water supply) and additional costs are minimized.

These tertiary pipes are to be installed in narrow roads, where excavation machine such as backhoes may not access the construction site. In such cases, manual excavation should be adopted. The traffic control plan including diversions during the construction work should be carefully prepared.

8.5.3 Service Connection with Water Meter

For the construction of service connections, the following work shall be undertaken by different parties.

a) Procurement of equipment

   The contractor to be selected for the construction of distribution pipelines will procure required equipment for the service connection before installation of distribution pipelines.

b) Collection of information on customers including mapping on the location of water meter to be installed

   CWASA staff trained by PANI will undertake the required work in the field as early as possible after loan agreement.

c) Preparation of installation plan for service connections

   The contractor to be selected for the construction of distribution pipelines will prepare plan using information collected by CWASA staff.

d) Construction of distribution pipeline up to water meter for each service connection

The contractor install tertiary main pipe/lateral pipe and conduct leakage test. After confirmation of no leakage in the pipe, service connections will be installed from the pipe to each water meter near the boundary of public and private land.

e) Connection work from CWASA pipeline to each customer connection pipe in the premises of each house/building

The customers will make contract with private company for the connection of pipes between newly constructed CWASA pipe and existing private pipe.

All customers should be informed sufficiently in advance of the timing of works to change the connection pipe, such that they can make arrangements for the storage of water and for the works required to be undertaken by the customer. Works should be carried out timely such that disturbance to customers is minimized (for example by carrying out works when commercial establishments are closed) and the duration of the cut off in supply is also minimized.

About 52,000 connections are planned in the Phase 2 project. After water pressure test of tertiary distribution main pipe, service connections (from saddle installed at tertiary main pipe up to water meter box) will be installed as the last work in the series of pipe laying process before backfilling. “Spaghetti Connections” shall be strictly prohibited.

When new connections are installed, some problems may occur. Joint planning and work among concerned parties, including CWASA staff is indispensable. Before the installation of service connections, CWASA staff shall prepare a map showing the exact location of the water meter for each consumer. The contractor (for package 3: construction of distribution pipelines) will install the service connection up to the construction boundary, as shown in Supporting Report 8.5.2 (i.e. up to a short distance inside the private land from the boundary between public and private land).

The project cost includes installation cost of service connections; however, connection fee to be collected from customers later will be utilized for the maintenance of service connections by CWASA.

Water meter management center is planned to be accommodated in the building which is planned to be completed in 2013 financed by GOB.

CHAPTER 9

OPERATION AND MAINTENANCE OF WATER SUPPLY FACILITIES

CHAPTER 9 OPERATION AND MAINTENANCE OF WATER SUPPLY FACILITIES

9.1 General

The Operation and Maintenance (O&M) of water supply facilities after completion of the Phase 2 Project is discussed in this Chapter considering the planned sectorization of the distribution system with the provision of DMAs.

The planned requirements for O&M of the Phase 1 facilities are firstly studied, such that they are utilized fully in this study, following which the additional requirements to meet the Phase 2 requirements are proposed. There are six additional major items, as enumerated below, which have to be considered in planning of operation and maintenance.

(1) Monitoring and control of overall water supply system in use of SCADA System

SCADA system is included in the Phase 1 Project, but limited to the major facilities: intake facility, WTP and Nashirabad Reservoir. In the Phase 2 project, the SCADA system will be expanded up to the entrance to each Sector in the distribution system.

(2) Sludge Treatment at WTP both for Phase 1 and 2

Sludge generated in the water treatment process from both Phases 1 and 2 will be treated at the WTP site. The arrangement for the sludge treatment in the transition period during the construction of the Phase 2 WTP after completion of Phase 1 WTP shall be established such that the construction work for Phase 2, as well operation of the Phase 1 facilities can be managed within the limited land area.

(3) Manner of operation of transmission pump facilities at Nashirabad Reservoir to service reservoir/elevated tanks (total 3 in number)

The water which is stored at Nashirabad Reservoir is transmitted to the reservoir/elevated tanks for pressure adjustment. Transmission of water shall be carried out to meet the water demand from years 2020 to 2030 by using an appropriate number of the duty pumps which are planned to meet the demand in the year 2030 and such that energy consumption and cost are minimized.

(4) O&M of communal faucet systems planned to be constructed along the transmission pipeline in the Phase 2 Project

Several faucet systems are planned along the transmission pipeline in Phase 2, in order to mitigate complaints from the residents, who live outside the KSA and CWASA service area. Periodic technical supervision by CWASA entailing communications with the users is a requisite to maintain the facilities properly.

(5) Leakage monitoring and control in each DMA

DMAs are planned in each Sector in the distribution system. Survey teams will conduct surveys in the night time to detect leakage, with leak investigation/repair teams using information from the surveys to develop and implement countermeasures accordingly.

(6) Calibration, repair and replacement of water meter

One of the major causes of NRW is inadequate water meters. CWASA shall maintain all water meters in a satisfactory condition providing various kinds of countermeasures.

The above mentioned points are discussed in detail in the following sub-sections.

9.2 O&M Plan prepared in Phase 1

The O&M plan, which was prepared in the SAPROF for Karnaphuli Water Supply Project in 2005, focused on O&M of Karnaphuli WTP, as well as leak detection and the reduction of errors included in NRW in the existing distribution network.

In the plan the organizational arrangement is discussed and the number of staff required for O&M work for water supply facilities including the intake, WTP and distribution reservoirs is recommended to be 81 persons in total. In the O&M work for the WTP, setting up an operation plan for the WTP to meet the annual increase in water demand, adjustment of chemical dosing rate using jar-tests and scheduled replacement of filter media are emphasized. Table 9.2.1 presents routine maintenance work including inspection and examination items, repair and maintenance, and data recording, as proposed in the SAPROF.

Regarding leak detection and error reduction, the following actions are recommended referring to the previous studies and field observations. In the Phase 1 project, treated water was planned to be distributed to the existing network. Under such an arrangement, error reduction related to NRW was a major concern. In this regard, the following are recommended by the ongoing PANI, which commenced after completion of the SAPROF study.

- Set up Task Force for leak detection
- Introduction of special contractor license issued by CWASA for minor water works, especially for service connections and repair works
- Introduction of aggressive index (AI) to compare the performance of pipes
- Supervisory service for leak detection by hired engineers

With reference to the above mentioned requirements, two teams have been established in CWASA as follows:

- NRW Reduction Management Team, which is responsible for the preparation of a NRW Reduction plan.
- NRW Reduction Action Team which is dedicated to NRW Reduction field management and operation.

The above mentioned teams have been trained by PANI team and actions by themselves are planned to start from year 2012.

Table 9.2.1 List of Routine Maintenance Works at WTP

Frequency	Inspection and examination Items	Repair and maintenance	Data Recording
1) Daily Inspection (3 times a day)	・ Water Pressure ・ Water Quality ・ Noise ・ Heat ・ Smell ・ Vibration ・ Lamp test on electrical-monitoring panel ・ Leakage ・ Others	・ Cleaning ・ Check of oil and grease ・ Drain ・ Others	・ Quantity of Intake/Supply ・ Pressure gauge and water level ・ Quality of raw water and treated water ・ Amount of chemicals added and stock volume ・ Status of noise ・ Heat ・ Temperature ・ Smell ・ Vibration of equipment ・ Particular comments on failure ・ Attendance and performance of staff members ・ Others
2) Periodical Inspection (Once a week, a month, 3 months and 6 month)	・ Electrical lamp ・ Mixer ・ Pump ・ Leakage ・ Others	・ Check and repair of pressure gauge ・ Level meter ・ Sensor of water quality monitoring devices ・ Confirmation of performance of all devices ・ Refilling of oil and gauge ・ Screw up loose bolts and nuts ・ Repair of leakage ・ Clean-up of premises ・ Others	・ Quantity of Intake/Supply ・ Water quality ・ Water Level ・ Weekly average water production/transmission ・ Consumed Chemicals and power ・ Staff attendance and performance evaluation ・ Expense ・ Production Cost ・ Preparation of weekly/monthly report ・ Others
3) Medium Term Inspection (Once a year)	・ Performance test of equipment ・ Condition of Paint work ・ Condition of sludge accumulation ・ Calibration of all measurement equipment ・ Others	・ Drain work ・ Sludge removal ・ Touch up painting ・ Calibration of instruments ・ others	・ Preparation of annual report
4) Long Term Inspection (Over 3 years or longer interval)	・ Overhaul check Integrated functional diagnosis of the plant	・ Overhaul Repair ・ Others	
5) Emergency Inspection (as needed)	・ Investigation on major defects and accidents ・ Others	・ Repair of major defects and accidents ・ Others	

9.3 Monitoring and Control of Overall Water Supply System in Use of SCADA System

As mentioned in Section 7, data and information on water flow, water pressure, water level and operational conditions at the major water supply facilities are collected through the SCADA system in the control center at the WTP. Based on the analysis on the data collected, system operators will manage the system on a 24 /7 basis, such that for example pressure is maintained in the system at pre-set levels. The SCADA system will also provide details of the operation status of machinery/equipment, including showing abnormal values and failure signals, in order to facilitate rapid checks and repairs. Data on the water production/Supply amount during a certain period can be compared with the billed volume to assess NRW, which is one of the performance indicators of the water supply system. Sector meter data in the distribution system will be used both for (1) the equitable distribution of water to all sectors and (2) NRW control. Further details on these matters are discussed below.

(1) Equitable distribution of water to each sector concerned is essential and inequitable conditions among sectors have to be adjusted immediately. Irregularities in the trend of distribution to the sectors can be attributed to leakage, illegal connections or a large amount of water consumption by some specific individuals/enterprises. Through the study by leakage monitoring team of CWASA on billed water volume and DMA survey, the reasons for irregularities in the trend of distribution shall be identified and appropriate countermeasure shall be taken.

(2) Records of flow data from the meters to each sector are also useful for leakage control. The NRW percentage in each sector can be easily calculated by comparing the inflow water volume with the billed water volume. Priority sector/s for leakage detection will be determined based on this study followed by DMA survey by the team of CWASA.

9.4 Intake/Conveyance Facilities

(1) Intake Facilities

The operation of the intake pumps is adjusted to meet the planned treatment volume of the WTP in accordance with annual increase in water demand. Removal of screened debris and sedimentation from the inlet point and O&M of mechanical/electrical equipment are the major work, which is required to be undertaken. Sampling and analysis of raw water is also an important daily task.

(2) Conveyance Facilities

A surge tank is installed on the line of the conveyance pipeline as a protection facility for the pumps and pipeline from water hammer in case of abrupt interruptions of the power supply. The water level in the tank shall be maintained, such that it can operate as designed at any time.

9.5 Water Treatment Plant

The Phase 1 and 2 Water Treatment Plants are arranged to be accommodated in the land area, which was acquired during Phase 1. Under such an arrangement, the sludge treatment method for both phases is modified from that planned for Phase 1 only. In Phase 1, “Sedimentation Basin-Lagoon- Disposal process” was planned, however, the process of “Sedimentation basin- Gravity type Sludge Thickener- Sludge Drying Bed-Disposal” is selected in this survey, as presented in section 7. The water treatment process in the Phase 2 Project is same as that of Phase 1 Project, with the Phase 1 pre-sedimentation basin being used for both phases. Therefore, this sub-section focuses on the O&M work for the sludge treatment processes.

The pre-sedimentation basin will normally be used during the rainy season, from May to October, when the turbidity of the river water becomes high (more than 100 NTU).

The sludge lagoons, which will be temporarily used for the Phase 1 WTP shall be converted to sludge drying beds (together with sludge thickeners) during the Phase 2 construction stage. Appropriate countermeasures shall be developed for the smooth change from the sludge lagoon process to the sludge drying bed process without disturbing treatment of sludge from the Phase 1 WTP.

9.5.1 O&M of Sludge Treatment Facility After Completion of Phase 2 WTP

(1) Sludge Thickener

For the sludge treatment, four units of sludge thickener (two pairs of sludge thickener, primary and secondary) are planned to cope with inflow of higher turbid raw water during rainy season. For the design of the facilities, the design conditions and criteria are established, as shown in Table 9.5.1.

Table 9.5.1 Design Conditions & Criteria for Sludge Treatment

Season	Design Conditions	Inflow Sludge to thickener		Sludge inflow to SDB	Removed Sludge
		Primary	Secondary		
Dry	Q_{in}300,000m^3/d Turbidity 40NTU Removal Ratio 90%	C=99.5 % V=2,340 m^3/d Ds=11.6 t/d	-	C=97 % V= 390m^3/d Ds=11.6 t/d	C≦65%
Rainy	Q_{in}300,000m^3/d Turbidity 100NTU Removal Ratio 90%	C=99.5 % V=5,680 m^3/d Ds=28.6 t/d	C=97 % V= 950m^3/d Ds=28.6 t/d	C=94 % V=470 m^3/d Ds=28.6 t/d	

Note: C; content of water %, V; volume, Ds; dry solids per day, SDB; sludge drying bed

Primary thickeners are operated all year round, while secondary thickeners are used only during days when raw water has a high turbidity during the rainy season. Cleaning of thickener equipment and the connection pipes shall be carried out in dry days.

(2) Sludge Drying Bed

1) Control of supernatant from sludge drying bed

Discharge of supernatant after the initial filtration of water through sub-layer of sand/gravel shall be carefully managed by manual operation of stop-logs.

2) Disposal of dried sludge

As dried sludge does not contain toxic substances, it can be supplied to local manufacturers/residents for the production of bricks or use as soil conditioner.

3) Replacement of sub-layer sand and gravel

Part of the sand filtration media on the top of the sludge drying beds shall be refilled every time after dried sludge is removed and all filtration media shall be replaced at least every 3 years to prevent clogging of the media.

(3) Vehicle/Equipment required for sludge disposal

Dried sludge is collected manually and loaded to a dump truck using a backhoe, following which surplus sludge (which has not been sold or supplied as discussed above) is transported to a land reclamation or landfill site. The required number and type of vehicles in Phase 2 is summarized in Table.9.5.2, which also shows the planned number and type of vehicles in the Phase 1 Project.

Table 9.5.2 Required Vehicles for Sludge Disposal

Vehicle	Quantity in Phase 1	Additional Quantity in Phase 2	Total
Dump-truck	2	-	2
Backhoe	-	2	2

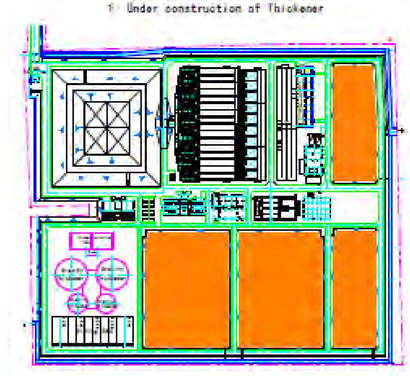
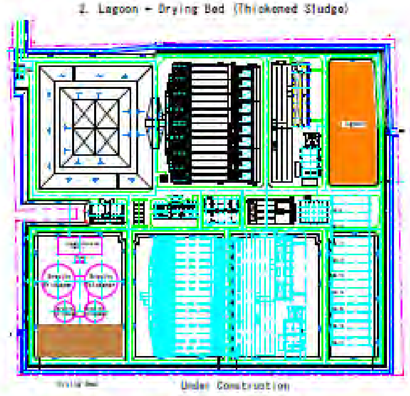
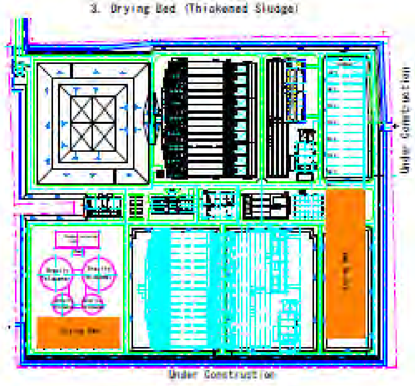
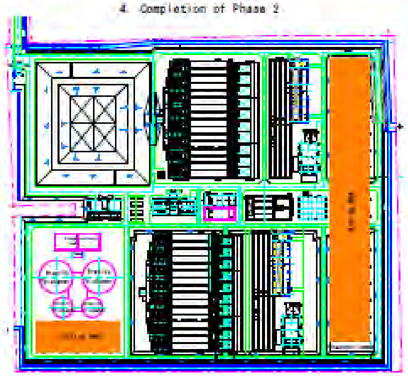
9.5.2 Arrangements for the Treatment of Sludge in the Transition Period from Completion of Phase 1 to the Completion of Phase 2 Work

Before completion of the Phase 2 construction work, appropriate arrangements shall be made so as not to disturb the sludge treatment process for the Phase 1 WTP, which uses sludge lagoons located in the area where the Phase 2 water treatment facilities are planned to be constructed. Table 9.5.3 and Table 9.5.4 show the sludge treatment facility arrangements and operation method in four stages; (1) during construction of thickener units and Sludge Drying Bed in the open space, (2) during construction of Phase 2 water treatment facility and a part of Sludge Drying Bed, (3) during construction of the rest of Sludge Drying Bed and finally (4) completion of Phase 2.

Table 9.5.3 Arrangements for Sludge Treatment in the Transition Period

Stage		Sludge Generation Volume	Sludge Treatment Facility	O&M of Sludge Treatment
1	During Construction of 4 units of Thickener and 5 units of Sludge Drying Bed (treatment of Phase 1 sludge)	(Q_{in}=150,000 m^3/d) Dry season 5.9 Dt/d 1,180 m^3/d Rainy season 14.2Dt/d 2,840m^3/d	4 Sludge Lagoon A:3,669m^3 x 0.7m B:5,492m^3x0.7m C:5,492m^3x0.7m D:3,669m^3x0.7m	5 month/unit in 1 cycle use: Inflow 2.5 months Drying 2.0 months Removal 0.5 month 4 Lagoon are used in turn
2	During Construction of Phase 2 Water Treatment Facility and 9 units of Sludge Drying Bed (treatment of Phase 1 sludge)	Ditto	4 Sludge thickener D=30m x 2 tank D=18m x 2 tank 5 Sludge Drying Bed 500m^2x5=2,500m^2 1 Sludge Lagoon 3,669m^3, H: 0.7m (A=5,241 m^2)	Thickened Sludge volume Dry Season 5.9/(1-0.97)= 200 m^3/d Rainy season 14.2/(1-0.94)= 240 m^3/d 1 Lagoon and 5 Drying Beds are used for the drying of Phase 1 Sludge.
3	During Construction of 8 units of Sludge Drying Bed (treatment of Phase 1 sludge)	Ditto	4 Sludge thickener D=30m x 2 tank D=18m x 2 tank 14 Sludge Drying Bed 500m^2x14=7,000m^2	Thickened Sludge volume Dry Season 5.9/(1-0.97)= 200 m^3/d Rainy season 14.2/(1-0.94)= 240 m^3/d Total 14 Sludge Drying Beds are used.
4	After Completion of Phase 2 with additional 8 units of Sludge Drying Bed (treatment of Phase 1 & 2 sludge)	(Q_{in}=300,000 m^3/d) Dry season 11.7 Dt/d 2,330 m^3/d Rainy season 28.2 Dt/d 5,630 m^3/d	4 Sludge thickener D=30m x 2 tank D=18m x 2 tank 22 Sludge Drying Bed 500m^2x22=11,000m^2	Thickened Sludge volume Dry Season 11.7/(1-0.97)= 390 m^3/d Rainy season 28.2/(1-0.94)= 470 m^3/d Total 22 Sludge Drying Beds are used.

Table 9.5.4 Staged Arrangements for Sludge Treatment during Transition Period

Stage	1	2	3	4
Layout Plan of Sludge Treatment Facility				
	Common conditions 1 Lagoon can receive 2.5 months of sludge in an average as planned in Phase 1. Sludge inflow load to Drying Bed is assumed to be around 60 kg-Ds/m^2 /day in dry season In case of 500m^2 Drying Bed, sludge weight is 5,900kg in Phase 1 and inflow day is 500 /(5,900/60)=5.08 days → 5 days Target drying period is assumed to be 2.0 months (=60 days) for lagoon system and 45 days for Sludge Drying Bed system considering filtration function of the bed. 2days for sludge removal is required in case thickened sludge is fed into drying beds. 0.5 month is required for lagoon system fed with un-thickened sludge. In case thickened sludge is fed into lagoon, 45 days for drying and 15 days (0.5 month) for removal shall be assured.			
	4 units of sludge lagoon are constructed in Phase 1 and operated during this stage (1 cycle; 5.0 months/unit) 2.5 month; sludge inflow 2.0 month ; Drying 0.5 month; scraping and removing dried sludge	Lagoon is divided into 2 units and each receive 1.25 month=37days of sludge inflow (1 cycle of Lagoon) 37 days of sludge inflow 45 days of drying and 15 days of scraping and removing of dried sludge Total 97 days (1 cycle of Sludge Drying Bed) 5 days of sludge inflow 45 days of drying and 2 days of scraping and removing of dried sludge Total 52 days	Thickened sludge is dried in 14 units of Sludge Drying Bed with total area of 7,000m^2. (1 cycle) 5 days of sludge inflow 45 days of drying and 2 days of scraping and removing of dried sludge Total 52 days	Thickened sludge is dried in 22 units of Sludge Drying Bed with total area of 11,000m^2. (1 cycle) 3 days of sludge inflow 45 days of drying and 2 days of scraping and removing of dried sludge Total 50 days In this case, inflow days are; 500/(11,700/60)=2.56→3.0 day

Average capacity of four lagoons in first stage is 4,580m^3 and each lagoon can accept 442.5t of sludge, which is generated during 2.5 months (5.9t x 2.5 x 30=442.5t) in the first stage.

In case a lagoon receives thickened sludge in second stage, a lagoon can receive the same weight of sludge. The lagoon is divided into 2 units and thickened sludge will inflow to each unit, the amount of which is equivalent to 1.25 month (2.5months/2=1.25month=37 days). 5 units of Sludge Drying Bed are used, together with the lagoon in the second stage and each unit is fed with sludge for 5 days based upon the standard inflow load. Both facilities are operated in accordance with the cycle times in Table 9.5.4.

During the third stage, 14 units of Sludge Drying Bed are operated to treat 5.9t/d of sludge in Phase 1. Each unit is fed with sludge for 5 days. It takes 70 days (5 days x 14 =70 days) before the first bed is fed again, which means that the 45 days of drying time and 2 days of removal time for one bed are ensured.

The final stage is the Phase 2 stage and a total 22 units of Sludge Drying Bed are operated. Due to the volume of sludge to be fed to the Sludge Drying Beds being double that in Phase 1 stage, the inflow time is shortened to 3 days. In this case, also 45 days of drying time and 2 days of removal time are ensured by feeding the Sludge Drying Beds sequentially. It takes 66 days (3 days x 22 =66 days) before the first bed is fed again.

9.6 Transmission Facilities

Transmission facilities in this project include;

- Transmission pipeline from WTP to Nashirabad Reservoir and another 3 transmission pipelines from Nashirabad Reservoir to each distribution reservoir/elevated tank, and
- Transmission pump facilities at WTP and at Nashirabad Reservoir

Nashirabad Reservoir is planned for storage of the required volume of water for the adjustment of peak hour demand in the entire Karnaphuli service area.

For the economical operation of pump facilities at Nashirabad Reservoir according to the increase in the annual water demand, a combination of some pump units with different capacities shall be studied considering intermediate year 2025, from year 2020 (Phase 2 completion year) to year 2030 (design target year). For Nashirabad E.T and Halishahar E.T, 1.5 times the daily maximum demand (equivalent to hourly maximum flow) shall be sent from Nashirabad Reservoir, whereas for Battali Hill Reservoir, 1.2 times the daily maximum water demand shall be pumped.

Communal faucet systems are planned to provide water for the residents living along part of the route of the transmission pipeline from the WTP to Nashirabad Reservoir. These systems and surge tank, as well as air release valve and drain pipe of the transmission pipeline shall be inspected as routine work.

9.6.1 Operation of Transmission Pump Facilities from Nashirabad Reservoir to 3 Distribution Reservoir/Elevated Tanks

(1) Water Demand and Retention time at E.T tank/ Reservoir by target year

The projected water demand for each reservoir/ E.T service area; northern, central and western areas, is shown in Table 9.6.1.

Table 9.6.1 Staged Water Demand by Sub-service Area

Year		2020		2025		2030	
Unit		m^3/d	m^3/min	m^3/d	m^3/min	m^3/d	m^3/min
North	Q_{dmax}	50,000	34.7	61,000	42.4	78,400	54.4
	Q_{hmax} (=1.5xQ_{dmax})	75,000	52.1	91,500	63.5	117,600	81.7
Central	Q_{dmax}	93,000	64.6	104,000	72.2	128,000	88.9
	Q_{hmax} (=1.5xQ_{dmax})	139,500	96.9	156,000	108.3	192,000	133.3
	1.2xQ_{dmax}	111,600	77.5	124,800	86.7	153,600	106.7
West	Q_{dmax}	58,000	40.3	66,000	45.8	79,600	55.3
	Q_{hmax} (=1.5xQ_{dmax})	87,000	60.4	99,000	68.8	119,400	82.9
Total	Q_{dmax}	201,000	139.6	231,000	160.4	286,000	198.6
	Q_{hmax} (=1.5xQ_{dmax})	301,500	209.4	346,500	240.6	429,000	297.9

Table 9.6.2 shows the retention time at each reservoir against the daily maximum water demand.

Table 9.6.2 Retention time to Daily Maximum Water Demand by Target Year

Reservoir/E.T	Capacity (m^3)	Retention Time (hour)		
		2020	2025	2030
Nashirabad Reservoir	51,100	6.1	5.3	4.3
Nashirabad E.T	2,200	1.1	0.9	0.7
Battali Hill Reservoir	8,500	2.2	2.0	1.6
Halishahar E.T	2,400	1.0	0.9	0.7

(2) Operation Plan of transmission pump by target year at Nashirabad Reservoir for service reservoir/ elevated tank

All pump facilities required in 2030 are planned to be installed in Phase 2 Project. Before year 2030 less on-off operation of the pump facilities occurs, as the water demand in 2020 and 2025 is less than that in 2030. Careful inspection of the condition of the pumps is necessary to provide immediate countermeasures in case of a problem. On the other hand, pump operation will be made by using a combination of some pump units to meet the fluctuation in water demand in the day.

9.6.2 O&M of Communal Faucets

Several faucet systems to be installed along the transmission pipe from WTP to Nashirabad reservoir shall be technically maintained by CWASA. However, the association shall be organized by the beneficiaries. Monitoring and maintenance of the facilities shall be made as a joint effort of CWASA and the association.

9.7 Distribution Facilities

Distribution Facilities comprise distribution reservoir/elevated tank, distribution pipeline (including lateral pipes) and service connections with water meters. Ancillary equipment of the distribution pipeline includes air release valve, drain pipe and fire hydrant, which are inspected in routine work and are repaired/ replaced, as required.

Distribution reservoir/elevated tanks including Nashirabad Reservoir are filled by transmission pumps so that the water level in each is maintained at the planned level shown in Table 9.7.1.

Table 9.7.1 Water Level of Reservoir

Reservoir	HWL	LWL	Remarks
Nashirabad Reservoir	+36.3m	+30.0m	
Battali Hill Reservoir	+49.6m	+43.6m	
Nashirabad Elevated Tank	+51.0m	+45.0m	
Halishahar Elevated Tank	+36.0m	+30.0m	

The distribution system is divided into 10 Sectors and flow volume and water pressure is monitored and controlled by the pressure regulating valve, sector by sector. The NRW percentage is estimated by sector. In order to assess the leakage in a DMA, night time flow is measured at the DMA inlet chambers provided with fire hydrant outlets.

Water quality examination at the service connections shall be made taking samples of tap water periodically to confirm the water quality compared to the national drinking water standard. Important water quality indices, frequency and sampling number for water quality examination are listed in Table 9.7.2. CWASA shall publicize officially the result of water quality test every month.

Table 9.7.2 Water Quality Test for Drinking Water

Water Quality Indices	Frequency	Remarks
Coliform Bacteria	Once a month	Sampling: one in 1,000 connections
Residual chlorine		
Nitrate		

9.7.1 DMA

DMAs are utilized as a primary diagnostic tool to reduce the volume of leakage. The night time flow at the entrance to a DMA (inlet chamber) is measured to analyze the existence of leakage in the DMA. The work flow for leakage detection, which is used in the development of countermeasures, is shown in Figure 9.7.1.

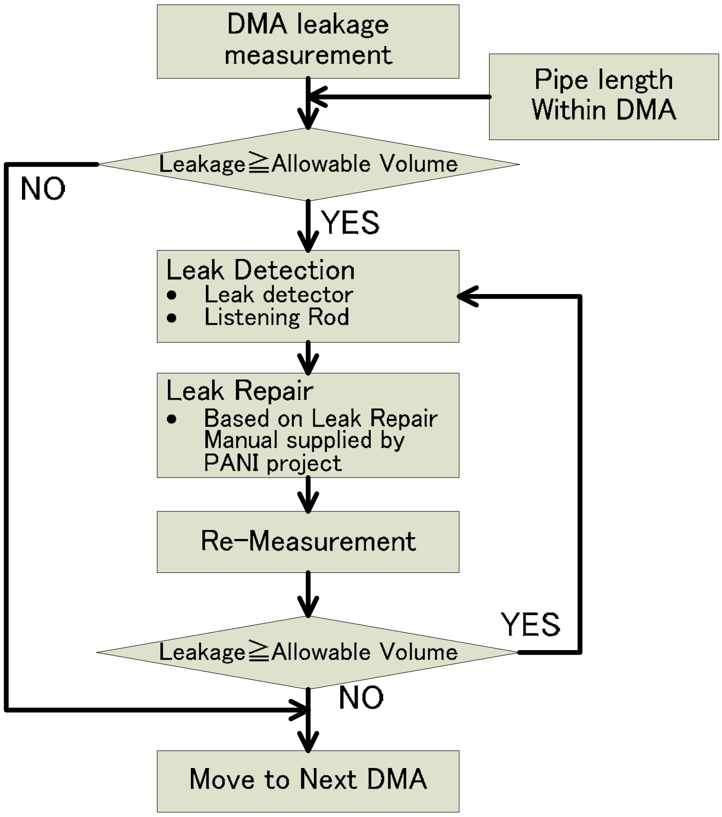


Figure 9.7.1 Work Flow of Leakage Reduction in DMA

An image of night time minimum flow is illustrated in Figure 9.7.2.

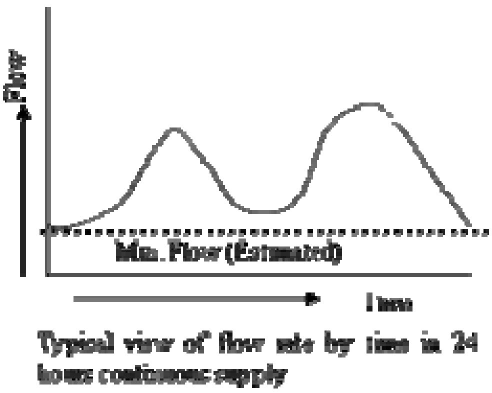


Figure 9.7.2 Image of Night time Minimum Flow

The allowable volume of night time flow is about 10-20 liters / min / km of Pipe based on the experiences in Japan.

Three teams of monitoring team shall be organized to cover the three sub-service areas; Northern, Central and Western areas. These teams shall survey all DMAs in a year (3teams x 7 DMAs x12 month = 252 points). Each team shall be equipped with vehicle mounted electro-magnetic flow meter. Two sets of ultrasonic flow meter shall also be procured to use in narrow roads where vehicles cannot access the DMA inlet chamber.

Leak investigation/repair team will get information on the monitoring results from the monitoring team and if there is evidence of leakage, they will try to identify points of leakage point/s in the DMA using detectors, listening rods, following which repair works will be carried out. In case repair work is large, it shall be contracted out to a Contractor.

Data management and analysis shall be used by the staff to prepare a leakage reduction manual. An annual plan for the work shall be prepared at the beginning of a year. A Leak repair manual will be prepared by PANI team and it shall be updated based on the experience and lessons learned of the teams.

Data management staff members are expected to conduct the following work.

(1) Analysis on the causes of leakage

Following repair data is statistically necessary to determine the causes of leakage.

- Location of leaking point/s (GIS information, distribution block, DMA, etc.)
- Pipe info. (diameter, material, laying depth, backfill materials, completion year, etc.)
- Leak condition (estimated leak amount, leaking portion, etc.)
- Repairing condition (method, used material, backfill materials, etc.)

(2) Analysis of Flow Balance of subject DMA and comparison at each DMA

Water balance data including night time flow shall be collected. These data categories of DMA shall be included for improvement of analytical precision. It is desirable to collect water meter reading data within the DMA. Such analysis enables more effective NRW countermeasures. Comparison of each DMA data also assists in clarifying the l characteristics of leakage within the Sectors

(3) Review of Leak Reduction Manual

It involves criteria for the judgment of leakage-prone DMA. Repair work must be performed properly, in order to prevent the recurrence of the leakage. This manual must be prepared covering clear topics such as external construction standards of road excavation and restoration in consultation with the concerned authorities.

9.7.2 Water Meters

Water tariff collection based on accurate reading of water meters contributes significantly to the sound operation of the CWASA and also improves the water-saving consciousness of the customers. It is fair for all customers to charge them in proportion to the water they use.

As a large number of nonfunctional water meters have not been replaced and many water meters are reserved in the stock yard un-checked for accuracy, appropriate and improved management of water meters is indeed necessary.

(1) Organization and Equipment Needed

A water meter management center shall be established for common use for all water supply systems in the city through the future. The center should undertake accuracy test of all new meters, collection of expired meters, repair and recycling of the collected meters and on-site accuracy test of existing water meters. A new test yard equipped with accuracy test tools shall be constructed in CWASA compound in Halishahar.

1) New Meter Accuracy Test

- A meter error is examined in the meter test shop through authorized measuring method.
- Tolerant range of water meter is set up at ±4% in practical use, that of examination value is set at ±3% in case of new meter examined in test yard.
- All meters procured are subjected to the accuracy test.

2) Replacement Schedule

Replacement term is set up as follows:

- 1/2 inch – 8 years
- 2～3/4 inch – 5years
- Over 3 inch – 3 years

Based on the replacement term, expired meters should be replaced. In case collected meters are in good condition, they should be recycled after repairing. The target number of replacement and recycle is as follows:

- 1,000 meters per month (12,000 meters per year)
- While 500 meters, half of collected meters, are scrapped and disposed, 500 meters are repaired and reused.

Sample equipment for accuracy test is shown in Figure 9.7.3 and on-site test (calibration) is shown in Figure 9.7.4

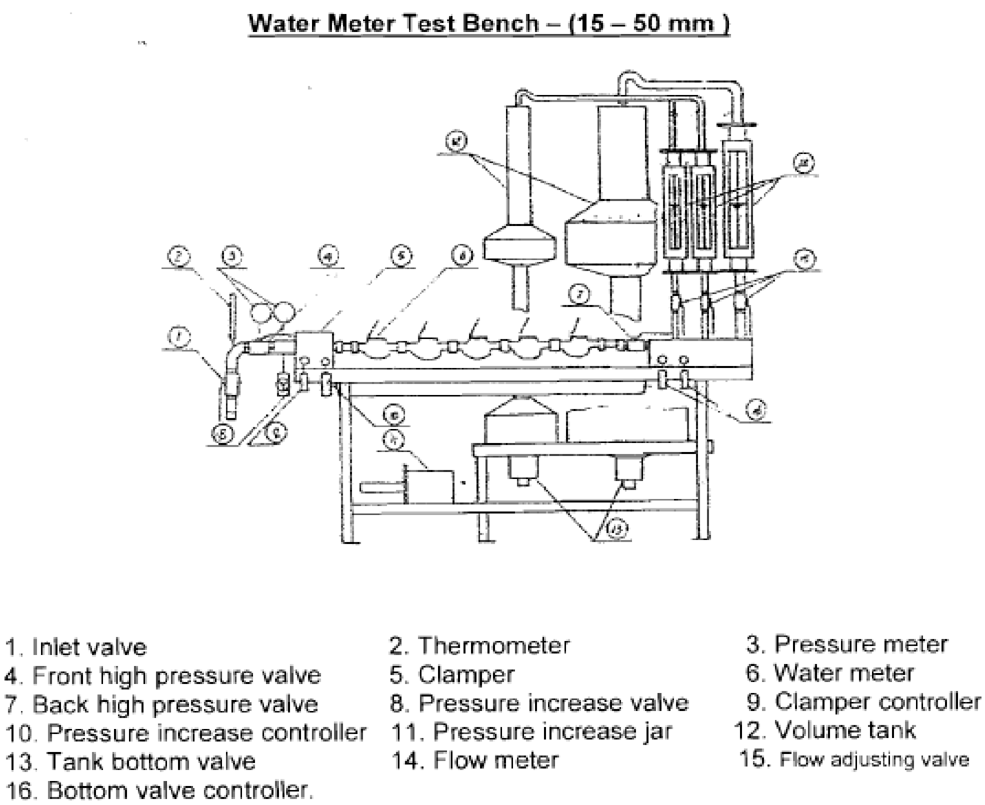


Figure 9.7.3 Meter Accuracy Test Bench

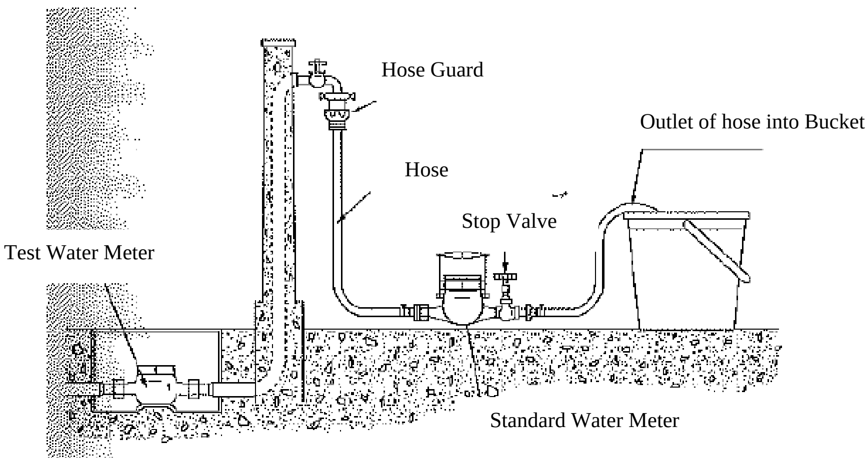


Figure 9.7.4　On-site Calibration Test

9.8　Countermeasures to Reduce O&M Cost

(1) Personnel Cost

As to the personnel cost, introduction of SCADA system can reduce the O&M cost, especially the personnel cost for data collection and on-site control.　Other IT related equipment also contributes to the cost reduction.　Another countermeasure for reducing personnel cost is done mainly by outsourcing of O&M work.　Potential works to be subcontracted are as follows;

- Disposal of dried sludge
- Water meter reading and tariff collection work
- Water quality test

(2) Power/Fuel Cost

To save the pump operation cost, which accounts for major part of power cost, introduction of higher efficiency motor is recommended.　Cost saving lightning equipment, such as LED illumination equipment shall also be considered.　Ventilation facilities and air conditioners are to be operated adequately.

(3) Chemical Cost

Karnaphuli WTP consumes a lot of chemicals, Alum, Lime and Chlorine.　Chemicals which can be stored on site for periods can be procured more cheaply as the quantity of one order increases.　A scheduled procurement plan, based on procurement in large (as opposed to small) quantities is helpful to reduce the cost of chemicals.

9.9　Institutional Structure and Technical Capacity Needs for CWAS to Manage Phase 2 Facilities

(1)　Required Organization for O&M work for Karnaphuli Water Supply System

The organization for O&M of Karnaphuli Water Supply System is recommended from functional view point as a total system of Phase 1 and Phase 2.　The requirements for administrative, engineering (planning and design), commercial/ marketing and public relations are regarded to be managed by CWASA head office, as common services to all water supply systems in Chittagong city.　Therefore, the Karnaphuli Water Supply System Office has an independent function for O&M of the facilities.　Figure

9.9.1 shows the organization for O&M of the Karnaphuli Water Supply System (covering Phase 1 and Phase 2).

The organization for O&M of Karnaphuli Water Supply System consists of the two divisions (broken down into two groups among the major facility components) as shown below. System management from Intake to the entrances to the sectors of the distribution main pipelines will be undertaken by monitoring and control staff under the Assistant KWS System Manager.

1) O&M for Intake- Transmission Pipeline
2) O&M of Distribution Facilities

The following are the functions of water supply system management and the two divisions.

a) Water Supply System Management

This work is directly supervised by Assistant KWS System Manager. Overall monitoring and control of water supply system shall be undertaken by the staff and coordinated with the two O&M divisions. There are three groups; monitoring and control of the entire system using the SCADA system, data collection/processing and analysis in order to develop an improved operation plan for/manual of the entire water supply system, and environmental monitoring and countermeasures .

b) O&M for Intake- Transmission Pipeline

Under the Department Manager of O&M for Intake to Transmission Pipeline, Process, Mechanical, Electrical and Instrumentation Engineers will be engaged in the required O&M work related to the intake, water treatment (water and sludge treatment processes) and pipe line. The laboratory for water quality examination operated by the section manager (Chemist) is also in this division. This section will analyze and monitor the raw water, process water and service water.

Operators/ technicians shall be assigned under the sections of Intake, Water Treatment, Sludge Treatment, Pipeline maintenance and laboratory.

c) O&M for Distribution Facilities

The Department Manager of O&M for the Distribution Facilities will manage concerned sections consisting of (1) reservoir/elevated tank, and (2) main & sub-main Pipelines with Sector Inlet chambers, DMA networks with DMA chambers.

Main pipe/Section Inlet chamber & DMA Section includes (1) 10 Sector offices, (2) Leakage Detection Teams for the three sub- distribution systems which cover 10 sectors, and (3) Water Meter Maintenance Center, which will be commonly used for all established Water Supply System in Chittagong City. The Water Meter Center is engaged in the water meter accuracy test, periodical on-site meter calibration and replacement of broken meters.

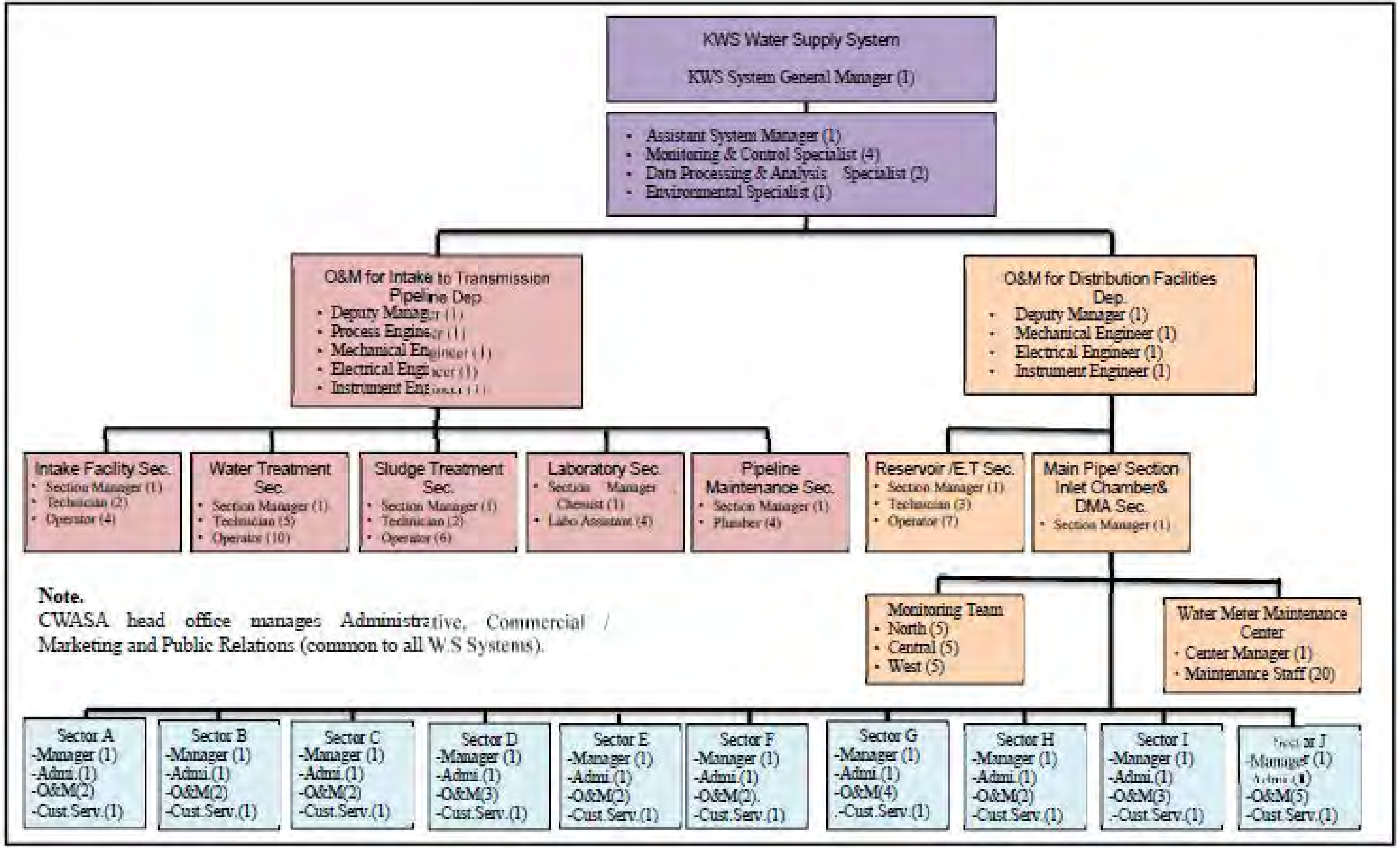


Figure 9.9.1 Organization for O&M of Karnaphuli Water Supply System

The field office of each sector shall be established before completion of respective DMAs to manage the water supply business in their territories including marketing, water tariff collection, and monitoring/control of water use and repair of facilities (leakages). For the establishment of comprehensive management for the water supply in the KSA, incentives to staff members and appropriate compensation shall be provided through the competition on the performance of the sectors.

(2) Staff Members required for O&M of Karnaphuli Water Supply System

Table 9.9.1 presents required number of staff members with job descriptions (refer to Figure 9.1.1).

Table 9.9.1 Staff Numbers required for O&M of Karnaphuli Water Supply System

Department	Section	Number of Staff	Job Description
KWS System Manager		1	Overall management for KWS system operation and coordination with CWASA head office
KWS Assist. Manager		1	Assist System Manager and responsible for overall system monitoring & control
	Monitoring & Control	4	Monitoring and control of the system using SCADA system coordinating sections of major facilities
	Data Processing & Analysis	2	Data collected from major facilities will be managed with analysis for improvement and stable operation of the facilities through the future
O&M for Intake to Transmission Pipeline			Physical O&M of the facilities from Intake to Transmission Pipelines
	Department Manager	1	Management of the Department (organizational & personnel, budget and technology)
	Process Eng	1	Water and sludge treatment processes are managed
	Mechanical Eng	1	Inspect, study and find countermeasures on mechanical equipment for concerned facilities.
	Electrical Eng	1	Inspect, study and find countermeasures on electrical equipment for concerned facilities.
	Instrumentation Eng	1	Inspect, study and find countermeasures on instrumentation equipment for concerned facilities.
	1.Intake Facility Sec.		O&M of Intake Facilities
	Section manager	1	Management of the Section
	Technician	2	Maintenance of Intake facility
	Operator	4	Intake pump operation
	2.Water Treatment Sec.		O&M of water treatment facilities
	Section manager	1	Management of the Section
	Technician	5	Maintenance of water treatment facilities
	Operator	10	Monitor and Operate water treatment facilities
	3.Sludge Treatment Sec.		O&M of sludge treatment
	Section Manager	1	Management of the Section
	Technician	2	Maintenance of sludge treatment facilities
	Operator	6	Monitor and Operate sludge treatment facilities
	4.Laboratory		Water quality examination
	Section manager (Chemist)	1	Management of the Section with quality control in the examination
	Labo. Assistant	4	Conduct water quality examination
	5.Pipeline maintenance Sec.		O&M of conveyance and transmission pipelines with accessories (including serge tank & communal faucet systems)
	Section Manager	1	Management of the Section

De-partment	Section	Number of Staff	Job Description
	Plumber	4	Survey and repair of pipes
O&M for Distribution Facilities			Physical O&M of the distribution facilities
	Department manager	1	Management of the Department
	Mechanical Eng.	1	Inspect, study and find countermeasures on mechanical equipment for concerned facilities.
	Electrical Eng.	1	Inspect, study and find countermeasures on electrical equipment for concerned facilities.
	Instrumentation Eng.	1	Inspect, study and find countermeasures on instrumentation equipment for concerned facilities.
	1.Reservoir/ E.T Sec		O&M of Reservoir/ E.T
	Section manager	1	Management of the Section
	Technician	3	Maintenance of reservoir/ E.T
	Operator	7	Operate transmission pump
	2.Main Pipe/Sector Chamber & DMA Sec.		O&M of main pipeline, Sector chambers and DMA
	Section Manager	1	Management of the Section
	Leakage Monitoring Team	15	Conduct monitoring of leakage by DMA for three sub-service areas
	Sector Manager	10	Management of Water supply business
	Administrative staff	10	Administrative work
	IO&M of facilities(including investigation & repair)	27	Conduct investigation on leakage receiving information from monitoring team and repair pipes as required
	Customer service	10	
	3.Water Meter maintenance Center		Meter calibration and replacement of broken meters and promotion of willingness to pay by customers
	Center manager	1	Management of the Section and conduct public education on water meter use
	Water Meter Maintenance staff	20	Meter calibration and replacement of broken meters
Total No.		164	

Under Customer Services at the ten Sector Field Office, a total of 290 staff is required for meter reading and public relation works as summarized in Table 9.9.2 (150 connections/person are assumed to estimate required number of staff in Customer Services).

Table 9.9.2 Number of Customer Services in Each Sector

Sector	Number of Staff	Sector	Number of Staff	Sector	Number of Staff
Sector A	18	Sector D	47	Sector H	33
Sector B	25	Sector E	26	Sector I	33
Sector C	15	Sector F	27	Sector J	10
		Sector G	47		
Sub-Total	58	Sub-Total	147	Sub-Total	85
Total 290					

CHAPTER 10

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

CHAPTER 10 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

10.1 Project Requirements for Environmental Procedures in Bangladesh

10.1.1 Environmental Clearance Required for Water Supply Project

(1) Environmental Clearance Requirements

As discussed in Chapter 2.2.3, in accordance with Clause 7 of the Environmental Conservation Rules, 1997 (ECR), all new industries and projects must apply for a Site Clearance Certificate (SCC, or Environmental Site Clearance (ESC)) and/or an Environmental Clearance Certificate (ECC) to obtain necessary environmental clearance from the DOE.

As specified also in Clause 7 (1) of the ECR, for the purpose of the issuance of ECC, the industrial units and projects shall, in consideration of their sites and potential environmental impacts, be classified into four categories i.e. (a) Green, (b) Orange – A, (c) Orange – B and (d) Red.

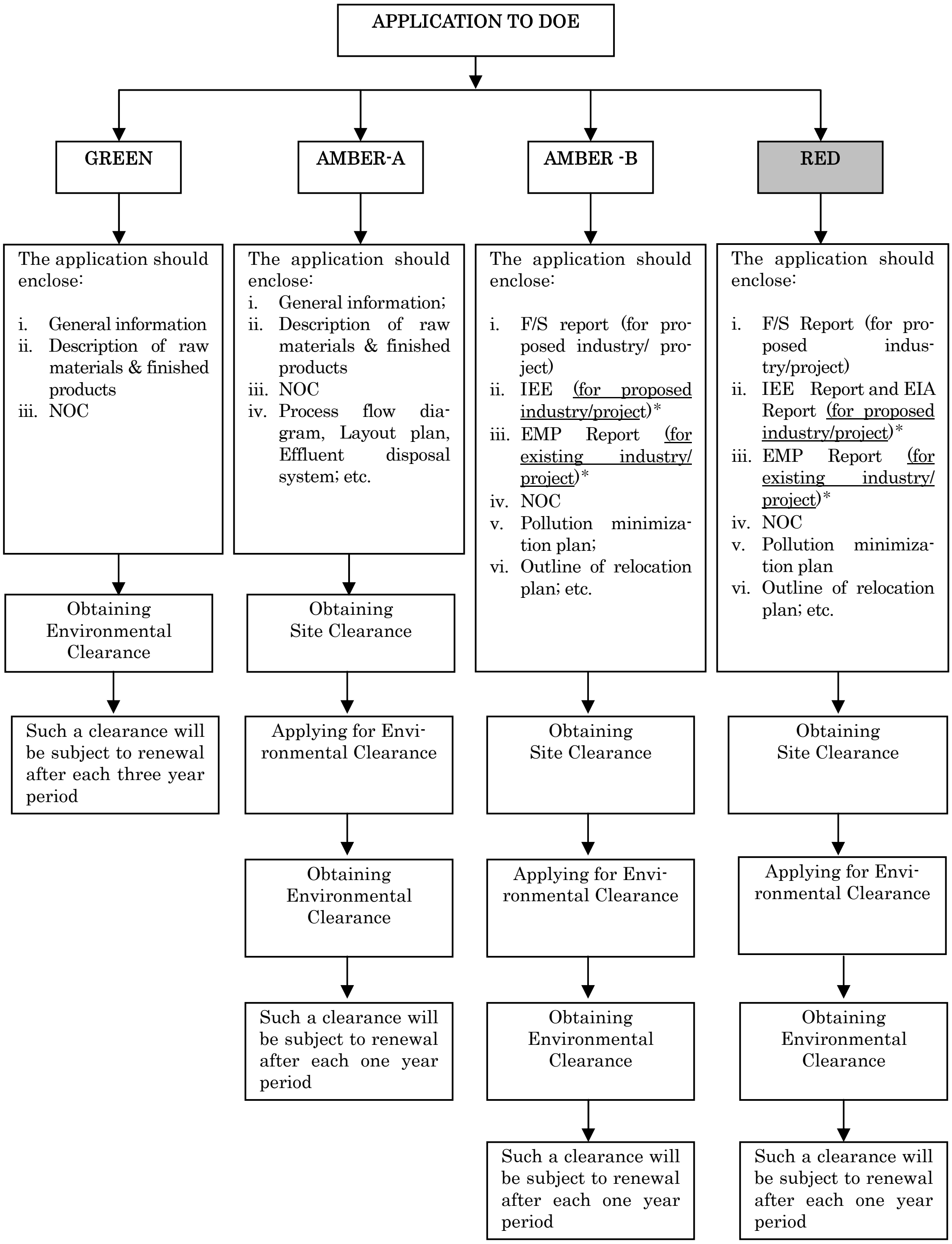
(2) Categorization of the Karnaphuli Water Supply Project

Schedule 1 of the ECR is the category classification of the most common industries and projects, with the “Red” category including “No.62 Water treatment plant” and “No.64 Water, power and gas distribution line laying/relaying/extension”. Thus, the Karnaphuli Water Supply Project was previously (during Phase 1) classified as a “Red” category project and this is still the case in accordance with the prevailing legislation.

Consequently the project proponent (CWASA) was required to prepare IEE and EIA reports according to the relevant laws and guidelines, which are discussed in Chapter 2.2.3. The above reports were prepared as part of Phase 1 of the project, as discussed in Chapter 10.2.

(3) Application for Environmental Clearance

As specified in Clause 7 (5) of the ECR, a project proponent shall apply to the concerned Divisional Officer of DOE in Form-3 along with the appropriate fees and necessary documents for environmental clearance. These procedures are shown in Figure 10.1.1.



NOC ; No Objection Certificate, usually obtained from local government, F/S; Feasibility Study, IEE; Initial Environmental Examination, TOR; Terms of Reference, EIA; Environmental Impact Assessment, EMP; Environmental Management Plan,
** ; See 3) Environmental Assessment Process in WARPO Guidelines*
Source; EIA Guidelines for Industry 1997, DoE, MoEF,

Figure 10.1.1 Flow Chart of Environmental Clearance Procedure

10.1.2 Summary of Phase 2 Project Components

The Phase 2 Project is the expansion of the Phase 1 Project, as discussed in Chapter 7, with the main project components of Phase 2 shown in Table 10.1.1 and the location of the project area and the main facilities shown in Figure 10.1.2.

Table 10.1.1 Project Components of Phase 2

		Major Works	
1	Intake Facilities	1) Mechanical Works	Pumps for 150,000m^3/d
		2) Electrical Works	Additional transformer and generator
		3) Civil Works	Yard piping
2	Conveyance Pipeline	DN 1200mm in road	From Intake to WTP including surge tank
3	Water Treatment Plant	Production capacity 143,000 m^3/d	Civil, Mechanical, Electrical works.
4	Transmission Pipeline	DN 1200 mm in road	From WTP to Nashirabad Reservoir including surge tank
5	Nashirabad Reservoir	Reservoir with a capacity of about 24,800 m^3/d and associated works	Civil, Mechanical, Electrical works.
6	Transmission Pipeline	DN 1,100 mm in road	From Nashirabad Reservoir to Halishahar Elevated Tank
7	Halishahar Elevated Tank	Volume 2,400 m^3	Located on land owned by CWASA
8	Distribution Pipelines	1) Northern service area	Area 566 ha, L=89.8km
		2) Central service area	Area 1,213 ha, L=185.6km
		3) Western service area	Area 1,284 ha, L=207.4km
9	Lateral Pipelines		In above sub-service areas, covering an area of 3,063 ha
10	Service Connections		About 51,360 nr

Figure 10.1.2 Location of the Phase 2 Project Area

10.1.3 Environmental Laws and Regulations to be considered for Design of Project Facilities

(1) General

As discussed in Chapter 2.2 the most important environmental rules and regulations are as follows:

- Environmental Conservation Act 1995 (ECA)
- Environmental Conservation Rules 1997 (ECR)

(2) Environmental Conservation Act 1995

The ECA is the basic law on the environment and mainly contains the following items:

- Environmental conservation
- Authority to control development and pollution
- Preparation of environmental standards including effluent standards
- Review and approval of environmental impact assessment (EIA)
- Authority of entry for inspection
- Regulation of fine to violation

Section 12 of the Act stipulates “No industrial unit or project shall be established or undertaken without obtaining environmental clearance from the Director General of DOE in the manner prescribed by the Rules”.

(3) Environment Conservation Rules (ECR), 1997

The ECR has been promulgated, under the ECA, to evaluate and review the environmental impact of various projects and activities. The necessary procedures for environmental approval are also established in the ECR as mentioned in Chapter 10.1.1.

In addition, the Environmental Quality Standards for Bangladesh (EQS), which are included in the ECR have been set to control the ambient environmental quality. The specified limits, which may have adverse impacts on the environment, are shown in the respective standards for the following fields (Standards are shown in Supporting Report 10.1.1 to Supporting Report 10.1.10):

- Air quality standards
- Water quality standards (Inland surface water and Potable water)
- Noise quality standards (General)
- Noise quality standards (For Motor vehicle or mechanical vessel)
- Motor vehicle exhaust quality standards
- Quality standards for mechanized vessel exhaust
- Quality standards for Odour
- Sewer discharge quality standards
- Waste discharge quality standards for industrial units and projects
- Gaseous discharge quality standards for industrial units and projects
- Waste emission or discharge quality standards for classified industries
  (Fertilizer, Integrated textile mill & large processing unit)

Most of the above environmental standards are included in Appendices 10.1.1 to 10.1.10.

(4) Other Laws /Regulations/Plans Related to the Environment

There are a considerable number of other laws, regulations and standards related to the environment, such as the Factories Act, Factory Rules, Acquisition and Requisition of Immovable Property Ordinance, Building Construction Act, Forest Act and the Bangladesh National Environment Action Plan.

The Government of Bangladesh has already ratified (or signed on) the major international conventions/legislation for environmental conservation, such as the UN Framework Convention on Climate Change, Convention of Biological Diversity, World Heritage Convention, and RAMSAR Convention.

The major laws, regulations and standards, which are to be considered relevant to the project, are shown in Table 10.1.2. This table also includes details of which stage of the project they are relevant.

Table 10.1.2 Major Laws/Regulations and Standards to be considered in the Project

Title	Environmental Clearance	Planning Stage	Construction Stage	Operation Stage	Project as a whole
I. Environmental Clearance					
Bangladesh Environmental Conservation Act 1995	x	x	x	x	x
Environmental Conservation Rules 1997 as a whole	x	x	x	x	x
-Form-1 Application for remedy					x
-Form-2 Notice of intention for collection of sample			x	x	x
-Form-3 Application for Environmental Clearance Certificate	x	x	x	x	x
-Form-4 Pollution under Control Certificate			x	x	
-Schedule-1 Classification of industrial units or projects based on its location and impact on environment	x				
-Schedule-2 Standards for Air			x	x	
-Schedule-3 Standard for Water			x	x	
-Schedule-4 Standard for Sound			x	x	
-Schedule-5 Standards for Sound originating from Motor Vehicles or Mechanized Vessels			x	x	
-Schedule-6 Standards for Emission from Motor Vehicles			x	x	
-Schedule-7 Standards for Emission from Mechanized Vessels			x	x	
-Schedule-8 Standards for Emission from Mechanized Vessels			x	x	
-Schedule-9 Standards for Sewage Discharge			x	x	
-Schedule-10 Standards for Waste from Industrial Units or Projects waste			x	x	
-Schedule-11 Standards for Gaseous Emission from Industries or Projects			x	x	
-Schedule 12 Standards for Sector-wise Industrial Effluent or Emission					
-Schedule-13 Fees for Environmental Clearance Certificate or Renewal	x				x
-Schedule-14 Fees to be realized by the Department of Environment for supplying various analytical information or data or test results of samples of water, effluent, air and sound.					x

Title	Environmental Clearance	Planning Stage	Construction Stage	Operation Stage	Project as a whole
Bangladesh Environment Conservation Act (Amendment 2000)			x	x	
Bangladesh Environment Conservation Act (Amendment 2002)			x	x	
II. Planning Stage (Land Acquisition and Resettlement)					
Acquisition and Requisition of Immovable Property Ordinance 1982		x			x
The Acquisition of Immovable Property Rules 1982		x			x
Land Reform Ordinance		x			x
he Movable Property Requisition (Compensation) Rules, 1990		x			x
Acquisition and Requisition Act, 1994		x			x
III. Construction Work and Operation of Water Supply Facilities					
East Bengal protection and conservation of fish Act 1950			x	x	
The Protection and Conservation of Fish Rules 1958			x	x	
Antiquities Act 1958			x	x	
Port Rules, Shipping Operation (1960,1966)			x	x	
Factories Act 1965			x	x	
Pesticide Ordinance 1971					
Antiquates (Amendment) Ordinance 1976					
Municipal Ordinance 1977					x
Factory Rules 1979					x
Agricultural pesticide (amendment) act					
Agricultural pesticides (Amendment) ordinance 1983					
The Pesticide Rule 1985					
Bangladesh standard specification for drinking water 1990			x	x	
The Penal Code 1996			x	x	x
Building Construction (Amendment) Act and Building Construction Rules 1996			x		x
Inspection and Enforcement Manual 2008			x	x	x
Labor Act 2006			x	x	x
Public Health Ordinance 1994			x	x	x

10.2 Present Status on Environmental Clearance for Karnaphuli Water Supply Project (Phase 1and 2 Projects)

10.2.1 Progress in Obtaining Environmental Clearance

An IEE report (dated December 2005) and an EIA report (dated June 2007) were prepared for the Karnaphuli Water Supply Project and both were submitted to the Department of Environment (DOE) to obtain the necessary approvals. The descriptions in both reports cover Phases 1 and 2 of the Project.

CWASA received approvals with conditions from the DOE as follows:

(1) Environmental Site Clearance, issued on January 9, 2006 (Memo No. DoE /Clearance /2225 /2005/75).

In accordance with Item No.11 of the Terms of Conditions, “The Clearance is valid for one year from the date of issuance and CWASA shall apply to the Chittagong Divisional Office of DOE at Chittagong with a copy to Head Office at least 30 days ahead of expiry.” The terms and conditions of the ESC are shown in Supporting Report 10.2.1, which is rewritten from the original version.

(2) Approval of Environmental Impact Assessment (EIA) Report, issued on September 13, 2007 (Memo No. DoE/Clearance/2225/2005/2416).

Approval of the EIA Report allows CWASA to undertake activities for land and infrastructural developments including construction work. These activities are in progress at present.

The approval includes various conditions, such as requirements for proper mitigation countermeasures and monitoring for the site preparation, construction and operation stages and for the resettlement plan. It is also stated in Clause 10 that “the Project Proponent (CWASA) shall, after installation of the plant as well as other pollution control facilities and equipment, apply for Environmental Clearance Certificate”. Supporting Report 10.2.2 is a copy of the approval, which is rewritten from the original version.

Table 10.2.1 summarises the status of the steps leading to the current status of Environmental Clearance for the project (both Phases 1 and 2), as well as future steps, based upon the above approvals and relevant legislation.

Table 10.2.1 Progress in Obtaining Environmental Clearance for Karnaphuli Water Supply Project (Phases 1 and 2)

Subject	Action/Process	Record and Status of Progress		
I. Procedure of Environmental Clearance (Obtaining SCC* and ECC)				
(1) Preparation of Project Plan	Prepared by the proponent	Done		
(2) Preparation of IEE Report	Prepared by a certificated consultant (sub-contract) and submit to the project proponent	Done	by House of Consultants Ltd.	Dec. 10th, 2005
(3) Acceptance of IEE Report	Draft IEE report shall be accepted by the proponent and finalized.	Done	by CWASA	
(4) Obtain NOC from District Commissioner	On the other hand, NOC (No Objection Certificate) will be obtained from Local Authority (Commissioner at each District office) separately	No Need	by CWASA (Chittagong District Commis-sioner)	
(5) Submit necessary documents to obtain SCC (Site Clearance Certificate) from DOE	Proponent should submit the Final IEE Report to Divisional DOE with an application letter (Form 3 Application for Environmental Clearance) and NOC	Done	by CWASA	Dec. 4th, 2005
(6) Issuance of SCC	IEE report and the Application Form will be reviewed and ESC will be issued without/with terms and conditions by DOE	Done	by DOE	Jan. 9th, 2006
(7) EIA study and EIA report preparation	After obtaining SCC, EIA study will be conducted and EIA report including Environmental Management Plan will be prepared by a consultant and submitted to proponent.	Done	by House of Consultants Ltd.	Nov. 3rd, 2007
	In case that the terms and conditions are accompanied with SCC, EIA report should satisfy them.	Done	by CWASA	
(8) Acceptance of EIA report	Proponent should review and accept the EIA report for finalization	Done	by DOE	
(9) Submit necessary	Proponent should submit the Final EIA Report to Divi-	Done	by CWASA	Mar.

Subject	Action/Process	Record and Status of Progress		
documents to DOE to obtain ECC	sional DOE with an application letter (Form 3 Application for Environmental Clearance) for obtaining ECC.			14th, 2006
(10) Approval of EIA Report	The EIA Report and the Application Form will be reviewed and ECC will be issued without/with terms and conditions by DOE. Without obtaining approval of EIA Report, proponent shall not be able to start the physical activity of the project and also not be able to open L/C.	Done	by DOE	Sep. 17th, 2007
	If the EIA Report and the Application Form are not satisfied with requirement by DOE, Approval of EIA Report, instead of ECC, will be only issued by DoE with terms and conditions. Thus proponent should fulfil them in revised EIA Report or in additional documents to obtain ECC.	Done	by DOE	
(11) Submit further necessary documents to DOE to obtain ECC	Upon completion of activities for land and infrastructure development including construction work, proponent should submit further necessary documents to Divisional DOE with an application letter for obtaining ECC.	Not yet	by CWASA	
(12) Issuance of ECC	The documents will be reviewed and ECC will be issued without/with terms and conditions by DOE.	Not yet	by DOE	
(13) Start Operation of the Project	After issuance of ECC the proponent can start operation of the project.	Not yet	by CWASA	
II. Renewal of Environmental Clearance				
(1) Submit necessary document to renew SCC from DOE	Renewal of SCC should be done after each one-year period	done	by CWASA	Jul. 5, 2012
(2) Issuance for Renewal of SCC	The documents were reviewed and renewal of SCC was issued /with terms and conditions by DOE.	done	by DOE	Jul. 31, 2012
(3) Submit necessary document to obtain SCC for Phase 2 Project from DOE	Renewal of SCC should be done after each one-year period	done	by CWASA	Sep. 20, 2012
(4) Issuance of SCC of Phase 2 Project	Expected to receive from DOE Chittagong by the end of November, 2012	Not yet	by DOE	

10.2.2 Issues, Problems and Countermeasures

Table 10.2.2 summarises the terms and conditions of the DOE, together with the countermeasures/actions taken by CWASA to address them during the preparation of the detailed design and bidding documents (and subsequent Contract Documents) and during construction supervision, together with future actions.

Table 10.2.2 Terms and Conditions of DOE Relating to ESC and Approval of EIA Report on Karnaphuli Water Supply Project and Action to be taken

Issue/Item	Terms and Conditions	Countermeasures/Action Taken
	1. Project Proponent may undertake activities for land development and infrastructural development of the project subject to conditions laid out in the Site Clearance issued from the DOE on 09 January 2006 as well as the following:	
I. Pre-Construction (Planning) Stage		
(1) Land acquisition/resettlement	1.11 Resettlement plan should be properly implemented and people should be adequately compensated, where necessary.	Resettlement plan was implemented by CWASA.
(2) Updating water quality data before the design of WTP	8. Before finalizing of the design of Karnaphuli Water Treatment Plant following water quality data should be updated: (1) Spatial variability of water quality along the rivers Karnaphuli and Halda. (2) Variables to be chosen for water quality analysis should include: temperature, TSS, TDS, turbidity, conductivity, pH, DO, hardness, nutrients (NH4-N, NO3-N), Phosphorus), organic matter (COD, BOD), major	Further sampling and analysis of water quality was carried out during the detailed design and the results of this were taken account of in the preparation of the detailed design.

Issue/Item	Terms and Conditions	Countermeasures/Action Taken
	ions (Sodium, Potassium, Calcium, manganese, Chloride, Sulphate, other inorganic variables (Fluoride, Boron, Cyanide), trace elements, heavy metals, Arsenic, Organic contaminants (oil and petroleum products, pesticides), faecal coliform and total coliform. (3) Hydrodynamic and water quality models should be used by constructing different scenarios for production and quantification of the potential impacts on water quality.	
	9. Based on up-to-date water quality data, model out-put as well as other scientific study WTP should be designed, installed and operated.	Design and specification of WTP takes account of up-to-date water quality. Operation of the WTP will be adjusted as necessary depending upon the raw water quality, in order to ensure that treated water quality meets the National Standard and such that water discharged from the site and sludge meet the prevailing regulations.
II. Countermeasures against construction work		
(1) Top soil restoration and soil erosion	1.1 During site preparation, top soil shall be kept aside and be restored after completion of the said activities	Construction practices are required to be in accordance with this requirement.
	1.3 Soil erosion caused by removal of vegetation cover and excavated loose soil shall be checked through repopulation with local vegetation as soon as possible; loose soil shall be covered and stored away from the edge of the hoar/river.	Construction practices are required to be in accordance with this requirement.
(2) Protection habitats and fish breeding sites	1.4 Proper construction practices shall be followed that minimize loss of habitats and fish breeding, feeding & nursery sites.	Construction practices are required to be in accordance with this requirement.
	1.8 Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora and fauna would be demolished or destructed.	Construction practices are required to be in accordance with this requirement.
(3) Solid waste management	1.12 Construction material should be properly disposed of after the construction work is over.	Construction practices are required to be in accordance with this requirement.
	1.2 The open areas that are grasslands can be used for construction but with appropriate safeguards to maintain materials and dump sites from contaminating hoar/river waters.	Construction practices are required to be in accordance with this requirement.
(4) Air pollution	1.10 To control dust vehicles and equipment to be used for this project shall be maintained properly, water trucks shall be used, stockpiles to be located away from sensitive receptors and vehicle speed limits shall be enforced.	Construction practices are required to be in accordance with this requirement.
(5) Noise pollution	1.6 In order to control noise pollution, vehicles & equipment shall be maintained regularly; working during sensitive hours and locating machinery close to sensitive receptors shall be avoided.	Construction practices are required to be in accordance with this requirement.
(6) Sanitation in labour camps	1.5 Proper and adequate sanitation facilities shall be ensured in labour camps throughout the proposed project period.	Construction practices are required to be in accordance with this requirement.
(7) Permission from concerned authority (trees, hilly land)	< ESC incidental Conditions 7. > No activity of cutting/razing/dressing of hill or hilly land is endorsed without permission/clearance of the concerned authority of the government.	Permission to be obtained, if required.
	< ESC incidental Conditions 8..> Appropriate permission would be required to obtain from the forest department in favor of cutting/felling of any plant/sapling forested by individual or government before doing such type of activity.	Permission to be obtained, if required.
III. All Stages (Pre-construction, Construction, Operation)		
(8) Comply with air and water standards	2. Limit Condition for Discharges to Air and Water: The Site Clearance Certificate must comply with schedule 2 and 10, rule 12 of the Environment Conservation Rules, 1997.	Design complies with schedules 2 and 10. Construction practices are required to meet the schedule.

Issue/Item	Terms and Conditions	Countermeasures/Action Taken
(9) Comply with noise standard	3. Noise Limit: The Site Clearance Certificate must be comply with schedule 4, rule 5(2) of the Noise Pollution (Control) Rules, 2006.	Design complies with this requirement. Construction practices are required to meet the schedule.
(10) Environmental Management Plan	1.13 The Environmental Management Plan included in the IEE and EIA reports shall be implemented and kept functioning on a continuous basis.	The EMP is being implemented during the construction contracts.
	1.9 All the required mitigation measures suggested in the IEE and EIA reports along with the emergency response plan are to be strictly implemented and kept operative/functioning on a continuous basis.	The mitigation measures are included in the design and contract documents, where appropriate. During construction mitigation measures are being taken.
IV. Obtaining Environmental Clearance Certificate		
(1) Without ECC Operation cannot start	10. Project Proponent shall, after installation of the plant as well as other pollution control facilities and equipment apply for Environmental Clearance Certificate without which, proponent shall not start operation of the project.	To be actioned by CWASA in the future.
(2) Renewal of ESC after 6 years absence	< ESC incidental Conditions 11.> Environmental Site Clearance (ESC) is valid for one year from the date of issuance (January 9, 2006) and CWASA shall apply for renewal to the Chittagong Divisional Office of DOE at Chittagong with a copy to Head Office at least 30 days ahead of expiry.	Renewed
V. Environmental Monitoring		
(1) Record of monitoring	4. Monitoring and Recording conditions:	
	M1.1 The results of any monitoring required to be conducted by this Clearance Certificate must be recorded.	To be actioned by CWASA
	M1.2 The following records must be kept in respect of any samples required to be collected for the purpose of this Clearance certificate:	
	(a) The date(s) on which the sample was taken;	
	(b) The time(s) at which the sample was collected;	
	(c) The point at which the sample was taken; and	
	(d) The name of the person who collected the sample.	
(2) Monitoring items and timing	M2. Requirement to monitor concentration of pollutants discharged	To be actioned by CWASA
	M2.1 For each monitoring, the Clearance Certificate holder must monitor (by sampling and obtaining results by analysis) the following parameter; (1) water flow, water quality, air quality (SPM), the surrounding areas for spread of invasive species, the changes in aquatic habitats before, during and after construction, (2) fish catching during and after construction.	
(3) Reporting	5. Reporting Conditions: Environmental Monitoring Reports shall be made available simultaneously to Head Quarters and respective Divisional offices of the Department of Environment on a quarterly basis during the whole period of the project.	To be prepared by CWASWA and concerned parties
(4) Notification of Environmental Harm	6. Notification of Environmental Harm: The Clearance Certificate holder or its employees must notify the Department of Environment of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident.	To be actioned as necessary by CWASA.
(5) Open L/C	7. Project Proponent may open L/C (Letter of Credit) for importing machineries for the project which shall also include machineries relating to pollution devices;	Actioned by CWASA

With regard to obtaining the issuance of ESC for Phase 2 Project, CWASA sent a letter to the DOE Chittagong on July 5th, 2012 requesting the DOE to advise on what needs to be done to address the fact that the ESC has not been renewed and on other issues related to the environment, taking into account the status of the Phase 2 project (refer to Supporting Report 10.2.3). DOE Chittagong responded on July 9th, 2012 stating that a fee of 875,000 BDT should be paid.

After the renewal of the ESC by CWASA, the DOE issued the letter on July 31, 2012 on the acceptance of the renewal with four conditions (refer to the letter in Supporting Report 10.2.4). These conditions and a further requirement, as abstracted from the letter are as follows:

> Renewal of the site clearance certificate will be valid for a period of 1 (one) year with effect from 17th January 2012 to 16th January 2013.
>
> 1) No activity of cutting/razing/dressing of hill, helloes is favoured with this renewal.
> 2) Must submit Environmental Monitoring reports as mentioned in the article 5 of the approved EIA
> 3) Application along with renewal fees must be submitted to this office prior to 30 days of the expiry of the certificate.

Beside this you will also abide by terms and conditions mentioned in the original Site Clearance Certificate and approved EIA (refer to the letter attached in Supporting Report 10.2 in this report).

As mentioned in the conditions, “Environmental Monitoring Report” on a quarterly basis, shall be submitted by CWASA with reference to the implementation of the Phase 1 Project.

With reference to the Phase 2 Project, CWASA sent a letter to DOE Chittagong to obtain “Environmental Site Clearance” on September 20, 2012. DOE Chittagong replied to CWASA on September 20, 2012 about the need for the site clearance certificate for Phase 2 of KWSP with requisite fees (refer to Supporting Report 10. 2.5).

According to the request from DOE Chittagong, CWASA submitted the requisites to obtain the ESC for the Phase 2 Project (refer to Supporting Report 10.2.6), following which DOE Chittagong will issue the ESC in November, 2012.

10.3 Specific Environmental and Social Aspects in the Project Sites

10.3.1 Social Aspect

This sub-section refers to social problems which are related to people’s participation in the Project and social problems caused by the implementation of the Project. Individual environmental problems and their mitigation measures are described in sub-section 10.3.2 and 10.4.

(1) Land acquisition and Resettlement

There is no need for additional land and resettlement for the construction of water supply facilities for Phase 2 project. The land required for Phase 2 will be managed within the area obtained during the project preparation stage for Phase 1 and/or owned by CWASA. However, before commencement of the Phase 1 Project, six households (about 40 persons) resided at the south-eastern edge of the WTP site, were relocated.

The route for the conveyance and transmission pipelines along Kaptai road shall be ensured, as negotiated with RHD both for Phase 1 and 2 Projects. Figure 10.3.1 shows the land area to be used for the expansion of facilities for Phase 2 within the area obtained for Phase 1. There is therefore no need for resettlement of people or compensation. The land where Halishahar Elevated Tank is located is owned by CWASA (as shown in Figure 10.3.1) and there is no need for resettlement of people.

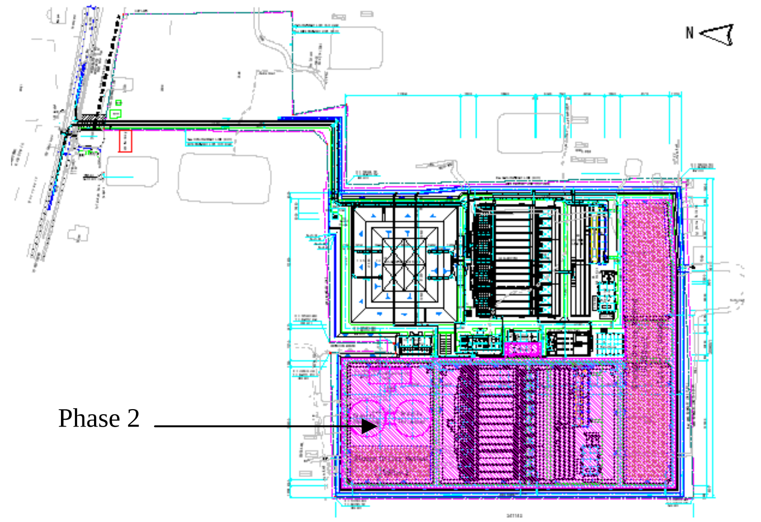
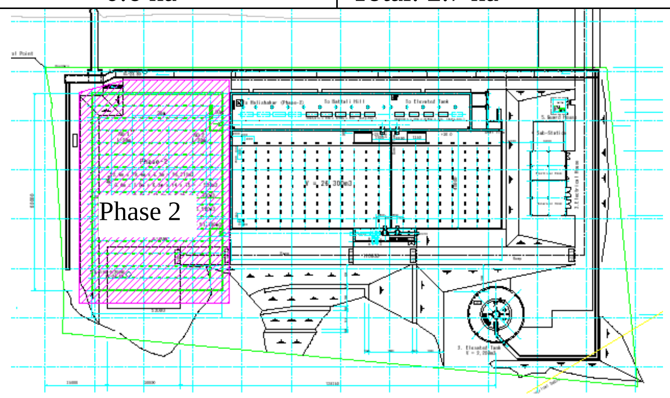
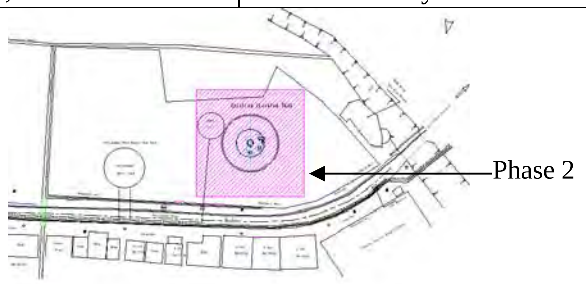
Facility	Required Area for Phase 2	Remarks
Karnaphuli WTP	5.0 ha	Total: 12.7 ha
		
Nashirabad Reservoir	0.6 ha	Total: 2.7 ha
		
Halishahar E.T	1,400 m^2	Land owned by CWASA
		

Figure 10.3.1 Land Area required for Expansion of Phase 2 Facilities within the Area obtained in Phase 1 and Additional Area

(2) People's Participation in the Project

1) Public's Response to the Project

Public consultation as a means of integration of local people's concerns into the Environmental Assessment process was conducted during the preparation stage of Phase 1 Project. The date and place of the meetings including the number of participants are shown below.

No	Date	Place	No. of Participants
1	12.09.05	Shantir Hat of Rangunia	20
2	12.09.05	Godown of Rangunia	24
3	13.09.05	Ward No.14 of Double Mooring thana	18
4	13.09.05	Ward No. 8 of Khulshi thana	20

Participants of public consultation meetings were local leaders, women's groups, representatives of professional groups such as farmers, businessmen, teachers, local elected representatives, etc. Both social and environmental consultants conducted the meetings together, which enabled them to collect/record opinions and views from their own perspectives. They explained all relevant points and issues in order to enable participants to comprehend the proposed project properly and to respond, accordingly.

The people also looked forward to participating indirectly in various economic activities and support activities associated with the project. Most of the people interviewed were not aware of any pollution hazard and also did not feel that the project would be a source of any hazard to them, except with regard to land acquisition for the project.

In general, the local people's response to the Karnaphuli Water Supply Project was positive and they were interested to receive the benefits of the project. Most of the people who live close to the treatment plant had no objection towards the implementation of the project, but they expressed concern about the loss of agricultural and productive land. The people along the pipeline did not feel concerned as the pipeline will go along an existing road. The people in the city area welcomed the project with great interest as it is likely to alleviate the problems of acute shortage of water from which they are suffering.

2) Willingness to Pay

People's "willingness to pay" for the water tariff is one of the criteria, which can be used in assessing residents' interest and understanding of the water supply service. The socio-economic survey which was conducted in July 2012 included the item "willingness to pay", as well as questions relating to various other issues, including water supply condition, sanitation and wastewater disposal. The survey was carried out in eight *Thana*s, which are part of the KSA, and answers from 1,047 properties of various types were collected. Ninety per cent of answers (939) were collected from households, and 10 per cent (107) from non-households, such as offices, hotels and schools. The results of the social survey are attached in Supporting Report 10.3.1.

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The survey covered three types of house/ building under the category of household and samples were collected from Pucca (41%), Semi-Pucca (33%) and Kutcha (26%), with the sampling of households being equitably distributed among different income groups. The percentage of households with a water supply connection was 98% in Pucca (high income group), 84% in Semi-Pucca (middle income group) and 24% in Kutcha (low income group). The connection percentage is higher in the higher income level households than in the low income level households. Therefore, service coverage at present (47%) is mainly contributed by Pucca and Semi-Pucca in household category. The average monthly income by type of house/building is 63,182 Taka in Pucca, 25,186 Taka in Semi-Pucca and 14,716 Taka in Kutcha. The average number of people per household is 5.80 persons and the overall average monthly income is 38,051 Taka/household affected by high income level households. In Pucca households the average monthly income is about 4 times higher than in Kutcha, whereas there is not such a big difference between incomes in Semi-Pucca and Kutcha households.

The present water supply provided by CWASA is not on a 24/7 basis for the majority of the service area, with service being limited to several hours per day and not every day of the week. In the survey the overall average of water supply service hours (hrs) in a day is 3.84 hours ranging from 3.78 hrs in Pucca to 4.27 hrs in Kutcha. Regarding the relationship between service hours of water supply in a day and willingness to pay, the respondents in the group of "1-3 hour of water supply" is the most positive (78% of respondents) to paying a higher water tariff.

According to the answers from households, 74% (696) of respondents have water supply connections from CWASA with the range being from 24% to 98% in the different house/building types, as mentioned above. Residents' opinion regarding willingness to pay for an improved water supply service is relatively positive and overall an average of 76% (512) of respondents served by CWASA (ranging from 43% in Kutcha to 82% in Pucca) are willing to pay a higher water tariff for provision of an improved services. The overall average amount that respondents are willing to pay is 353 Taka/month/household (0.9% of monthly income), with the monthly amount by income level as follows:

- Pucca: 442 Taka (0.7% of monthly income)
- Semi-Pucca: 246 Taka (1% of monthly income)
- Kutcha: 198 Taka (1.3% of monthly income)

With reference to willingness to pay, respondents are willing to pay about 1% of their monthly income, which is well below 5% that is usually applied in developing countries with reference to affordability by low income households.

3) Improvement in People's Consciousness on the Importance of Water Supply

In the recent survey all of the respondents requested CWASA to provide improved water supply services in terms of 24/7 service, sufficient water pressure and water quality for drinking purposes. On the other hand, the results of the previous social survey, which was conducted in 2000, showed that 85% of respondents requested a continuous supply, 48% sufficient water pressure, 45% water quality for drinking purpose. Although the number of samples was limited to only 60 in the survey of 2000, the results imply that the residents' expectation of the water supply service was not so high, except for 24/7 service. After 12 years, people's concerns and expectations on the need for an improved water supply in all respects has drastically increased.

(3) Social Problems Caused by Construction Work and Mitigation Measures Required

During construction work for the Project inconvenience to the people's lives may occur. In this regard, topics about how to deal with residents' complaints and concerns on the construction work is discussed. On the other hand, environmental problems including social related matters and mitigation countermeasures thereto are summarized in sub-section 10.3.5, Environmental Management Plan.

1) Complaints from Residents to Construction Work

Disruption to traffic and congestion, mainly caused by pipe laying in and beside roads is potentially the reason for the highest number of complaints. In order to minimize complaints traffic management measures in major roads, such as Kaptai Road will be provided, with working areas limited to 100 meters long in order to minimize disturbance to traffic flow (refer to Chapter 8). Inconvenience to residents may also occur during the construction of the distribution network in built up areas.

To mitigate inconvenience, residents' complaints and opinions should be collected at timely public meetings in the concerned areas. Public meetings can be opportunities for building mutual understanding between residents and the Contractor/ CWASA, and people's participation in the project as well.

Residents along the conveyance and transmission pipelines (outside the CWASA service area) are not served by this Project, although they may be inconvenienced by construction work along Kaptai Road. For their benefit, community faucet systems are planned to be installed along the transmission pipeline route, as discussed in Chapter 7.

2) Residents Concern on the Migration of Large Number of Labor to the Construction Area.

According to the public consultation, residents were concerned that assembly of people during project activities may adversely influence the local environment. The problem can be negligible in the case where local residents are employed in the Project. In the case where non-local labor forces are employed, they need to be trained regarding hygienic habits and behavior. However, the influence of migration may be minimal because the increase in the number of workers is limited to the construction period.

Public meetings shall be timely conducted before and during construction work to concerned people. Further details on impacts and mitigation countermeasures are described in the following sub-sections from 10.3.3 to 10.3.5.

10.3.2 Physical Environmental Aspect

In general the following items/issues should be carefully considered to avoid, minimize and/or mitigate possible negative impacts due to the project in terms of physical environment (natural environment and items related to environmental pollution).

(1) Location of Project Sites in and Vicinity of the Protected Areas and Environmentally Sensitive Areas

1) Protected Areas

No protected area and national park/reserve are located in and around the project area. There are two wildlife sanctuaries (Pablakhali and Rampahar Sitaphar) which are located in Chittagong Zila/District, but these are not in or in the vicinity of the project area.

2) Areas with Unique Archeological, Historical or Cultural Value

Chittagong City and the neighboring areas have some historical/cultural/tourism locations such as the Tomb of Sultan Bayazid Bostami, World War II Cemetery, Shrine of Shah Amanat, etc. However, none of the locations are located in or in the vicinity of the construction sites.

3) Areas with Specific Topographical and Geological Features

Existing topographic and geological conditions are described in Chapter 2. There are no areas with specific topographical or geological feature in the project area.

(2) Vegetation, Animals and Valuable and Endangered Species

As it is located in a tropical climate zone with much rainfall, there are many trees and grass lands in Bangladesh. The Chittagong District/Zila is known for its timber-yielding plants such as teak, chambal, gurfan. Besides, there are also many medicinal plants grown in the forests. However, the vegetation areas are scattered in the urban area. Trees are mostly seen on slopes of hills, along roadsides or in the yards of houses. Trees commonly seen are Sisoo, Mahogonj, Babla, Neem, *Eucalptus sp.*, etc. In addition, fruits and horticultural crops are grown in farmlands or homesteads. These includes mango, jack fruit, coconut, etc.

There is no remarkable wildlife in the project area, except some common lizards, as human activities covering the whole area. In Chittagong District/Zila, there are some endangered species of terrestrial fauna and flora, which are recorded in an environmental data book. However, it may be unlikely to find such species in the project area.

(3) Rich Fish Resources and Fishery Activity

Both Karnaphuli River and Halda River are located upstream of the estuary of the Bay of Bengal, and are tidal rivers. Therefore, the rivers are rich in freshwater and marine fish resources having habitat of breeding and hatchery and river fishery is active. There are 76 species and 35 families of fish in the area, of which 49 species are either endangered or threatened.

(4) Specific Hydrological Conditions of Karnaphuli River and its Tributaries due to Coastal and tidal Effect

The most important hydrological characteristic of the Karnaphuli River is that it is a tidal river the river flow is influenced by the tide, with the tide reversing the direction of the river flow. Saltwater intrusion is one of the significant environmental factors for the river. The tidal flow generally reaches to a location about 10 km upstream from the confluence of the Karnaphuli and Halda Rivers. Saltwater intrusion depends on conditions such as the tide water level, discharge of the Halda and Karnaphuli Rivers.

(5) Air Pollution

In Chittagong, many old vehicles run without control of exhaust emissions and large industries are located in and around the city. Accordingly, gases (SO_X, NO_X, etc.) and suspended particles (smoke, dust, fumes and etc.) are a serious concern. However, there is no site specific air quality data. At present, the only reliable means to assess the air quality in the project area is the clear visibility of the surrounding area. The project area is located beside a number of rivers. Clean air flowing over the rivers spreads on and around the project area. From visual inspection air is clean and there is no sign of air pollution except at the roadside in populated urban areas.

(6) Surface Water Quality

Regarding point sources and non-point sources of wastewater discharge to the Karnaphuli River, the point sources such as factories are mostly located in the city except for Karnaphuli Paper mill, which is located at Chandraghona nearly 12 km upstream of the intake point. Major non-point sources of wastewater are drainage from built-up areas and agricultural fields along the Karnaphuli and Halda Rivers.

Based on the survey in the EIA study in Phase 1, water quality in the Karnaphuli River is not polluted and relatively good in comparison with that in other major rivers in the country.

(7) Ambient Noise

Chittagong is a noisy city because of many kinds of sound, especially from old vehicles. It seems that most people do not care about noise at present and the requirement for an environment without noise is much lower than in other development countries, although it may be better for the people if the environment was quieter.

(8) Solid Waste Disposal

In general, solid waste which is generated from construction work will be earth material and other materials used for concrete structures, mechanical facilities and pipes. No toxic and hazardous wastes will be generated. However, there is a significant length of existing asbestos cement pipes in the project area. It is planned that all asbestos cement pipes will be replaced, although the pipes may remain in the ground and be abandoned. In the replacement work (including disposal of the pipes, if they are removed) such pipes should be treated carefully taking into consideration the possible health effect to workers due to inhalable fine fibers.

10.4 Identification of Possible Environmental Impacts and Necessary Measures

10.4.1 Manner of Impacts Identification and Examination

According to the procedure shown in Figure 10.4.1 the following are summarized in this sub-section.

- Identify possible negative and positive impacts caused by the project
- Study possible mitigation methods and prepare Environmental Management Plan (EMP) and environmental monitoring plan.

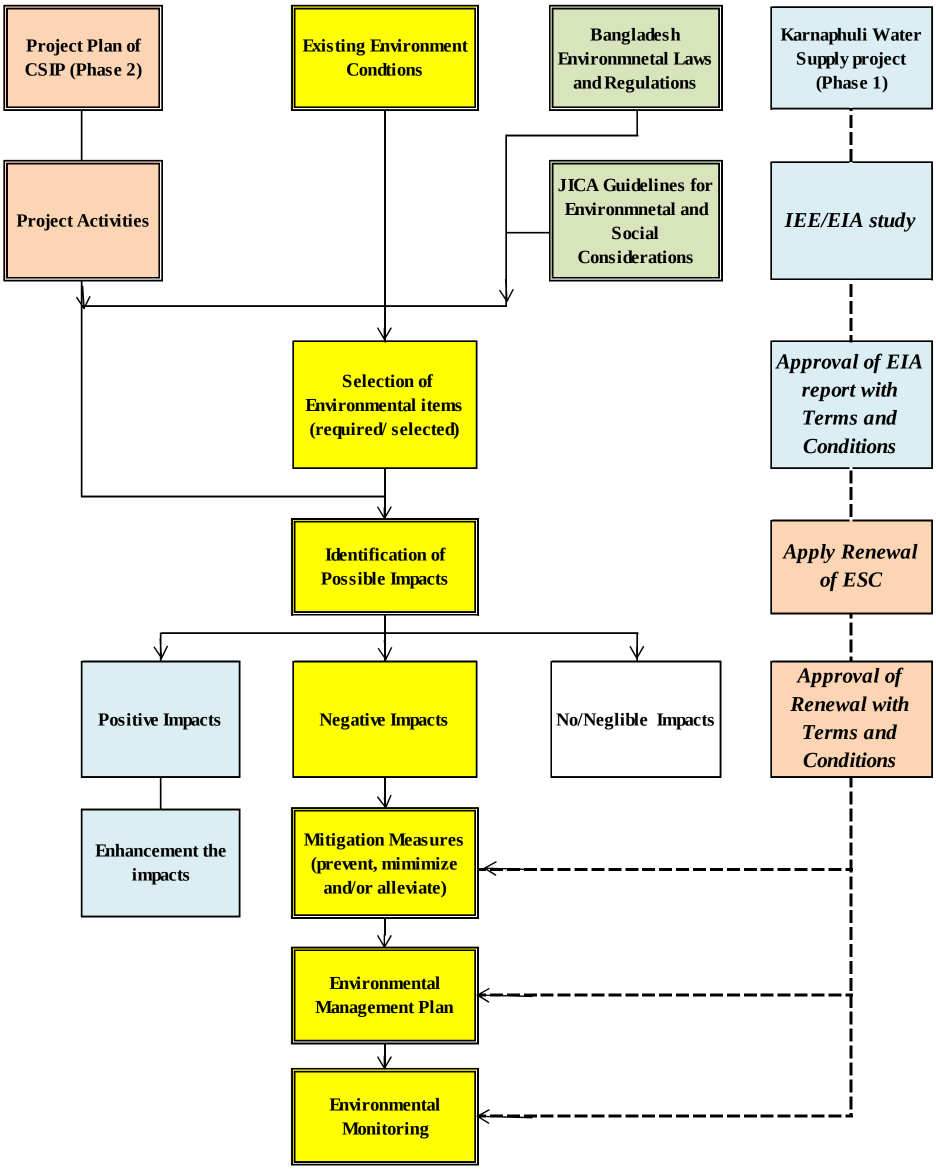

Figure 10.4.1 Flow of Identification of Possible Environmental Impacts

10.4.2 Setting of Environmental Components and Items

According to the JICA Guidelines for Environmental and Social Considerations, anticipated impacts to be assessed include those on human health and safety, as well as on the natural environment, which are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.

In addition to the direct and immediate impacts of projects, the derivative, secondary, and cumulative impacts as well as impacts associated with indivisible projects will also be assessed with regard to environmental and social considerations, so far as it is rational to do so.

In this examination by taking into consideration the above and laws and relevant guidelines of the GOB, as well as the features of the project and the location of the project area, as indicators expressing environmental and social conditions following the three environmental components, as shown below, are chosen and the components are sub-divided into a total of 35 environmental items, as shown in Table 10.4.1.

(A) Social Environment (Socio-economic Environment)
(B) Natural Environment (Physical and Biological Environment)
(C) Environmental Pollution (Physical Environment related to Pollution)

Table 10.4.1 Environmental Components/Items

Environmental Components/Items
(A) Social Environment (Socio-economic Environment)
(1) Involuntary Resettlement (Land Acquisition and Resettlement)
(2) Local economy
(3) Change in land use and utilization of local resources
(4) Social institutions such as social capital and local decision-making institutions,
(5) Existing social infrastructure and services -1 Water supply
(6) Existing social infrastructure and services -2 Others such as transport
(7) The poor, indigenous or ethnic people
(8) Misdistribution of benefit and damage
(9) Local conflict of interests
(10) Cultural property and heritage
(11) Water Rights, Fishing Rights, and Rights of Commons
(12) Public health and Sanitation
(13) Infectious diseases such as HIV/AIDS
(14) Working condition (occupational safety)
(15) Hazard/risk (disaster, security)
(16) Accidents
(B) Natural Environment (Physical and Biological Environment)
(17) Topography and Geology
(18) Soil erosion
(19) Groundwater
(20) Hydrological situation/Drainage pattern
(21) Coastal area

Environmental Components/Items
(22) Terrestrial flora, fauna and ecosystem
(23) Fishes and aquatic ecosystem
(24) Protected zone
(25) Landscape and visual amenity
(26) Local Climate
(27) Global Warming/Climate change
(C) Environmental Pollution (Physical Environment related to Pollution)
(28) Air pollution
(29) Water pollution
(30) Soil contamination
(31) Bottom sediment
(32) Waste
(33) Noise and Vibration
(34) Ground Subsidence
(35) Offensive odor

10.4.3 Anticipated Activities due to the Project

Activities related to the Project, which might affect the environment are discussed for each of the three stages of project implementation, i.e. pre-construction (planning), construction and operation stages as shown in Table 10.4.2.

Table 10.4.2 Anticipated Activities due to the Chittagong Water Supply Improvement Project (Phase 2)

Stage	Expected activities due to the project
Planning Stage (I)	Securing land/space (land acquisition. easement, resettlement etc.)
	Change in use of land and local resources
Construction Stage (II)	Construction work (earth moving and engineering works)
	Operation of plant, machines, vehicles etc.
	Installation of warehouse, plants and worker's camp
	Construction of water supply related facilities such as WTP
	Construction of pipelines for conveyance, transmission and distribution lines
Operation Stage (III)	Operation of water supply related facilities
	Spatial occupancy of the facilities

10.4.4 Identification of Anticipated Environmental Impacts

For each activity by stage shown in Table 10.4.2, the extent of the anticipated environmental impacts are evaluated one by one with rating against the 35 environmental items (social environment, natural environment and environmental pollution) which are tabulated in Table 10.4.1. In the evaluation, the following rating criteria are adopted depending on the extent of impacts.

A (+/-) – Significant positive/negative impact is expected,
B (+/-) – Positive/negative impact is expected to some extent but not significant,
C (+/-) - Extent of positive/negative impact is little but not negligible
D or Blank - Negligible or no impact is expected.

The results of the identification are shown in Table 10.4.3.

Table 10.4.3 Identification of Possible Impacts

Environmental Item	Stage			Reasons
	I	II	III	
(A) Social Environment				
(1) Involuntary Resettlement (Land Acquisition and Resettlement)	D	D	D	(I) All the necessary land and space for the project related facilities have been secured by land acquisition and relocation of people during Phase 1. Therefore, involuntary resettlement is not expected.
(2) Local economy	B+	B+	B+	(III) Beneficial impacts are expected on the local economy, such as creation of employment opportunity for public works during construction and easier access to drinking water will contribute to the reduction of the burden on women and children to collect water and improvement, thus improving living conditions.
(3) Land use and utilization of local resources	D	C-	D	(II) 1) Temporary occupancy of space for construction related facilities (office, worker's camp, material storage, waste disposal) may cause nuisance to the community and people. 2) Groundwater will be used for some construction works. (III) Amount of water used for the proposed water treatment plant is manageable, taking into account lowest flow in the Karnaphuli river
(4) Social institutions such as social capital and local decision-making institutions	B-	B-	B-	(I, II, III) If information disclosure of the project plan and procedure and public participation are not properly conducted, anxieties and complaints may spread amongst the people and communities, resulting in difficulties in obtaining a thorough understanding of the project and obtaining a consensus with them.
(5) Existing social infrastructure and services -1 Water supply	D	D	A+	(III) The project may contribute to easier access of safe drinking water and improvement in sanitary conditions, as well as a decrease in the number of cases of water-borne diseases.
(6) Existing social infrastructure and services - such as transport	D	B-	D	(II) Construction works, especially laying pipelines in existing roads may cause traffic congestion and nuisance to business activities and living conditions.
(7) The poor, indigenous or ethnic people	D	D	C+	(III) It is expected that improvement in the water supply system will contribute to a reduction in the daily workload of women and children. However, there is some concern that the load may not change, if the water tariff is higher than their willingness to pay and the site selection of public water taps is not appropriate.
(8) Misdistribution of benefit and damage	B-	B-	B-	(I, II, III) There is some possibility of misdistribution of benefit and damage, if the project plan for the water service areas and implementation plan for the construction work are not properly disseminated and consultation with residents, communities and other stakeholders is not carried out at an early stage.
(9) Local conflict of interests	B-	B-	B-	(I, II, III) There is some possibility of local conflict of interests, if the project plan for the water service areas and implementation plan for the construction work are not properly disseminated and consultation with residents, communities and other stakeholders is not carried out at an early stage.
(10) Cultural property and heritage	D	D	D	(I, II, III) There is no evidence of archaeological, historical and cultural landmarks located in and in the vicinity of the proposed project area.
(11) Water Rights, Fishing Rights, and Rights of Commons	D	D	D	(III) There no official water rights, fishery rights and rights of commons in Bangladesh. However, the Government reserves the right to allocate water to ensure equitable distribution, efficient development and use and to address poverty. Water supply for domestic and municipal use generally has priority over other uses. Therefore, infringements relating to water use and related rights are not expected in the Karnaphuli River and the project area.

Environmental Item	Stage			Reasons
	I	II	III	
(12) Public health and Sanitation	D	B-	A+	(II) Construction work may have an adverse effect on the health condition of residents and workers due to pollution and nuisance such as dust, noise and traffic congestion. (III) The supply of safe drinking water will contribute to an improvement in the health and sanitation situation, resulting in a reduction in the number of cases of water-borne diseases.
(13) Infectious diseases such as HIV/AIDS	D	B-	D	(II) In other developing countries construction workers and construction vehicle drivers are considered as having a high potential for the spread of sexually transmitted diseases (STDs) and HIV/AIDS virus due to their mobility. Infection with HIV/AIDS and venereal disease has often been reported at worker's camps in other countries.
(14) Working condition (occupational safety)	D	B-	D	(II) Many workers will be engaged in construction work and stay at worker’s camps under poor living conditions. Thus, the health and safety of the workers may be jeopardized, especially due to the physical work required in construction.
(15)Hazard/risk (disaster, security)	D	B-	D	(II) Risk of security and crime are somewhat expected due to construction workers who move into and stay in the project area.
(16) Accidents	D	B-	C-	(II) An increase in the number of traffic accidents could occur due to traffic congestion and disturbance laying pipelines along roads. (III) Accidental leakage of chlorine gas for disinfection of treated water may happen.
(B) Natural Environment				
(17) Topography and Geology	D	D	D	(II) No large scale alteration of ground, which may give rise to a change in topography and geology, is expected.
(18) Soil erosion	D	B-	D	(II) Soil erosion is somewhat expected due to excavation, cutting and filling of earth and removal of vegetation cover.
(19) Groundwater	D	C-	A+	(II) Groundwater will be used for some construction work, subject to permission being received from the concerned authorities. (III) Water supply in terms of both quality and quantity will be improved by the project. Thus the present dependence on the use of groundwater will be reduced.
(20) Hydrological situation/Drainage pattern	D	C-	C-	(III) 1) Karnaphuli River discharges into the Bay of Bengal. It is a tidal river and the tidal flow generally reaches to a location about 10 km upstream from the confluence of the Karnaphuli and Halda Rivers, which is downstream of the intake point and no salinity problem has been reported, due to salt intrusion from the rising tide. 2) The impact on the river regime is expected to be negligible considering the size of the rivers and the flow discharge.
(21) Coastal area	D	D	D	(III) River mouth of Karnaphuli river is located in coastal zone of the Bay of Bengal. However, the project sites including the water intake are more than about 40 km upstream from the river mouth. Therefore, effects related to coastal erosion and sedimentation of sand are not expected.
(22) Terrestrial flora, fauna and ecosystem	D	C-	C-	(II, III) No rare, endangered or endemic terrestrial plant or animal species are expected in the project area. However, planted trees along the road contribute to the greenery and visual amenity providing relaxation and recreation area to local residents.
(23) Fishes and aquatic ecosystem	D	C-	C-	(II, III) The project area being estuarine is rich in fish resources as both marine and freshwater fish roam the area. There are 76 species and 35 families of fishes in the project area. Out of the 76 species 49 are either endangered or threatened. Both the Karnaphuli and Halda rivers are rich in fish and good locations for hatcheries. River

Environmental Item	**Stage**			**Reasons**
	I	**II**	**III**	
				fishing is active in both rivers. However, the project would not involve any direct interference with water bodies and water resources. Thus, effect on fishery resources activity is not expected.
(24) Protected zone	D	D	D	(I, II, III) There are no sites of protected areas such as National Parks, Wildlife Sanctuaries and Game reserves in the project area.
(25) Landscape and visual amenity	D	D	D	(III) No negative impact on the landscape is expected in view of the location, scale and design of water supply facilities.
(26) Local Climate	D	D	D	(III) No major infrastructure development and reclamation, which may give rise to a change in the micro-climate is expected.
(27) Global Warming/Climate change	D	D	D	(II) The amount of greenhouse gases such as CO_2, which are generated due to construction vehicles and machines, is expected to be negligible. (III) The amount of greenhouse gas emissions from diesel generators is expected to be negligible.
(C) Environmental Pollution				
(28) Air pollution	D	B-	C-	(II) Emission of air pollutants (dust, NOx, etc.) from vehicles and equipment during construction works is expected. (III) 1) Emission of air pollutants from diesel generators at the water treatment plant and other facilities is expected to be negligible. 2) In ordinary handling, chlorine gas emission is hardly expected from stored utilities and automatic injection equipment of chlorination.
(29) Water pollution	D	B-	C-	(II) 1) Discharge of wastewater from construction work and worker's camps is expected. 2) Water contamination is expected, if spillage of lubricating oil and asphalt emulsifier occurs. (III) The increase in the quantity of water supply will result in an increase in the quantity of wastewater and sludge. However, only supernatant water from the WTP will be discharged and sludge will be dried and utilized.
(30) Soil contamination	D	B-	C-	(II, III) Toxic materials such as lubricant oil and asphalt emulsifiers for construction works may give rise to soil contamination.
(31) Bottom sediment	D	D	D	Wastewater, which is discharged indirectly to the Karnaphuli River is supernatant water from the water treatment process. Thus pollution of bottom sediment is not expected.
(32) Waste	D	C-	C-	(II) 1) Generation of construction waste and garbage from worker's camps is expected. 2) Asbestos cement pipes, which are hazardous, are used in the existing distribution network. (III) Generation of sludge from water treatment plants – sludge will be dried and utilized.
(33) Noise and Vibration	D	B-	C-	(II) Generation of noise and vibration from construction vehicles, machines and plants is expected. (III) Generation of noise and vibration from water supply facilities (pumps, generator, etc.) is expected.
(34) Ground Subsidence	D	D	D	(II) Groundwater will be used for some construction works. However, the amount of groundwater will be small and not cause ground subsidence.
(35) Offensive odor	D	D	C-	(III) 1) Mal odor from water treatment sludge is hardly expected. 2) Offensive odor of chlorine gas is expected if accidental leakage may happen.

10.5 Environmental Management Plan

10.5.1 Mitigation Measures against Possible Negative Impacts

Regarding the impacts anticipated through the scoping, it is required to examine the possible mitigation measures and monitoring against negative impacts as much as possible.

Mitigation measures will minimize the negative impact to an acceptable level through the planning, construction and operation phases. Monitoring is required to ensure that the specified mitigation measures are properly carried out throughout the construction and operation stages.

As a result of identification of possible impacts shown in Table 10.5.1, the major possible negative impacts are as follows:

- Pre-Construction Stage
  (a) Change in land use and utilization of local resources

- Construction Stage
  (a) Nuisance and/or disturbance of business activities and living conditions affected by the construction work. In particular work for laying pipelines along existing roads may cause traffic congestion, resulting in nuisance and/or disturbance to business activities and living conditions in the project area.
  (b) Public health condition
  (c) Working condition
  (d) Accidents
  (e) Surface soil erosion
  (f) Hydrological condition
  (g) Air pollution
  (h) Water pollution
  (i) Noise and vibration
  (j) Solid waste disposal

- Operation Stage
  (a) Air pollution
  (b) Water pollution caused by sludge treatment at WTP
  (c) Noise and vibration caused by pump operation
  (d) Chlorine leakage from chlorine storage and injection facilities
  (e) Sewage volume increase according to the increase of water uses

- All Stages
  (a) Acceptability by people and local communities
  (b) Occurrence of conflict and discord within community due to worker's staying in the area and unfairness of benefits
  (c) Impact to Habitat of flora, fauna and endangered species
  (d) Impact to fishery resources

The proposed mitigation measures for the main negative impacts are shown in Table 10.5.1.

Table 10.5.1 Mitigation Measures against Possible Negative Impacts

Environmental Item	Stage			Mitigation Measures
	I	II	III	
(A) Social Environment				
(3) Land use and utilization of local resources	D	C-	D	(II) Plan to avoid or minimize nuisance to residents and local communities and disturbance to road transport.
(4) Social institutions such as social capital and local decision-making institutions	B-	B-	B-	(I, II, III) Information disclosure and public participation should be fully considered for all the stakeholders from the early stage of planning in order to obtain a thorough understanding of the project and consensus of the people and communities.
(6) Existing social infrastructures and services - such as transport	D	B-	D	(II) 1) In case of pipe laying work along roads, permission from concerned authorities should be obtained before start of construction works (and in the case of construction along Kaptai Road in the planning stage), by submission of drawings of pipe laying works in the roads, schedules, safety traffic control plan, etc. 2) To avoid or minimize traffic disturbance and nuisance to local people and communities, consideration should be given to pipelaying in one lane of a two way road (to allow vehicular access to be maintained), as well as providing construction signs and post with color taping, temporary fences and using watchmen. 3) In addition, at night time, the Contractor shall provide electric lighting/signal equipment indicating the location of the construction site to ensure safe traffic control and management.
(8) Misdistribution of benefit and damage	B-	B-	B-	(I, II, III) Consultation with stakeholders including residents and community organizations, should be planned from an early stage to obtain understanding and consent amongst the stakeholders in order to provide equitable benefits and damages.
(9) Local conflict of interests	B-	B-	B-	Consultation with stakeholders including residents and community organizations should be planned from an early stage to obtain understanding and consent among the stakeholders in order to avoid or minimize local conflict(s) of interests.
(12) Public health and Sanitation	D	B-	A+	(II) Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project period. Measures to minimize dust, noise and traffic congestion shall be taken, as mentioned in other items.
(13) Infectious diseases such as HIV/AIDS	D	B-	D	(II) 1) Education of and campaign of prevention and cure of HIV/AIDS to residents and construction workers. 2) Monitoring of cases of HIV/AIDS before, during and after the construction stage.
(14) Working condition (occupational safety)	D	B-	D	(II) 1) Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project period. 2) Medical check for workers, as required.
(15)Hazard/risk (disaster, security)	D	B-	D-	(II) 1) Consult with police and local government and establish vigilantes composed of CBOs and residents, if necessary. 2) Education of workers to keep manners and obey community rules. 3) Monitoring of cases and causes of hazard risks.
(16) Accidents	D	B-	C-	(II) 1) Suitable planning and management over construction work to prevent and minimize the number and consequences of accidents. 2) Monitoring cases and causes of accidents.
(B) Natural Environment				
(18) Soil erosion	D	B-	D	(II) 1) Soil erosion caused by removal of vegetation cover and excavated loose soil shall be checked and replantation with local vegetation carried out as soon as possible, as necessary. 2) Loose soil shall be covered and stored away from the edge of the hoar/rivers.
(19) Groundwater	D	C-	A+	Measures to prevent infiltration of polluted water to the ground and groundwater shall be implemented.
(20) Hydrological situation/Drainage pattern	D	C-	C-	(II, III) 1) Monitoring hydrological situation of Karnaphuli River as relevant to the river regime ,such as water level, discharge from Kaptai Lake, tid-

Environmental Item	**Stage**			**Mitigation Measures**
	I	**II**	**III**	
				al/saline water intrusion, etc. by collecting data from meteorological and hydrological observatories in the Karnaphuli River Basin and by visual inspection.
(22) Terrestrial flora, fauna and ecosystem	D	C-	C-	(II, III) 1) Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora and fauna would be demolished or destroyed. 2) No activity of cutting/razing/dressing of hills or hilly land shall be carried out without permission/clearance of the concerned authority of the government.3) Monitoring by visual inspection, as required.
(23) Fishes and aquatic ecosystem	D	C-	C-	(II, III) Proper and adequate on-site precautionary measures shall be ensured so that discharge of water (that does not meet the prevailing legislation), fuel, chemicals, etc. to rivers, watercourses does not occur (refer also to item 29).
(C) Environmental Pollution				
(28) Air pollution	D	B-	C-	(II) 1) Vehicles, machines and plant shall be properly and adequately maintained. 2) Water trucks shall be used and material stockpiles shall be located away from sensitive receptors. Vehicle speed limits shall be enforced. (III) To prevent accidental chlorine gas leakage from chlorine storage facilities and chlorine injection facilities, mitigation measures such as use of automatic injection equipment, safe operation and maintenance practices and provision of training to O&M personnel will be incorporated in the design of the facilities (as for Phase 1) and lessons learned from Phase 1 will be included in Phase 2. In addition, the existing Mohara water treatment which includes chlorination has been operated safely since commencement of operation.
(29) Water pollution	D	B-	C-	(II) 1) Measures for preventing spillover of soil and other construction materials due to earthmoving work. Proper treatment of water pollutants generated from construction work to comply with water quality regulation. (III) 1) Sludge generated from the water treatment plant should be dried and reused as manure and/or strengthening soil foundation. 2) After sludge treatment most of supernatant water will be sent back to WTP and some portion of supernatant water will be overflown to Karnaphuli river through nearby canal.
(30) Soil contamination	D	B-	C-	(II) Prevent spill over or leakage of toxic materials such as lubricant oil and asphalt emulsifiers into the soil.
(32) Waste	D	C-	C-	(II) 1) Consider ways to minimize waste generation in the construction work plan. 2) Proper treatment and disposal of wastes generated from construction work. 3) The open areas that are grasslands can be used for construction but with appropriate safeguards to maintain materials and dump sites from contaminating watercourses/rivers. 4) Where new pipelines are to be laid along the route of existing asbestos cement pipes and it is necessary to remove the existing pipes, these shall be handled and disposed of safely.
(33) Noise and Vibration	D	B-	C-	(II, III) 1) Vehicles, machines and plants shall be maintained regularly. 2) Working during sensitive hours and locating machinery close to sensitive receptors shall be avoided. 3) Use equipment with low noise and vibration. 4) Installation of soundproof walls/acoustic enclosures and provision of buffer zones.
(35) Offensive odor	D	D	C-	(III) 1) Strict management for use of chlorine. 2) Monitoring of leakage. 3) Good maintenance/ storage and injection facilities.

10.5.2 Environmental Management Plan (EMP)

The Environmental Management Plan (EMP) should be prepared for effectively implementing the mitigation measures. The EMP includes various monitoring plans, which may be necessary to confirm the level of impacts or the effectiveness of the mitigation measures. The EMP is shown in Table 10.5.2.

Table 10.5.2 Environmental Management Plan

Possible Negative Impact	Rating	Mitigation Measures (Further Survey, Mitigations and Monitoring)	Responsibility	
			Implementation	Supervising
I. Pre-Construction Stage				
No negative impact				
II. Construction Stage				
(1) Temporary occupancy of space for construction related facilities (office, worker's camp, material storage, waste disposal) may cause nuisance to the community and people.	C-	Plan to avoid or minimize nuisance to residents and local communities and disturbance of road transport.	Contractor	CWASA, Consultant, DOE
(2) Construction works, especially laying pipelines along existing roads may bring about traffic congestion and nuisance to business activities and living conditions.	B-	1) In case of pipe laying work along roads, permission from concerned authorities should be obtained before start of construction works (and in the case of construction along Kaptai Road in the planning stage), by submission of drawings of pipe laying works in the roads, schedules, safety traffic control plan, etc. 2) To avoid or minimize traffic disturbance and nuisance to local people and communities, consideration should be given to pipe laying in one lane of a two way road (to allow vehicular access to be maintained), as well as providing construction signs and post with color taping, temporary fences and using watchmen. 3) In addition, at night time, the Contractor shall provide electric lighting/signal equipment indicating the location of the construction site to ensure safe traffic control and management.	Contractor	CWASA, Consultant, DOE
(3) Construction work may have an adverse effect on health conditions of residents and workers due to pollution and nuisance such as dust, noise and traffic congestion.	B-	Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project period. Measures to minimize dust, noise and traffic congestion shall be taken, as mentioned in other items.	Contractor	CWASA, Consultant, DOE
(4) In other developing countries construction workers and construction vehicle drivers are considered as having high potential for the spread of sexually transmitted diseases (STDs) and HIV/AIDS virus due to their mobility. Infection with HIV/AIDS and venereal disease has often been reported at worker's camps in other countries.	B-	1) Education of and campaign of prevention and cure of HIV/AIDS to residents and construction workers. 2) Monitoring of cases of HIV/AIDS before, during and after the construction stage.	Contractor	CWASA, Consultant, DOE

Possible Negative Impact	Rating	Mitigation Measures (Further Survey, Mitigations and Monitoring)	Responsibility	
			Imple-mentation	Super-vising
(5) Many workers will be engaged in construction work and stay in worker's camps under poor living condition. Thus, the health and safety of the workers may be jeopardized, especially due to the physical work required in construction.	B-	1) Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed project period. 2) Medical check for workers, as required.	Contractor	CWASA, Consult-ant, DOE
(6) Risk of security and crime are somewhat expected due to construction workers who move into and stay in the project area.	B-	(1) Consult with police and local govern-ment, and establish vigilantes composed of CBOs and residents, if necessary. 2) Educa-tion of workers to keep manners and obey community rules. 3) Monitoring of cases and causes of hazard risks.	Contractor	CWASA, Consult-ant, DOE
(7) An increase in number of traffic accidents could occur due to traffic congestion and disturbance laying pipe-lines along roads.	B-	(II) 1) Suitable planning and management of construction work to prevent the number and minimize the consequences of accidents. 2) Monitoring cases and causes of accidents.	Contractor	CWASA, Consult-ant, DOE
(8) Soil erosion is somewhat expected due to excavation, cutting and filling of earthmoving work and removal of veg-etation cover.	B-	1) Soil erosion caused by removal of vegeta-tion cover and excavated loose soil shall be checked and replantation with local vegeta-tion carried out as soon as possible, as nec-essary. 2) Loose soil shall be covered and stored away from the edge of the hoar/river.	Contractor	CWASA, Consult-ant, DOE
(9) Groundwater will be used for some construction work subject to permission being received from the concerned authorities.	C-	Measures to prevent infiltration of polluted water to the ground and groundwater shall be implemented.	Contractor	CWASA, Consult-ant, DOE
(10) Emission of air pollutants (dust, NOx, etc.) from vehicles and equipment during construction works is expected.	B-	1) Vehicles, machines and plant shall be properly and regularly maintained. 2) Water trucks shall be used and material stockpiles shall be located away from sensitive recep-tors. Vehicle speed limits shall be enforced.	Contractor	CWASA, Consult-ant, DOE
(11) Discharge of wastewater from construction work and worker's camps is expected.	B-	1) Wastewater should be collected to the pit temporary constructed and discharged to water bodies after treatment by sedimentation process to comply with wastewater quality standards. 2) Sludge and/or sediment includ-ing clay and silt etc. should be reused or dis-posed of.	Contractor	CWASA, Consult-ant, DOE
(12) Toxic materials such as lubricant oil and asphalt emulsifiers for construc-tion works may give rise to soil con-tamination.	B-	In order to prevent spillover or leakage of toxic materials such as lubricant oil and as-phalt emulsifiers into soil, following measures should be implemented: (i) To keep clean storage sites of construction equipment, (ii) To install storage tank for preventing spill and leakage of lubricating oil and grease, etc. and (iii) Training of workers for proper handling of toxic materials.	Contractor	CWASA, Consult-ant, DOE

Possible Negative Impact	Rating	Mitigation Measures (Further Survey, Mitigations and Monitoring)	Responsibility	
			Imple-mentation	Super-vising
(13) Generation of construction waste and garbage from worker's camp.	C-	1) Consider ways to minimize waste generation in the construction work plan. 2) Proper treatment and disposal of waste generated from construction work. 3) The open areas that are grasslands can be used for construction but with appropriate safeguards to maintain materials and dump sites from contaminating watercourses/river waters.	Contractor	CWASA, Consult-ant, DOE
(14) Asbestos cement pipes are used for existing distribution pipes in some parts of the project area.	B-	1) If asbestos cement pipes are found, they should be abandoned and replaced by pipes made of other materials, which are safe enough. 2) At present in Bangladesh there is no clear provision regarding regulation of asbestos waste. Therefore, at first to consult measures for safe treatment and disposal of asbestos cement pipes and asbestos debris with DOE and other responsible organizations. In this regards Japanese laws and manuals such as Waste Management and Public Cleansing Law, Industrial Safety and Health Law, and "Manual for asbestos treatment and disposal of asbestos containing wastes" (Ministry of Environment, 2007.3. In Japanese) will be useful. 3) To confirm the existence of asbestos cement pipes for the replacement of pipes. 4) The replacement work of old asbestos cement pipes should be treated carefully taking into consideration possible health effect to workers by inhaling and adhering scattered fine fibers. Thus, the workers should be equipped with helmets, masks, shoes and wears to prevent inhalation and adhesion of asbestos fibers. All the equipped materials should be separately stored and safely disposed after replacement work. 5) While loading, unloading and transport, dug out asbestos cement pipes should be covered with plastic sheets and/or packed with closed containers or bags marking a sign of hazardous asbestos. 6) Collected asbestos pipes should be solidified with cement and/or transferred to secured final disposal site.	Contractor	CWASA, Consult-ant, DOE
(15) Generation of noise and vibration from construction vehicles, machines and plant.	B-	(II, III) 1) Vehicles, machines and plant shall be properly and regularly maintained. 2) Working during sensitive hours and locating machinery close to sensitive receptors shall be avoided. 3) Use equipment with low-noise and vibration. 4) Installation of soundproof walls/acoustic enclosures and provision of buffer zones.	Contractor	CWASA, Consult-ant, DOE
III. Operation Stage				

Possible Negative Impact	Rating	Mitigation Measures (Further Survey, Mitigations and Monitoring)	Responsibility	
			Imple-mentation	Super-vising
(1) The increase in the quantity of water supply will result in an increase in the quantity of wastewater and sludge.	C-	Sludge generated from water treatment plant should be dried and reused. 2) Supernatant separated from sludge will be sent back to water treatment process, some portion of which will be overflown to Karnaphuli river through nearby canal. Water quality of the supernatant complies with Bangladesh wastewater standards (such as SS 150 mg/l and BOD 50 mg/l) by flocculation, sedimentation and sand filtration process.	CWASA	CWASA, DOE
(2) The increase of water supply will generate an increase in the quantity of discharged water and sludge.	C-	Proper implementation plan to manage that only supernatant after water treatment process will be discharged and sludge produced in water treatment process will be dried and reused.	CWASA	CWASA, DOE
(3) Toxic materials such as lubricant oil and asphalt emulsifiers for construction works may give rise to soil contamination.	C-	(II) Prevent spillover or leakage of toxic materials such as lubricant oil and asphalt emulsifiers into the soil.	CWASA	CWASA, DOE
(4) Generation of sludge from water treatment plants. However, water treatment sludge was dried and already utilized to manure.	C-	(II) 1) Consider ways to minimize waste generation in the construction work plan. 2) Proper treatment and disposal of wastes generated from construction work. 3) The open areas that are grassland can be used for construction but with appropriate safeguards to maintain materials and dump sites from contaminating hoar/river waters.	CWASA	CWASA, DOE
(5) Generation of noise and vibration from water supply facilities (pumps, diesel generator, etc.)	C-	(II, III) 1) Vehicles, machines and plant shall be properly and regularly maintained. 2) Working during sensitive hours and locating machinery close to sensitive receptors shall be avoided. 3) Use equipment with low noise and vibration. 4) Installation of soundproof walls/acoustic enclosures and provision of buffer zones.	CWASA	CWASA, DOE
(6) Malodor due to leakage of chlorine	C-	(III) 1) Strict management for use of chlorine. 2) Monitoring of leakage. 3) Good maintenance/ storage of injection facilities.	CWASA	CWASA, DOE
IV. One or More Stages				
(1) If information disclosure of the project plan and procedure and public participation are not properly conducted, anxieties and complaints may spread amongst the people and communities, resulting in difficulties in obtaining a thorough understanding of the project and obtaining a consensus with them.	B-	(I, II, III) Information disclosure and public participation should be fully considered for all the stakeholders from early stage of planning in order to obtain a thorough understanding of the project and consensus of the people and communities.	CWASA	CWASA, DOE

Possible Negative Impact	Rating	Mitigation Measures (Further Survey, Mitigations and Monitoring)	Responsibility	
			Imple-mentation	Super-vising
(2) There is some possibility of misdistribution of benefit and damage, if the project plan for the water service areas and implementation plan for the construction work are not properly disseminated and consultation with residents, communities and other stakeholders is not carried out at an early stage.	B-	(I, II, III) Consultation with stakeholders, including residents and community organizations should be planned from an early stage to obtain understanding and consent amongst the stakeholders in order to share equally benefits and damage.	CWASA	CWASA, DOE
(3) There is some possibility of local conflict of interests, if the project plan for the water service areas and implementation plan for the construction work are not properly disseminated and consultation with residents, communities and other stakeholders is not carried out at an early stage.	B-	(I, II, III) Consultation with stakeholders, including residents and community organizations, should be planned from early stage to obtain understanding and consent amongst the stakeholders in order to avoid or minimize local conflict of interests.	CWASA	CWASA, DOE
(4) 1) Karnaphuli River discharges into the Bay of Bengal. It is a tidal river and the tidal flow was observed to take place up to about 10 km upstream of the confluence with the Halda River However, the rising tide cannot come up to the intake point and no salinity problem was reported due to salt intrusion from the rising tide. 2) The impact on the river regime is expected to be negligible considering the size of the rivers and the flow discharge.	C-	(II, III) 1) Monitoring hydrological situations of Karnaphuli River relevant to river regime such as water level and discharge from Kaptai Lake, tidal/saline water intrusion, etc. by collecting data from meteorological and hydrological observatories in the Karnaphuli River Basin and by visual inspection.	CWASA	CWASA, DOE
(5) No rare, endangered or endemic terrestrial plant or animal species are expected in the project area. However, planted trees along the road contribute to the greenery and visual amenity providing relaxation and recreation area to local residents.	C-	(II, III) 1) Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora and fauna would be demolished or destroyed. 2) No activity of cutting/razing/dressing of hill or hilly land is endorsed without permission/clearance of the concerned authority of the government.3) Monitoring by visual inspection, as required.	Contractor, CWASA	CWASA, DOE
(6) The project area being estuarine is rich in fish resources as both marine and freshwater fish roam the area. There are 76 species and 35 families of fishes. Out of the 76 species 49 species are either endangered or threatened. Both Karnaphuli and Halda rivers are rich in fish and good location for hatcheries. River fishing is active in both rivers. However, the project would not involve any direct interference with water bodies and water resources. Thus, effect on fishery resources activity is not expected.	C-	(II, III) Proper and adequate on-site precautionary measures shall be ensured so that discharge of water (that does not meet the prevailing legislation), fuel, chemicals, etc. to rivers, watercourses does not occur.	Contractor, CWASA	CWASA, DOE

In preparation for implementation of the EMP, the following items should be considered.

(1) Institutional arrangement with staffing

The establishment of a practical organization for the implementation of effective and necessary environmental mitigation measures is essential.

Although there are alternative organizations that could be considered, the most suitable one is as follows:

- Establishment of an Environment department/section in CWASA. The Environmental section would be in charge of all environmental issues, including preparing the definite/detailed plans for environmental management and monitoring, as well as implement these plans effectively. This section would also be in charge of legal procedures and public relation matters with local residents, CBOs and relevant stakeholders.
- Establishment of cooperative relationship with related government offices/agencies including the Chittagong regional office of DOE.

(2) Compliance with Bangladesh Laws, Standards and Regulations as well as the JICA Guidelines

In general, attention to environmental matters by the GOB is high. There is already a well-established legislative system in Bangladesh including ECA, ECR and EIA guidelines. The Bangladesh environmental standards cover all the basic items such as water pollution, air pollution, noise, odor, etc.

(3) People's Participation

People's participation in the environmental control and management is considered to be an essential matter. It will be effective from various viewpoints such as cost saving, avoiding disputes, enhancement of people's concerns, taking quick measures, etc.

The environment section (to be established) is required to consider the people's participation for preparation of the implementation plan.

(4) Preparation of Implementation Plan

For implementing the mitigation measures of the predicted environmental impacts, a definite implementation plan is required to be prepared. The implementation plan needs to contain the implementation schedule, the organization and staffing, the section/division of objective sites, the survey and monitoring program, the budget allocation, the facilities & equipment list, etc.

10.5.3 Emergency Response Plan

In the terms and conditions, which accompanied with Issuance of ESC and Approval of EIA Report on Karnaphuli Water Supply Project by DOE, the following issues shall be considered (See Table 10.2.2 III (10) Environmental Management Plan).

- 1.9 All the required mitigation measures suggested in the IEE and EIA reports along with the emergency response plan are to be strictly implemented and kept operative/functioning on a continuous basis.

Therefore, an Emergency Response Plan (ERP) shall be prepared for the Phase 2 Project referring to the IEE and EIA report and considering additional items to address emergent environmental risks.

(1) Emergency situation and design of ERP

In general, the following emergency situations may occur during the construction and operation stage.

- Serious injury or fatality
- Vehicle accident
- Major property or equipment damage
- Electric shock
- Fire
- Gas leakage
- Natural hazards
- Security breach

(2) Emergency response system and procedure

It is required in any pre-set emergency response procedure that the ERP includes at least implementation and training in the following procedures.

All the construction and operation work shall be done utilizing good practice in responding to the requirement of emergency work and as such:

- All tools, equipment, machinery and materials shall be properly stored such that they can be used immediately on call.
- Procedures and routes for emergency escape shall be established
- Presence of employees and members of the public, if involved, must be taken into account for evacuation
- Emergency shut-down procedures should be established and qualified personnel should be available
- Accounting for all employees after emergency evacuation shall be carried out
- Rescue procedures shall be established, as well as medical duties for employees who will perform rescues
- Preferred means of reporting fires and other emergencies shall be established
- Names and job titles of persons to contact for more information about the plan shall be included.

(3) Alarm systems

The CWASA shall establish a system to alert all employees of an emergency within the operation facility. If the alarm system is meant to serve more than one purpose, it should emit a different sound for each purpose. As a result, no one should mistake an evacuation alarm for one that signals the need for the emergency response team.

(4) Training

CWASA shall train all concerned employees regarding use and purpose of the Emergency Response Plan, including:

- When the plan is developed
- Whenever emergency action plan responsibilities change
- Whenever the plan changes.

(5) Standard Operating Practices (SOPs)

Carefully written practices (procedures) will form the basis for implementing and recommendations as well as action plan for environmental and safety.

Practices will specify who is to carry out tasks, give step-by-step instructions for how tasks are to be accomplished, and include directions for dealing with departures from the practices. Setting and maintaining effective practices involves five stages:

1) hazard identification,
2) risk assessment,
3) identifying risk control measures,
4) preparing and implementing procedures to maintain control; and
5) on-going audit and review of those procedures.

(6) Approach to emergency response

Emergency response systems should be in place to deal with dangerous goods if any, uncontrolled releases spills, natural calamities, fires, burns and injuries. There shall be trained emergency response teams, specific contingency plans and incident specific equipment packages in place to cope with the above types of emergency. Should an incident occur immediate action must be taken to mitigate the impacts. In order to minimize the possibility of injury to the people who respond to an emergency and others it is important that the people who respond follow a specific sequence of actions, which are clearly stated in the SOPs of CWASA.

10.5.4 Environmental Monitoring Plan

As part of the environmental management plan, environmental monitoring needs to be undertaken to ensure that the mitigation measures are implemented and have the intended result.

In order to implement the environmental monitoring effectively following institutional arrangement should be done:

(1) CWASA

In CWASA officer(s) in charge of environment and safety management should be assigned. In addition, the officer(s) should collaborate with the officer(s) in charge of Operation & Maintenance for following matters:

- Ensure worker's health and safety and to cope with accidents during both construction and operation stages and;
- Comply with Bangladesh environmental standards during operation.

Environmental Specialist (officer) shall be transferred to O&M organization after construction work.

(2) Contractor

The Contractor side should assign staff/engineer(s) who will be responsible to environment and safety management for the whole construction work. The staff/engineer(s) should consult with CWASA as required.

The environmental monitoring plan is shown in Table 10.5.3.

Table 10.5.3 JICA Monitoring Plan - Karnaphuli Water Supply Improvement Project (Phase 2)

Monitoring Item	Parameter	Subject /Location of Monitoring	Meth-ods/Relevant Standards	Frequency	Responsibility
I. Pre-Construction Stage (Planning Stage)					
(1) Social Environment					
Involuntary Resettle-ment	Not applicable - Neither land acquisition nor resettlement id expected.				
(2) Natural Environment					
Almost all items	Not applicable – already surveyed in Phase 1 project.				
(3) Environmental Pollution					
1) Air quality	Dust from surface soil and exhaust emissions	Around WTP and related facilities	1) Complaint by people, 2) Visual inspection	As required	CWASA (Officers in charge of Environment Management)
2) Noise and vibration	Nuisance due to noise and vibration	Project area	1) Complaint by people, 2) Physical observation	As required	CWASA (Officers in charge of Environment Management)
3) Surface water qual-ity	pH, turbidity, Chlo-ride, COD	3 Stations of Karnaphuli and Halda River*	Bangladesh Standard for In-land Surface Water	Monthly	CWASA (Officers in charge of Environment Management)
II. Construction Stage					
(1) Social Environment					
1) Nui-sance/disturbance of living conditions and business activities	Cases and causes	Construction sites	(1) Complaint by people, (2) Physi-cal observation	As required	Contractor (Staff in charge of Environmen-tal Management)
2) Accident	Cases and causes	Construction sites	(1) Report of ac-cidents, (2) Com-plaint by people	As required	Contractor (Staff in charge of Environmen-tal and Safety Manage-ment)
3) Worker's health	General health condition and communicable diseases such as water-borne dis-eases	Construction sites	Medical consulta-tion and examina-tion	Occasional and as re-quired	Contractor (Staff in charge of Environmen-tal and Safety Manage-ment)
4) Worker's safety	Cases and causes of accidents	Construction sites	(1) Report of ac-cidents, (2) Com-plaint by workers	As required	Contractor (Staff in charge of Environmen-tal and Safety Manage-ment)
(2) Natural Environment					
1) Soil erosion	Cases and causes	Construction sites	(1) Complaint by people, (2) Visual inspection	As required	Contractor (Staff in charge of Environmen-tal Management)
2) Change in flora, fauna and terrestrial and aquatic ecosystem	Habitat of flora and fauna	Project area	(1) Complaint by people, (2) Visual inspection	As required	Contractor (Staff in charge of Environmen-tal Management)
3) Change in fishery resources	Habitat of fish and fish breeding, feeding and nursery sites	Project area	(1) Complaint by people, (2) Visual inspection	As required	Contractor (Staff in charge of Environmen-tal Management)
(3) Environmental Pollution					
1) Air quality	Dust from surface	Construction	(1) Complaint by	As required	Contractor (Staff in

Monitoring Item	Parameter	Subject /Location of Monitoring	Meth-ods/Relevant Standards	Frequency	Responsibility
	soil and exhaust emissions	Sites	people, (2) Visual inspection		charge of Environmental Management)
2) Noise and vibration	Nuisance due to noise and vibration	Construction Sites	(1) Complaint by people, (2) Physical observation	As required	Contractor (Staff in charge of Environmental Management)
3) Surface water quality	Temperature, pH, turbidity, Chloride, COD	3 Stations of Karnaphuli and Halda River*	Bangladesh Standard for Inland Surface Water	Monthly	Contractor (Staff in charge of Environmental Management)
4) Wastewater	Countermeasures for wastewater control	Construction sites	(1) Visual inspection, (2) Complaint by people	Monthly	Contractor (Staff in charge of Environmental Management)
5) Solid waste	Countermeasures for solid waste disposal	Construction sites	(1) Visual inspection, (3) Complaint by people	Monthly	Contractor (Staff in charge of Environmental Management)
III. Operation Stage					
(1) Social Environment					
1) Acceptability of the project	Complaints	Project area	1) Complaint by people, 2) Interview survey, if necessary	Occasional and as required	CWASA (Officers in charge of Environment Management)
2) Accident	Cases and causes	Project area	(1) Report of accidents, (2) Complaint by people	As required	CWASA (Officers in charge of Environment Management/Operation & Maintenance)
(2) Natural Environment					
1) Change in flora, fauna and terrestrial and aquatic ecosystem	Habitat of flora and fauna	Project area	(1) Complaint by people, (2) Visual inspection	As required	CWASA (Officers in charge of Environment Management)
2) Change in fishery resources	Habitat of fish and fish breeding, feeding and nursery sites	Project area	(1) Complaint by people, (2) Visual inspection	As required	CWASA (Officers in charge of Environment Management)
(3) Environmental Pollution					
1) Noise and vibration	Nuisance due to noise and vibration	Around WTP, Nashirabad reservoir and Halishahar Elevated tank	(1) Complaint by people, (2) Physical observation	As required	CWASA (Officers in charge of Environment Management/Operation & Maintenance)
2) Surface water quality	Temperature, pH, turbidity, Chloride, COD	3 Stations of Karnaphuli and Halda River*	Bangladesh Standard for Inland Surface Water	Monthly	CWASA (Officers in charge of Environment Management/Operation & Maintenance)
3) Effluent quality	Temperature, pH, turbidity, Chloride, SS, COD	Effluent discharge from WTP	Standards for Industrial and Project Effluent	Monthly	CWASA (Officers in charge of Environment Management/Operation & Maintenance)
4) Drinking water quality	pH, turbidity, Chloride, hardness, re-	At least one tap water for	Bangladesh Standards for	Monthly	CWASA (Officers in charge of Environment

Monitoring Item	Parameter	Subject /Location of Monitoring	Meth-ods/Relevant Standards	Frequency	Responsibility
	sidual Chlorine, Total Coliform group bacteria	each sub-system	Drinking Water		Management/Operation & Maintenance)

*Note: * 3 monitoring stations of river water quality (Upstream of intake point of Karnaphuli River, downstream of WTP effluent discharge point, and downstream of confluence with Halda River)*

In the terms and conditions, which accompanied the Issuance of ESC and Approval of EIA Report on Karnaphuli Water Supply Project by DOE (See Table 10.2.2 V), following matters are required for environmental monitoring.

(1) Record of monitoring

Monitoring and Recording conditions

1) The results of any monitoring required to be conducted by this Clearance Certificate must be recorded.

2) The following records must be kept in respect of any samples required to be collected for the purpose of this Clearance certificate: (a) The date(s) on which the sample was taken; (b) The time(s) at which the sample was collected; (c) The point at which the sample was taken; and (d) The name of the person who collected the sample.

(2) Monitoring items and timing

Requirement to monitor concentration of pollutants discharged. For each monitoring, the Clearance Certificate holder must monitor (by sampling and obtaining results by analysis) the following parameter; (a) water flow, water quality, air quality (SPM), the surrounding areas for spread of invasive species, the changes in aquatic habitats before, during and after construction, (b) fish catching during and after construction.

(3) Reporting

Reporting Conditions: Environmental Monitoring Reports shall be made available simultaneously to Head Quarters and respective Divisional offices of the Department of Environment on a quarterly basis during the whole period of the project.

(4) Notification of Environmental Harm

The Clearance Certificate holder or its employees must notify the Department of Environment of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident.

10.6 Environmental Checklist

10.6.1 Bangladesh Environmental Checklist

Screening of potential environmental impacts and mitigation measures has been carried out for Phase 2 Project according to the Bangladesh Environmental Checklist. The results are shown in Supporting Report 10.6.1.

10.6.2 JICA Environmental Checklist and Monitoring Form

Based on the results in 10.4, confirmation of environmental and social considerations for the Phase 2 Project are carried out according to the JICA Environmental Checklist (No.14 Water Supply) and included in Supporting Report 10.6.2.

CHAPTER 11

IMPLEMENTATION PLAN AND CONSTRUCTION COST ESTIMATES

CHAPTER 11 IMPLEMENTATION PLAN AND CONSTRUCTION COST ESTIMATES

11.1 Issues and Problems in the Implementation of Phase 1 Project

The Phase 1 Project was planned to be completed by the year 2010; however, as of September 2012 an additional 5 years may be necessary up to the year 2015 considering the present progress of the construction work. The major reasons for the delay of the Project are summarized below. Referring to the problems in Phase 1, the Phase 2 Project shall be planned.

(1) Procurement of Consultants and Contractors

1) Consultants Selection

It took about 2 years for the selection of Consultants for design and construction supervision of the water supply facilities covering all packages in the Phase 1 Project. At least about one year more than the original schedule was required, mainly because of following reasons.

- Lack of experience of personnel in charge in the evaluation of the technical proposal and timely completion of selection process by CWASA in the procurement process was weak.
- It took a longer time than scheduled to obtain approval from the GOB.

2) Contractor Selection

Additional time was required for the contract negotiations, due to insufficient documents being submitted by the bidders on their qualification and experience for particular items to be procured, such as experience in manufacturing of large diameter pipes.

(2) Land acquisition for the WTP

It took a long time to obtain the land area for the WTP, which resulted in the preparation of the detailed design of the WTP being delayed by more than 1.5 years compared to the schedule.

(3) Management capacity of the contractors

The capability of the Contractor undertaking Package 1 (Intake and WTP) in construction management is poor (including management of sub-contractors and ability to communicate in English) and the Project Manager has been changed several times. The construction plan and shop drawings have not properly prepared and submitted timely to the Consultant, because of the limited experience and quality of the assigned engineers, as well as the overall management capacity. Among four packages, C1contract for construction of intake facilities and WTP, and C3 contractor for construction of reservoir are quite behind the schedule as of October, 2012 (17 % delay against planned performance of 23% for C1 and 27% delay against planned performance of 87% for C3).

(4) Influence by the climate

The rainy season this year has been extended with some heavy rainy days, which disturbed site preparation work including construction of access roads.

11.2 Conditions and Assumptions for Preparation of Implementation Plan

The implementation Plan for the Phase 2 Project shall be established referring to the lessons from the Phase 1 Project, as summarized in sub-section 11.1, and particular conditions and assumptions to be considered for the Phase 2 project.

(1) Needs for Improvement from the Phase 1 arrangements

1) Procurement of Consultants and Contractors

a) Selection of Consultants: CWASA shall employ an experienced and capable procurement specialist and on-the-job training by the Consultants specialist shall be provided for him before and during bidding stage for the selection of contractors. The approval process for the selection of the Consultants shall be simplified in the GOB.
b) Selection of Contractors: Conditions on the qualifications and experience of the bidders shall be stricter with a requirement to submit comprehensive and complete documents to show clearly evidence of experience of procurement of larger diameter pipes and equipment to be imported. The required qualifications shall at least satisfy those for Phase 1 Project (including certificate from the clients on the experienced projects).
c) Reduction in the duration of approval process in GOB: Bangladesh side shall study continuously to find a short cut way in the approval process for the procurement.

2) PQ conditions on the company's experience and quality and experience of Project manager (P/M) and engineers for construction work

a) Eligibility of bidders: The prime contractor shall be selected through International Competitive Bidding (ICB). However, local sub-contractors may be used for civil/architectural work. Nominated staff members shall have qualifications more than those for Phase 1 Project.
b) The qualification of bidders shall include the experience in the operation of WTP and leakage monitoring and repair to ensure quality of the construction work in order to ensure higher quality of the bidders (understanding by the bidders on the overall water supply system through the experience of concerned component works for water supply).
c) Quality and experience of staff: Conditions on the qualifications and experience of the P/M and engineers of the bidders (including communication capability in English) shall be stricter than that in Phase 1. The PQ and bid documents shall request bidders to submit comprehensive and complete documents including pictures at the project sites on experienced similar projects and certificates of completed project by the clients in the similar scope of work as Phase 2 Project, in order to show clearly the evidence of the capability of the P/M and engineers, as well as experience of the bidder on similar project(s) in Asian countries.

(2) Special conditions to be considered in Phase 2 Project

The Phase 1 Project is scheduled to be completed in 2015. However, the scope of the Project for the distribution network is limited up to primary and secondary distribution pipelines to the entrances to the sectors and it does not include pipeline systems in the DMAs. Such pipes up to the service connections in the DMAs are included in the Phase 2 Project covering the entire Karnaphuli service area. Therefore, after completion of the Phase 1 Project, the main/ sub-main pipelines will be temporarily connected to the existing main/sub-main pipes to continue water supply until the completion of the Phase 2 Project.

Construction of pipelines in the DMAs shall be given priority in the Phase 2 Project for the PANI area (Sectors C to H; total of 6 sectors). Aside from water supply service to the residents, Phase 2 Project will help increase the income of CWASA by the provision of distribution networks with water meters at appropriate locations.

In order to complete the construction of distribution networks in DMAs for the priority area (Sectors C to H) as early as possible (at the latest within 3 years after completion of the Phase 1 Project), the procurement of Consultants shall be started as soon as possible (upon finish of appraisal of the Project).

11.3 Scope of Work of Phase 2 Project

The scope of work for Phase 2 of the Karnaphuli Water Supply Project is tabulated in Table 11.3.1.

Table 11.3.1 Components of the Karnaphuli Water Supply Project

Facilities		Phase 1	Phase 2
1	Intake	C/A: 300,000m^3/d M/E: 150,000m^3/d	C/A: - M/E: 150,000m^3/d
2	Conveyance Pipeline	DN1200mm, L=3.6 km (including surge tank)	DN1200mm, L=3.6 km (including surge tank)
3	WTP	Production Capacity = 143,000m^3/d	Production Capacity =143,000m^3/d
4	Transmission Pipeline 1 (WTP to Nashirabad Reservoir)	DN1200mm, 24.4km (including surge tank)	DN1200mm, 24.4km (including surge tank)
5	Nashirabad Reservoir	Reservoir: 26,300m^3 Elevated Tank: 2,200m^3	Reservoir: 24,800m^3
6	Transmission Pipeline 2	Nashirabad – Battali Hill: L=5.2km DN1200/1000mm	Nashirabad – Halishahar : L≒10km DN1100mm
7	Halishahar Elevated tank	-	2,400m^3
8	Optical Fiber Cable	L=37km	L=20km
9	Primary and Secondary Distribution Pipeline	Northern, Central & Southern areas, DN300-DN1200mm L= 42.8km	Distribution Reservoir/ Elevated Tank to the ten (10) Sectors - Primary Distribution (Upstream from Sector Valve to Reservoir); L= 7.9km - Secondary Distribution (Downstream from Sector Valve to DMA; L=107.5km
10	Tertiary distribution pipeline （Within DMAs）	-	3,063ha (L=367.6km)
11	Service connection with water meter	-	About 51,360 connections
12	Consulting Services	Detailed Design & Construction Supervision	Detailed Design & Construction Supervision

11.4 Alternative Study on Implementation Plan

11.4.1 Packaging for Project Components

The major components of the Phase 2 Project are Intake, Conveyance Pipeline, WTP, Transmission Pipeline and Distribution facilities. The packaging of the Project for the major components shall be made by basically referring to the arrangements for the Phase 1 Project. However, for the distribution facilities, which include primary, secondary and tertiary pipelines (refer to the definition of pipeline in Chapter 6), distribution reservoir/elevated tank and distribution networks including service connections in the DMAs, it is considered to divide these facilities into two categories (1) primary pipelines to service connections in the DMAs; and (2) reservoir/ elevated tank (structure). Because of the magnitude and complexity of the work and required period for the detailed design (D/D) including investigations/survey and construction work, item (1) mentioned above shall be the priority package of all the required packages.

The following are the required packages for the Phase 2 project giving priority to the Distribution pipelines for early realization of water supply to the priority service area. For Package 4 procurement of equipment and vehicles, several lots shall be considered by different equipment and vehicle.

(1) Package 1:
(2) Package 2:
(3) Package 3:
(4) Package 4:

Non-disclosure Information

Package 3 is a very urgent component in the overall Karnaphuli Water Supply Project in order to provide water supply at an early stage in a cost effective manner. While, other packages may be implemented applying procedures that are normally used in loan projects for the implementation of the project components.

Package 3 shall be implemented considering priority area. The concerned priority Sectors in PANI area are C to H. Sectors I and J, which are located in the Western service area, will be served by Halishahar Elevated tank after completion of the Phase 2 construction work; however, during the transition period after completion of the Phase 1 Project, water supply to the sectors will be provided by a pipeline from the Central service area via Battali Hill Reservoir.

11.4.2 Procurement Methods for the Implementation of the Project

All packages may be implemented by application of the method used for normal loan projects.

(1) Possibility of Local Bidding

With regard to the manner of bidding for construction work, generally, Local Competitive Bidding (LCB) is more advantageous than International Competitive Bidding (ICB) in terms of the time required from the start of bidding to contract award. However, it seems to be difficult to adopt LCB for the Phase 2 Project, even for the construction of distribution networks under the arrangement of DMAs for the entire KSA. The major reasons are listed below.

- The work includes international procurement of DIP (Ductile Iron Pipe) with large diameters. However, local contractors are not familiar with international procurement.

- Capable engineers to construct pipelines in DMAs are limited in number at the present time. Local laborers, who are trained and have experience in pipe laying work are also limited in number.

Therefore, ICB shall be used for all packages to maintain the quality of the required facilities and timely completion of construction works, although local Contractors may be employed as sub-contractors.

(2) Package 3 Arrangement both for Consulting Services and Construction Work

1) Consulting Services

The scope of work for Package 3 covers construction of primary, secondary and tertiary pipelines, and lateral/ service connections in the DMAs. Detailed design in the Consulting services includes trial excavation along main pipelines (primary and secondary pipelines) to find underground facilities and topographic survey for a total of about 120 km of pipelines. The following are assumptions on the required days for trial excavation considering the present capacity of local contractors (mainly those from Dhaka based on the experience from the Phase 1 Project) and traffic/ living disturbance in the city, also based on Phase 1 experience.

a) Required number of excavation points: Assuming one point per 100m along distribution pipelines, about 1,200 points are required.
b) Number of excavation teams to be mobilized and performance by a team per day: 10 teams (about 80 persons are required) are assumed to work for 25 days/month (about 5 foremen are required). In other words, investigation on 10 points/day will be completed; however, the majority of work shall be implemented during the dry season.
c) Required months for trial excavation (about 1,200 points): Based on the assumptions on the number of points and performance per team, 120 days are necessary, about 4 months are required during the work in the dry season.

Topographic survey will be completed within 4 months in parallel to the implementation of the trial excavation work. The required period for D/D shall include for data/information collection and mapping thereto on underground facilities before trial excavation (2 months) and after the investigation and topographic survey has been completed, mapping on the findings (2 months) is also required, prior to design work being commenced. Thus, at least 8 months will be required before the start of detailed design work when investigation/ survey is commenced at the beginning of dry season and implemented smoothly. If unfavorable weather conditions and other hindrances occur, additional months will be required. Thus, it may be safe to consider a longer design period.

2) Construction Work

The construction capacity of local contractors was evaluated based on the experience of the Phase 1 Project with reference to the construction of distribution pipelines. Eleven local contractors were considered as potential sub-contractors by the prime contractor for Phase 1. Based on the experience during Phase 1 project implementation, the following conclusions can be made:

a) Some local companies do not have sufficient experience on the construction of pipelines
b) Permanent employees (engineers) are limited and engineers are employed on a project basis.

Construction of distribution pipelines with a length of about 483 km is planned in Package 3. In this connection, two cases are studied considering the mobilization of local laborers.

- Case 1: Construction of pipelines for all 10 Sectors is commenced at one time and completed within about one year

It is assumed that at least 10 construction teams per Sector (about 3 km/ Sector) are required to complete the work within 1 year. Therefor 100 construction teams are necessary for 10 sectors. Based on the experience in Phase 1, about 2,000 laborers are required (20 persons x 100 teams). This number of laborers (generally unskilled) may be found and employed, but it is very difficult to find 20-30 engineers who have knowledge of pipe laying to supervise the laborers at one time.

- Case 2: A smaller group of the Sectors (3 Sectors/group) with a priority will be implemented sequentially with a longer construction period than Case 1, which will give some allowance for a longer completion period of the work by the Contractor.

On the assumption of the construction schedule per construction team as Case 1, 30 construction teams would be mobilized with the total number of laborers required being 600 persons, as well as about 10 engineers. In this case, about two times of mobilization of laborers and engineers shall be made comparing with the arrangements by Phase 1 for pipeline construction.

As discussed above, Case 2 seems to be more realistic than Case 1 in construction arrangements. However, detailed planning and countermeasures by concerned parties against possible problems are required as the work will affect the living conditions of residents, businesses, etc. in many locations.

(3) Alternative Procurement Methods

In application of ICB, two alternatives for Package 3 are studied, focusing on the Consulting services. The manner of construction as discussed above (application of Case 2) is common to the two cases. The normal procurement procedure is recommended for the other packages (Packages 1, 2 and 4), based on the discussions in the above sub-sections.

1) Case 1: Common procurement method used in loan projects both for the selection of Consultants and Contractors by the use of ICB for the implementation of all 4 packages is adopted. However, for the Consulting services for Package 3, a longer D/D period (a total of 18 months) is considered to manage unexpected hindrances due to weather conditions, employment of 40 working teams at one time and night time working with reference to trial excavation for about 3,500 points.
2) Case 2: Common procurement method used in loan projects both for the selection of Consultants and Contractors by the use of ICB for the implementation of all 4 packages is adopted, which is the same as for Case 1. In order to expedite providing water supply to the priority area, the period required for Package 3 D/D is reduce to the minimum, which is considered to viable (a total of 13 months). For this case, the trial excavations should be arranged such that they commence and are completed within the dry season and augmentation of design engineers for distribution pipelines is a requisite (compared to Case 1).

The differences between Case 1 and Case 2 are related to the duration of the Consulting services, which is dependent to a large extent on the duration required to carry out the large number of trial excavation points along the pipelines. The construction schedule for the two cases are the same, as work is implemented in grouped sectors sequentially giving allowance for completion of the work by the Contractor, taking into account the present capability of local contractors. Table 11.4.1 summarizes the procurement methods both for Consultants and Contractors.

Table 11.4.1 Procurement Method

Procurement	Scope of Work	Manner of Procurement with required process/ events
Consultants	One consultancy package: D/D & C/S for all packages of work	ICB (PQ, Bid, Approval)
Contractor	Construction of facilities	ICB (PQ, Bid, Approval)

11.4.3 Implementation Schedule by Package /Procurement Case

(1) Conditions of Implementation Schedule

Appraisal of the Project and Exchange of the Note between GOB and GOJ and Loan agreement are assumed to be completed in December 2012 and March 2013, respectively, as shown in Table 11.4.2.

Table 11.4.2 Loan Agreement Schedule

Appraisal of the Project	December, 2012
Pledge of JICA Loan	February 2013
Exchange of Note between GOB and GOJ	March 2013
Signing of Loan Agreement	March 2013

Table 11.4.3 shows the required months for the implementation of the Project by case, under the following site conditions and contractual construction period for Phase 1.

- Rainy season from May to October affects the pipe laying works (50% reduction in working days during rainy season)
- Construction period of Phase 1 is assumed at 30 months
- Shop inspection for procurement of materials/equipment is included in the construction period.

Figure 11.4.1 shows the Work-flow of bidding procedure to select contractors (Two-Envelope Bidding under JICA Procedure) and required time by major work is summarized below.

- P/Q; 3 months
- Preparation of Bidding Document including JICA concurrence; 3 months
- Submission of Bid; 2 months
- Technical Evaluation/Price Evaluation including JICA concurrence; 6 months
- Negotiation to L/C; 2 months

The construction period for distribution pipelines in case of Sector A (L=31.4km) is calculated as follows:

Additional Trial excavation by contractor: 1 month
Submission of working drawings: 2 month
Pipe laying: 12 months (= 31.4km/12m/day/0.75/10 party = 348 days)
Working rate: 0.75 (= 0.5 + 0.5 x 50% rainy season)
Construction period in Sector (L=31.3km) =15 months

The construction period for other sectors is estimated in the same manner as shown for Sector A. Figure 11.4.2 shows a comparison of the implementation schedule for the two alternative cases for the procurement of consultants (refer to discussion prior to Table 11.4.1). Case 2 is better than Case 1 as completion is 5 months earlier, although there may be a risk with this case, as discussed previously.

Table 11.4.3 Package and Construction Periods

Item	Case-1 Consulting Services with safety period	Case 2 Consulting Services with minimized period
Expected Completion of Phase 1 Project	May 2015	
Project Appraisal/Loan Agreement	Dec., 2012/ Mar. 2013	
Selection of Consultant	9 months, Dec. 2012 to Aug. 2013	
Detailed Design	18 months, Sep. 2013 to Feb. 2015	13 months, Sep. 2013 to Sep. 2014
Selection of Contractor		
Package 1	Jan. 2015 to Apr. 2016	Aug. 2014 to Nov. 2015
Package 2	ditto	ditto
Package 3	ditto	ditto
Package 4	Jul.2014 to Feb. 2014	Feb. 2014 to Sep. 2014
Construction Stage		
Package 1	36 months May. 2016 to Apr.2019	36 months Dec. 2015 to Nov. 2018
Package 2	36 months May. 2016 to Apr. 2019	36 months Dec. 2015 to Nov. 2018
Package 3	62 months May. 2016 to Jun. 2021	62 months Dec. 2015 to Jan. 2021
Completion of Project including defects liability period	Jun. 2022	Jan. 2022

Note: Package 4, Procurement of equipment, is included in the part of consulting services.

11.4.4 Implementation Plan

In Case 1, completion of the project (excluding defects liability period) will be June 2021. For the distribution network for priority sectors (6 sectors in PANI area), it is planned to complete before the middle of 2019 starting from the middle of 2016 (construction period is about 3 years).

In order to expedite the phase 2 Project with reference to Package 3, giving priority to the sectors covered by PANI area, the period for consulting services is reduced to 13 months in Case 2, mainly by reducing the period required for trial excavations along the pipeline routes. For the application of this case, the start and completion dates for trial excavation should be during one dry season. In addition, the number of engineers for design of pipelines should be more than in Case 1. Under Case 2, construction of distribution pipelines for the priority 6 Sectors will be started the beginning of 2016 to be completed in the end of 2018.

It is favorable to adopt Case 2 in order to expedite water supply, especially to the priority sectors. The schedule for overall completion of the Project in Case 2 (January 2021) is also better than Case 1. However, in consideration of the large amount of work for Package 3 requiring many engineers of the Contractor and construction working teams as well as timely completion of consulting services with absolute conditions (dry season period for trial excavation, which is a critical condition to keep contract period), careful preparation and arrangements for Case 2 are indispensable.

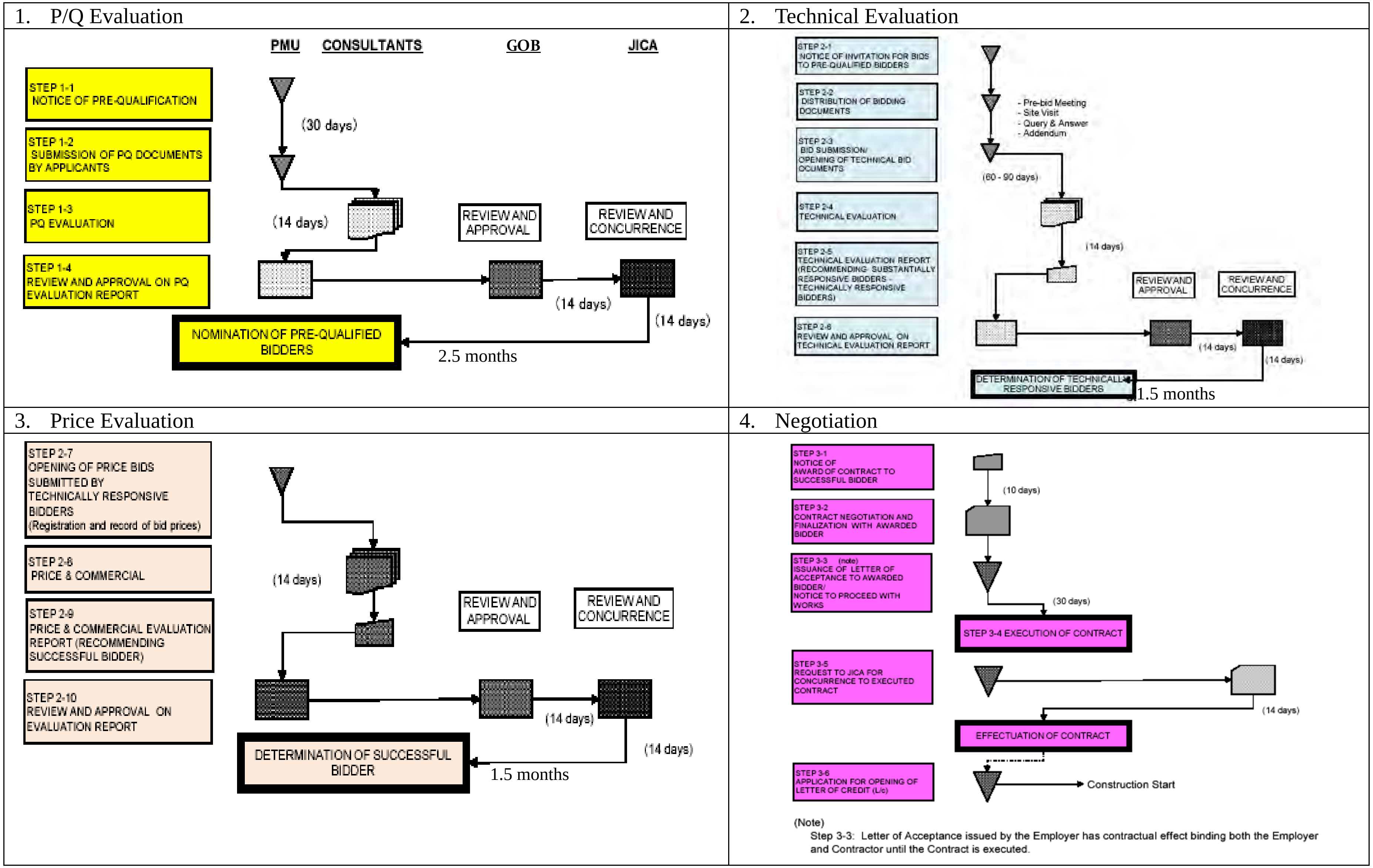

Figure 11.4.1 Work-flow of bidding Procedure (Two-Envelope Bidding under JICA Procedure)

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Case 1 Consulting Services with safety period

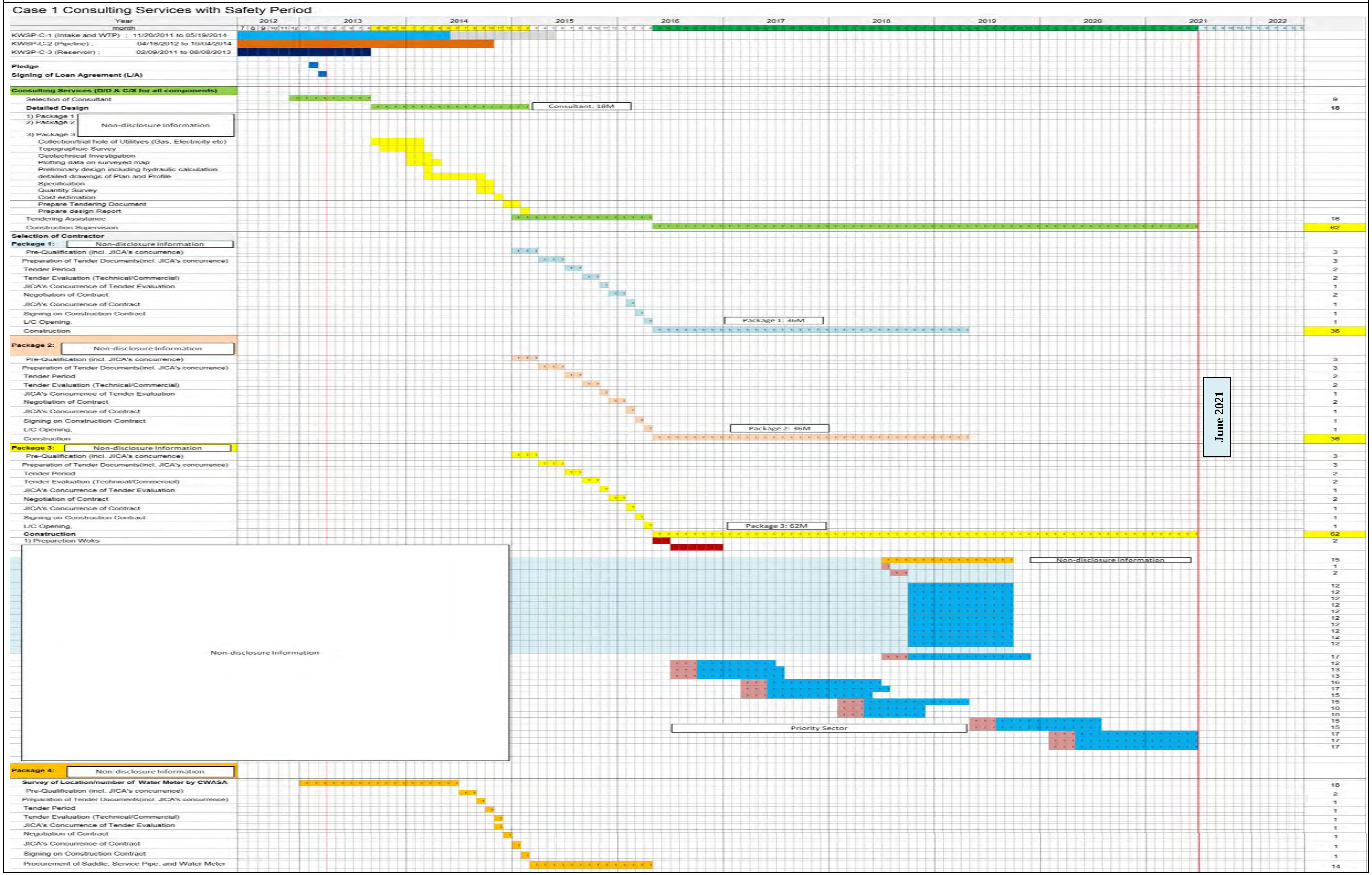

Figure 11.4.2 (1) Comparison of Implementation Schedule between Two Cases

Case 2 Consulting Services with minimized period

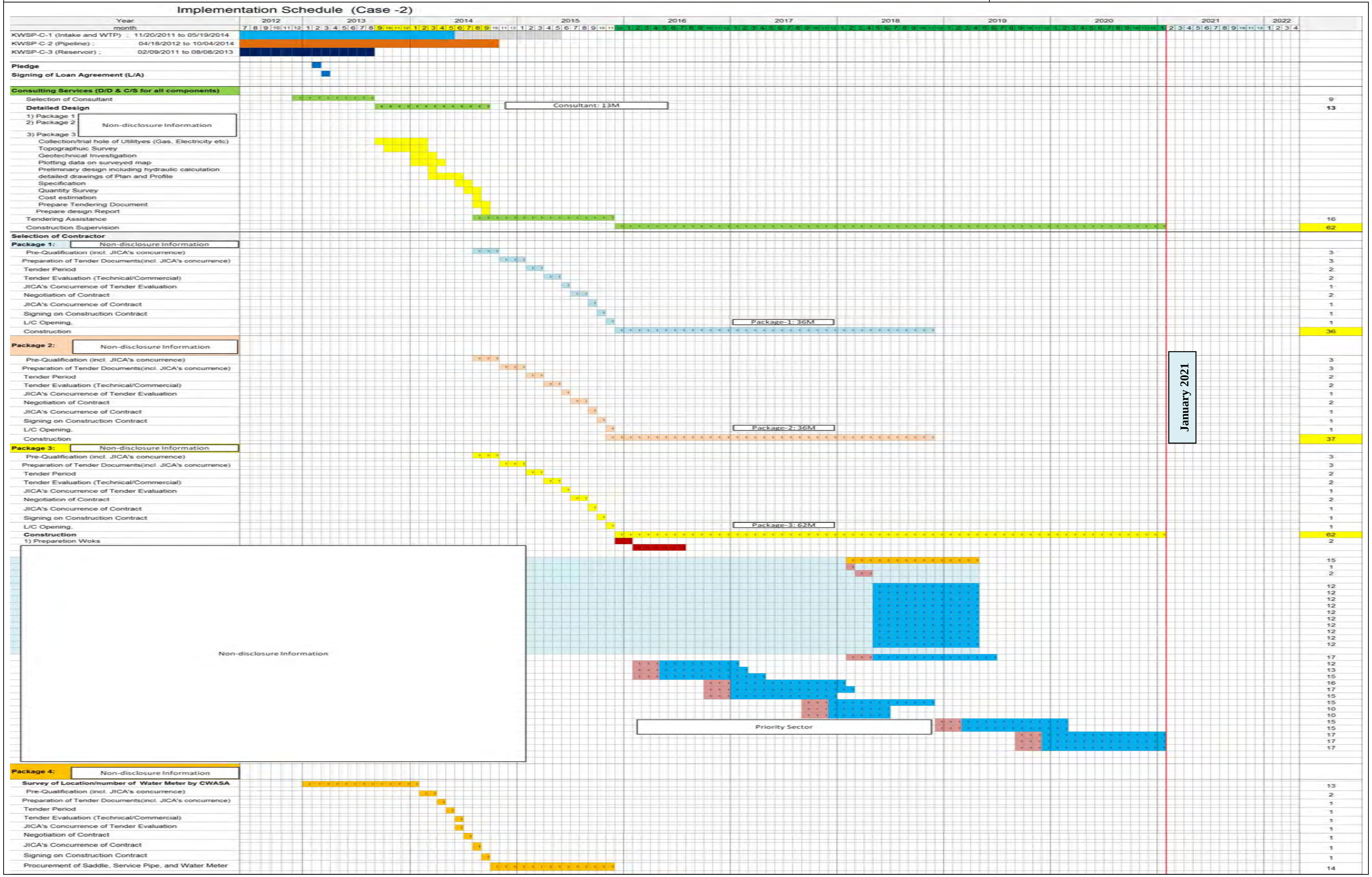

Figure 11.4.2 (2) Comparison of Implementation Schedule between Two Cases

11.5 Project Implementing Unit (PIU)

For the purpose of the smooth implementation of the Project, the Project Implementation Unit (PIU) shall be established within CWASA after approval of DPP. The PIU will have the authority to take necessary decisions and actions on all matters related to the Project implementation except selection of consultant and contractor: selection of consultant and contractor need to be approved by the committee, CWASA board, the line ministry, and the cabinet purchase committee. The PIU will be consisted of 97 staff and headed by the full-time Project Director (PD), supported by one full-time Deputy Project Director (DPD). The PD of KWSP2 and the PD of KWSP1 shall closely coordinate each other. The transitional PIU will be established in December 2012, appointing full-time PD and DPD from CWASA. After approval of DPP, CWASA will appoint necessary staff of PIU in accordance with the employment plan:

(i) two Accounting Officers by June 30, 2013,
(ii) one Procurement Specialist, one Environment Specialist, three Project Managers, seven Assistant Engineers by September 30, 2013, and
(iii) other staff by February 2016. CWASA will notify JICA of the list of appointed members within one week after appointment of staff.

The PD, DPD, Executive Engineer, as well as the officers/staff members who are assigned to the PIU will be engaged exclusively in the Project on full-time basis. Also, for the smooth implementation of the Project, CWASA will hire members for supporting project implementation ("Project implementation support") through open market competition, which consists of Procurement Engineer, Accounting Officer, Social Relationship Officer, Environment Specialist, Project Managers, and supporting staff. Also, PD and DPD may be recruited from outside in the course of the project implementation, those expense will be borne under JICA loan. Project implementation support members will be engaged exclusively in the Project on full-time basis and appointed to PIU. In the case of appointing CWASA staff to Project implementation support members, CWASA will supplement vacant posts not to affect CWASA's work other than KWSP2. The proposed Project Implementing Unit (PIU) in CWASA is shown in Figure 11.5.1.

Knowledge and experience obtained in the course of the project implementation need to be transferred and succeeded to CWASA. Therefore, the Project implementation support members need to be appointed as CWASA's proper staff after the completion of the Project. CWASA will consider appointing the members as CWASA staff, introducing suitable market-based payment scale and organizational arrangement by 2019 before the project completion. Job description and qualification requirements are shown in Table 11.5.1.

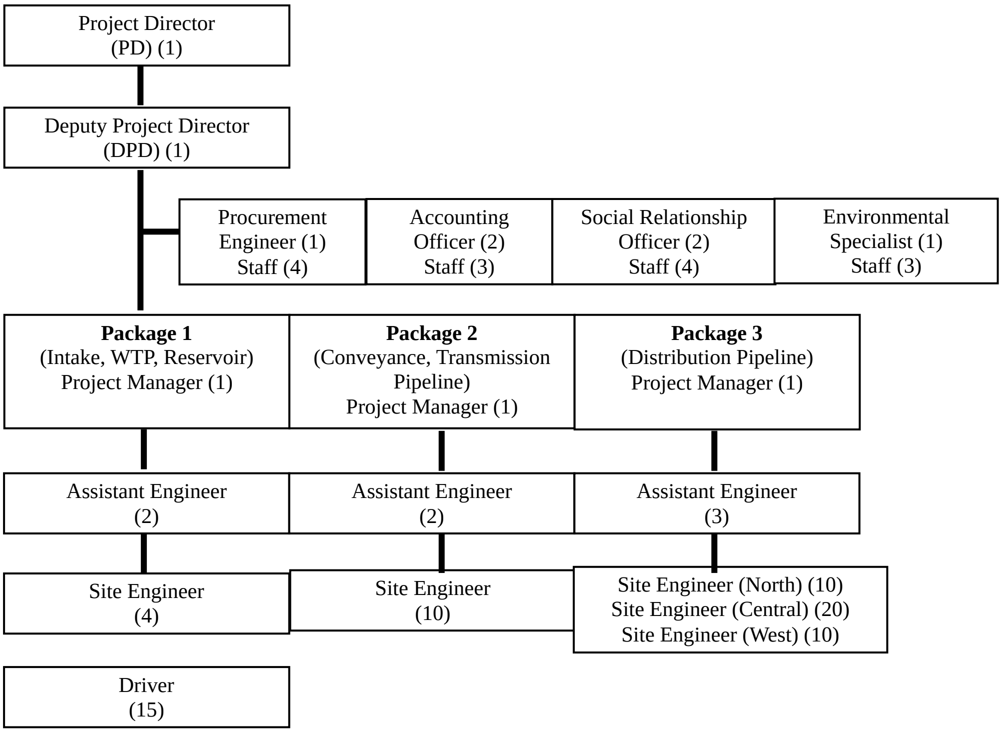

Figure 11.5.1 Proposed PIU in the CWASA Organization

Table 11.5.1 Job Description and Qualifications

Job Title	Job Description	Qualifications
Project Director (PD) (1)	• Responsible for project implementation and management of the PIU.	• Experiences of project management for infrastructure projects, including selection of international consultants and contractors/suppliers through international competitive bidding, as PD or DPD. • Experiences of water supply related projects. • Being familiar with the coordination among the government agencies.
Deputy Project Director (DPD) (1)	• Responsible for supporting PD for overall project management.	• Experiences of project management for infrastructure projects, including selection of international consultants and contractors/suppliers through international competitive bidding, as DPD or Executive Engineer. • Experiences of water supply related projects. • Being familiar with the coordination among the government agencies.
Procurement Engineer (1)	• Responsible for all procurement procedures of the Project.	• Experiences of selection of international consultants and contractors/suppliers through international competitive bidding.
Accounts Officer (2)	• Responsible for all accounting related issues of the Project	• Experience of project accounting/payment control. • Being familiar with the cash flow monitoring of multiple sub-projects, as well as international payment procedures.
Environmental Specialist (1)	• Responsible for environmental monitoring/countermeasures	• Experience for environmental monitoring and providing countermeasures

Job Title	Job Description	Qualifications
Social Relation-ship Officer (2)	• Responsible for all social (customers and residents) related issues of the Project.	• Experience of mitigation measure for social impact in infrastructure projects. • Being capable of coordinating the works carried out by the engineering consultants/contractors who will explain the implementation schedule of the project etc. to the residents, especially, for construction works of distribution network.
Project Manager (1)	• Responsible for activities of construction works	• Experiences of the project management in relatively large size as a construction manager or an assistant construction manager in water supply projects.
sistant Engineer (7)	• Responsible for supporting Executive Engineer as construction manager	• Experiences of the project management in relatively large size as a construction manager or an assistant construction manager in water supply projects.
Site Engineer (54)	• Responsible for supporting Assistant Engineer as assistant construction manager	• Degree or experiences of civil engineer.
Driver (15)		• Driver's experience

11.6 Consulting Services

11.6.1 Terms of Reference

(1) Consulting Service for Detail Design, Assistance for Bidding, Procurement of equipment and Construction Supervision

CWASA will procure consulting services for detailed design, assistance to bidding, procurement of equipment and construction supervision of Phase 2 Project through ICB. The consultants' team shall consist of international and local professional and supporting staff. Consultants will be selected through a short list method to avoid lowering of quality and in accordance with the "Guidelines for the Employment of Consultants under Japanese ODA Loans".

The scope of work in the Terms of Reference (TOR) for the consulting services includes detailed design of the intake facilities, conveyance pipeline, WTP, transmission pipeline, and distribution facilities and construction supervision aside from the assistance to WASA. It will also include preparation of tender documents entailing detailed technical specifications for the four packages; (1) intake facilities, WTP and distribution reservoir/elevated tank, (2) conveyance and transmission pipelines and optical fiber cable, (3) distribution pipelines up to installation of service connections, and (4) procurement of saddles, service pipes, valves and water meters for service connections.

The TOR is prepared considering requirements discussed in the previous sub-sections, especially with reference to the critical conditions for Package 3, detailed design for distribution pipelines with a length of about 483 km.

The TOR for Consulting Services for Detailed Design and Construction Supervision is included in Supporting Report 11.6.1.

11.6.2 Cost Estimates for Consulting Services

The contract of consulting services includes preparation of detailed design, assistance for bidding and construction supervision, and procurement of equipment for Phase 2 Project. A total of NDI man-months of foreign and NDI man-months of local engineers are considered. The service will also include on-the job training for CWASA staff from investigation/design, construction supervision and trial operation of facilities. The engineers assigned for the work will transfer technologies to CWASA staff who shall be assigned as counterpart staff members during the implementation of the Project. CWASA staff will stay with Consultants staff in the field during the period of on-the-job training without additional expenditures.

Under the above conditions total cost for the consulting services is estimated at approximately NDI million yen (Foreign portion: NDI million yen, Local portion: NDI million Taka). The detailed cost estimate for the consulting services is shown in Table 11.6.1.

Table 11.6.1 Estimated Cost for Consulting Services

TK = 0.966 Yen

		Unit	Qty.	Foreign Portion		Local Portion		Combined Total
				(Yen)		TK		Yen
				Rate	Amount ('000)	Rate	Amount ('000)	('000)
A.	**Remuneration**							
1	Professional (A)	M/M						
2	Professional (B)	M/M						
3	Supporting Staffs	M/M						
	Subtotal of A							
B.	**Direct Cost**							
1	International Airfare							
2	Domestic Airfare							
4	Domestic Travel							
5	Accommodation Allowance							
	Professional (A)	Month						
	Professional (B)	Month						
	Supporting Staffs	Month						
6	Vehicle Rental	Month						
7	Office Rental	M/M						
8	International Communications	M/M						
9	Domestic Communications	M/M						
10	Office Supply	M/M						
11	Office Furniture and Equipment	Ls						
12	Report Preparation	Month						
13	Topographic & Soil Survey	Ls						
14	Trial Digging	Ls						
	Subtotal of B							
	Total							

Non-disclosure Information

11.7 Preliminary Cost Estimates

11.7.1 Conditions and Assumptions for Cost Estimates

Following conditions were assumed for the cost estimates of construction, and administrative cost and tax.

(1) Construction Cost

1)	Base Year	December, 2012
2)	Exchange Rate	1 Taka = 0.966Japanese Yen 1 USD = 81.7 Taka = 79.0 Japanese Yen
3)	Price Escalation Rate per annum	Foreign Currency = 2.1%, Local Currency = 4.9%
4)	Physical Contingency	5%

(2) Administration Cost and Service Tax

1)	Administration Cost	5% (of the Eligible Portion)
2)	VAT for local currency	15% (of the expenditure in local currency of the eligible portion)
3)	VAT for foreign currency	15% (of the expenditure in foreign currency of the eligible portion for Consulting Service)
4)	Import tax	30% (of the expenditure in foreign currency of the eligible portion for Procurement/Construction)

11.7.2 Construction Costs

Details of the construction cost are shown in Table 11.7.1 and annual fund requirement for the Project are tabulated in Table 11.7.2. The detailed breakdown of the construction cost is included in Supporting Report 11.7.1.

Table 11.7.1 Construction Cost for Phase 2 Project

Item		Total (million)		
		FC (JPY)	**LC (BDT)**	**Total (JPY)**
A. ELIGIBLE PORTION		Non-disclosure Information		
I) Procurement / Construction				
1	Intake facilities, WTP, reservoirs and elevated tanks			
2	Conveyance and transmission pipeline			
3	Distribution pipeline and service connections			
4	Procurement of goods			
5	Project Implementation Support Unit			
	Base cost for JICA financing			
	Price escalation			
	Physical contingency			
II) Consulting services				
	Base cost			
	Price escalation			
	Physical contingency			
Total (I + II)				
B. NON ELIGIBLE PORTION				
a	Procurement / Construction			
	Base cost for JICA financing			
	Price escalation			
	Physical contingency			
b	Land Acquisition			
	Base cost			
	Price escalation			
	Physical contingency			
c	Administration cost			
d	VAT			
e	Import Tax			
f	Banking charge			
Total (a + b + c + d + e + f)				
TOTAL (A+B)				
C. Interest during Construction				
	Interest during Construction(Const.)			
	Interest during Construction (Consul.)			
D. Commitment Charge				
GRAND TOTAL (A+B+C+D)				
E. JICA finance portion (A)				

Table 11.7.2 Annual Fund Requirement for KWSP (Phase 2)

Item	Total			2012			2013			2014			2015			2016			2017			2018			2019			2020			2021			2022		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION																																				
Ⅰ) Procurement / Construction																																				
Intake facilities, WTP, reservoirs and elevated tanks																																				
Conveyance and transmission pipeline																																				
Distribution pipeline and service connections																																				
Procurement of goods																																				
Project Implementation Suppot Unit																																				
Base cost for JICA financing																																				
Price escalation																																				
Physical contingency																																				
Ⅱ) Consulting services																																				
Base cost																																				
Price escalation																																				
Physical contingency																																				
Total (Ⅰ+Ⅱ)																																				
B. NON ELIGIBLE PORTION																																				
a Procurement / Construction																																				
Base cost for JICA financing																																				
Price escalation																																				
Physical contingency																																				
b Land Acquisition																																				
Base cost																																				
Price escalation																																				
Physical contingency																																				
c Administration cost																																				
d VAT																																				
e Import Tax																																				
f Banking charge																																				
Total (a+b+c+d+e+f)																																				
TOTAL (A+B)																																				
C. Interest during Construction																																				
Interest during Construction(Const.)																																				
Interest during Construction (Consul.)																																				
D. Commitment Charge																																				
GRAND TOTAL (A+B+C+D)																																				
E. JICA finance portion (A)																																				
Administration Cost =																																				
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Interest during const																																				
Commitment Charge																																				
Balance of yen loan																																				
Commitment Charge																																				

Non-disclosure Information

11.8 Comparison of Construction Cost with Similar Projects

For the purposes of comparing the construction cost with other projects, the most relevant project in Bangladesh is the Saidabad WTP Phase II project in Dhaka. This project includes:

(1) WTP with a production capacity of 225,000 m^3/d, constructed on the same site as the Phase 1 WTP, including intake facilities. Some of the Phase I facilities such as laboratory, workshop and sludge treatment facilities are used to some extent.
(2) Pretreatment plant for Phase I and II with a production capacity of 450,000 m^3/d. This is provided to reduce levels of ammonia (which is high during the dry months) in the raw water
(3) Transmission mains with a total length of about 10 km
(4) 3 years operation and maintenance

The project is being implemented as a design-build contract, financed by the Government of Denmark, with the GOB financing taxes and other local costs. In accordance with the requirements of the donor, tendering was limited to eligible Danish firms, or in the event of joint venture, joint ventures with a Danish leader.

The invitation for prequalification was issued in May 2007, with tenders submitted in November 2008. The contract commenced in June 2010, with a nominal contract period of 30 months (excluding the operation and maintenance period). As of September 2012, it is envisaged that completion of the contract will be within the contract period.

There is no provision in the contract for price escalation and as such the Contractor had to allow for this when preparing the tender, as well as for carrying out the detailed design and allowing for various risks, which may not be in a conventional contract.

The Accepted Contract Amount for items (1) to (3) above is approximately NDI (excluding taxes), as shown in Table 11.8.1, which also includes a breakdown of the amount. In the following discussion all amounts are exclusive of taxes.

Further details of the above and other issues are included in Table 11.8.1.

Table 11.8.1 Accepted Contract Amount for Saidabad WTP Phase II project in Dhaka

S.L.	Facilities	Capital Cost (Million in EURO)			Total
		Civil	Mechanical	Electrical and ICA	
1	Treatment Plant & Construction (225mld)	Non-disclosure Information			
2	Pre-Treatment Unit (450mld)				
3	Site Works (Site Provisions & Preliminaries)				
4	Transmission Pipeline (10K.M.)				
5	Ancillary Structures				

WTP

Source: hearing from DWASA

There are various similarities between the WTP in the KWSP (Phase 2) and the Saidabad WTP Phase II project, including as follows:

- Treated water quality requirements
- Use of the existing site
- Use of some of the facilities constructed in/or being constructed in an earlier phase

- Scale of the project is similar (considering the capacity of the respective WTPs and the fact that other works are planned to be included in the same contact as the WTP in the KWSP (Phase 2)

However there are some important differences, including as follows, which are specific to the Saidabad WTP Phase II Project:

- Design-build contract used
- Contract period is the same as that proposed for the WTP and other works, Package 1 in KWSP (Phase 2). However within the contract period the Contractor has to carry out the detailed design (as well as obtaining approval to the design), which means that the period available for construction, commissioning and testing of the works is less than for the KWSP(Phase 2)
- No price escalation
- Tendering restricted
- Relatively long period between submission of tenders and contract commencement

Comparison of the construction cost needs to take account of the following main items, in addition to the scope of the project:

- Procurement method
- Provisions for price escalation
- Relative timing of the two projects
- Currency

The approximate Accepted Contract Amount for item (i) of the above only (including site provisions and preliminaries) is approximately NDI . If the contract had been implemented as a conventional contract then it is estimated that the Accepted Contract Amount would be of the order of NDI allowing for the fact that under the design-build contract, the Contractor (i) has to carry out the detailed design, (ii) allow for some risks that may be partly or totally borne by the Employer under a conventional contract and (iii) allow for the payment provisions regarding escalation. Based on an approximate exchange rate on the date of submission of the tender for the Saidabad WTP Phase II project of JPY 120 = EURO 1, then the above cost of NDI is equivalent to NDI (or about NDI /m^3 of production capacity).

Allowing for a nominal average increase in the construction cost of 5% per annum between the date of submission of the tender for the Saidabad WTP Phase II and the date of the estimate for this project then the cost of the Saidabad WTP Phase II project (at the date of the estimate) in terms of JPY/ m^3 of production capacity is about NDI /m^3 of production capacity. This is comparable with the estimate of NDI /m^3 (= about NDI /143,000m^3/d, excluding civil/architectural works at the Intake facilities) of production capacity for the WTP in the KWSP (Phase 2).

The construction costs of the WTPs at the Saidabad Phase II and KWSP (Phase 2) are summarized in Table 11.8.2.

Table 11.8.2 Comparison of Construction Cost

Item	Saidabad Phase II (Dhaka)	KWSP (Phase 2)
Production Capacity (m^3/d)	225,000	143,000
Tender submitted	November, 2008	-
Base year for Cost estimation	-	September, 2012
Cost of WTP (million)	Non-disclosure Information	

Item	Saidabad Phase II (Dhaka)	KWSP (Phase 2)
	Non-disclosure Information	

11.9 Performance Indicators

The performance indicators are studied for monitoring of inputs, outputs, outcomes, and impacts of a project. They are monitored during project implementation to assess project progress toward project objectives, and for evaluation of project accomplishments after project implementation.

Construction works for KWSP (Phase 2) will be completed in November, 2020. The projected indicators by target year are shown in Table 11.9.1. Service coverage will increase from 47% in 2012 to 51% in 2023. However, population to be served in 2023 against present population is about 70% (population is projected to increase about 40% from 2012 to 2023).

Table 11.9.1 Performance Indicators in Phase 2 Project in CCC

Indicator	2012	2023 (2 years after completion of facility)	
Water Production (Phase 1 + Phase 2)(m^3/d)	219,000	505,000	
Population Served/to be served (person)	1,363,000	2,008,500	90% in KSA Deep well; 343,000 persons
Daily maximum water consumption (m^3/d)	146,700	388,900	
Service coverage (%)	47	51	70% to present population
Water Supply per Capita (l/person/day)	107	120	
Percentage of facility utilization (%)	100	100	
NRW	33%	23%	

Note: 1) 2012;

Water Production =Mohara WTP + Kalurghat IRP + Deep Tube Well = 219,000m^3/d
Population in CCC = 2,900,000 person
Population Served =1,363,000person (51,000connection x 20person/connection + 343,000person)
Service coverage = 47% (including deep well supply)

2) 2023;

Water Production = 219,000 + 286,000 = 505,000m^3/d
Population in CCC= 3,964,000 person
Population in KSA =1,272,800 person
Population Served = 1,272,800 person x 90% + (51,000connection-25,000connection)
x 20person/connection + 343,000person= 2,008,500person
Service coverage = 2,008,500 / 3,964,000 = 51% (70% to present population, 2,900,000)
NRW% in 2030 = (0.33x0.43+0.15x0.57) =23%

CHAPTER 12

FINANCIAL AND ECONOMIC CONSIDERATIONS

CHAPTER 12 FINANCIAL AND ECONOMIC CONSIDERATIONS

12.1 Budgetary Plan for the Project

12.1.1 Fund Requirements

Based on the estimated capital costs presented in Section 11.7.2, the fund requirements for the Phase 2 Project are summarized in Table 12.1.1.

Table 12.1.1 Fund Requirements for Phase 2 Project

Particulars	FC Portion*1) (JPY mil.)	LC Portion*2) (BDT mil.)	Combined Total in JPY *3) (mil.)	Combined Total in BDT*3) (mil.)
A. Construction Works	Non-disclosure Information			
A-1. Base Cost				
A-2. Price Escalation				
A-3. Physical Contingency				
A-4. Sub-total				
B. Consulting Services				
B-1. Base Cost				
B-2. Price Escalation				
B-3. Physical Contingency				
B-4. Sub-total				
C. Total Cost (A.+ B.)				
D. CWASA Administration Costs				
E. VAT				
F. Import Duties				
G. Bank Charges				
H. Interest during Construction				
Total Amount of Funds Required				

*Note: *1) FC Portion: Foreign Currency Portion (JPY: Japanese Yen)*
**2) LC Portion: Local Currency Portion (BDT: Bangladesh Taka)*
**3) Currency Exchange Rate: US$1 = BDT81.7 =JPY79.0*
(The sub-total and total amounts may not be the same as the sum due to the round-off.)

Enumerated below are the base and assumptions used for estimating the fund requirement amounts shown in the above. These assumptions accord to the conditions predetermined by JICA for the estimation of the fund requirements.

(1) Base Cost for Construction Works and Consulting Services: As of December 2012
(2) Price Escalation: calculated for the estimated annual disbursement amounts of the base costs for construction works and consulting services (given in Table 12.1.2) by applying an annual escalation rate of 2.1% for FC (Foreign Currency) Portion and 4.9% for LC (Local Currency) Portion.
(3) Contingency: calculated at 5% of the escalated costs respectively for the construction works and consulting services.
(4) CWASA Administration Cost: estimated at 5% of the total cost for FC and LC Portions (Item C) combined in terms of Bangladesh Taka.
(5) VAT: estimated at 15% of the total costs for LC Portion (Item C).
(6) Import Duties: estimated at 30% of the total costs for FC Portion (Item C).

Table 12.1.2 shows the estimated disbursements of the base costs for construction works and consulting services given in Items A-1 and B-1 of Table 12.1.1.

Table 12.1.2 Estimated Annual Disbursement Amounts of Base Costs for Construction Works and Consulting Services

FC Portion: JPY million, LC Portion: BDT million

Year	Construction Works		Consulting Services		Total	
	FC Portion	LC Portion	FC Portion	LC Portion	FC Portion	LC Portion
2013	Non-disclosure Information					
2014						
2015						
2016						
2017						
2018						
2019						
2020						
2021						
2022						
Total						

Note 1. The total amount may not be the same as the sum due to the round-off.
2. Currency Exchange Rate: US$1 = BDT81.7 =JPY79.0

This estimate is made on the assumption that payments for the construction works and consulting services will accrue during ten years from 2013 through to 2022.

12.1.2 Financing Plan

It is proposed that the funds required for the Phase 2 Project will be financed with a JICA Loan to cover the whole amount of the components which are eligible for Loans, and the rest will be financed by GOB's development fund. Table 12.1.3 shows the financing plan for the Phase 2 Project formulated in accordance with the above policy.

Table 12.1.3 Financing Plan for Phase 2 Project

Particulars	FC Portion) (JPY mil.)	LC Portion (BDT mil.)	Combined Total in JPY (mil.)	Combined Total in BDT (mil.)
A Amounts proposed for financing with JICA Loan				
1) Construction Works	Non-disclosure Information			
2) Consulting Services				
Total				
B Amounts proposed for financing with GOB Fund				
1) CWASA Administration Costs	Non-disclosure Information			
2) VAT				
3) Import Duties				
4) Bank Charges				
5) Interest during Construction				
Total				
Grand Total (A + B)				

Note: 1) The total amount is not the same as the sum, due to the round-off.
2) Currency Exchange Rate: US$1 = BDT81.7 =JPY79.0

Table 12.1.4 shows the projection of the annual disbursement of the proposed JICA Loan and GOB fund.

Table 12.1.4 Projection on Annual Disbursement of Proposed JICA Loan and GOB Fund

Year	JICA Loan (JPY mil.)	GOB Fund (BDT mil.)	Combined Total in JPY (mil.)	Combined Total in BDT (mil.)
2013	Non-disclosure Information			
2014				
2015				
2016				
2017				
2018				
2019				
2020				
2021				
2022				
Total				

Note: 1) The total amount is not the same as the sum, due to the round-off.
2) Currency Exchange Rate: US$1 = BDT81.7 =JPY79.0

12.2 Forecast of Financial Position of the Project

12.2.1 General

The objective is to forecast the long-term financial structure of the Phase 1 and 2 Projects in terms of revenue, expenses and profit/loss to examine appropriate terms and conditions of the Government's subsidiary loan (re-lending of the JICA loan and lending of any additional GOB loans) to be considered for enabling these projects to be financially sustainable.

For this purpose, a long-term financial forecast is made in terms of annual income statement (showing income, expenses and profit/loss) and cash/fund-flow on both the Phase 1 and Phase 2 Projects.

12.2.2 Methodology of Financial Forecast and Assumptions

(1) Financial Forecast Model

The financial model used for the financial forecast is composed of the following three computation programs:

- Program A: computing annual operation net income (profit/loss) of the Phase 1 and Phase 2 Projects over a long-term period as defined later (called the "Long-term Forecast Period") with (i) annual water revenue from the Phase 1 and Phase 2 Projects less (ii) annual O&M costs and depreciation of these Projects
- Program B: computing annual debt-services (i.e., annual interest payable and annual repayment of loan proceeds) related to GOB's subsidiary loans (i.e., re-lending of JICA Loan and lending of GOB fund) to be provided for the Phase 1 and Phase 2 Projects over the Long-term Forecast Period
- Program C: computing annual cash/fund-flow and accumulated cash/fund flow and accumulated cash/fund flow over the Long-term Forecast Period based on the outputs of Programs A & B (i.e., (i) annual net operation cash/fund inflow less (ii) annual cash/fund outflow for the annual debt-services.

(2) Major Assumptions for Financial Forecast

The financial forecast is made on the basis of the major assumptions stated below.

1) Scope of water supply.

Scope of water supply is assumed as follows:

a) Supply of 143,000m^3/d from Karnaphuli Water Supply Project (Phase 1) to start in July 2015.
b) Supply of a further 143,000m^3/d from the Phase 2 Project to start in July 2020.

2) Billable water consumption (Accounted-for Water Consumption)

Assuming that the number of house connections with meters will be increased to meet the quantity of water supplied by the Phase 1 Project and then to meet the quantity of water supplied by the Phase 2 Project, the billable water consumption quantity is estimated by means of the following formulae:

DC.BWC + NDC.BWC = BWTC = WSV x (1 – NRWR)

where;

- BWTC: Billable water total consumption (Accounted-for water)
- DC.BWC: Billable water consumption for domestic customers (Accounted–for water for domestic use)
- NDC.BWC: Billable Water Consumption for non-domestic customers (Accounted-for water for non-domestic use)
- WSV: Water Supply Volume
- NRWR: Non-revenue Water Ratio (Unaccounted-for water ratio)

BWTC in each year is divided into DC.BWC and NDC.BWC based on the demand projection for the KSA service area, as presented in Chapter 4 and Chapter 5.

NRWR is assumed to be 33% in 2015 and then to decrease year by year so as to achieve 15% in 2025 along with the progress in construction of new secondary/tertiary distribution networks in the Karnaphuli Water Supply (KWS) service areas in accordance with the implement plan presented in Chapter 11.

The NRWR assumed for the financial forecast is given below.

Fiscal Year (FY)	NRWR (%)
2016	33
2017	30
2018	27
2019	25
2020	23
2021	20
2022	19
2023	18
2024	17
2025	16
2026 onward	15

(3) Water revenue

Water revenue is estimated by multiplying the estimated billable water (accounted-for water) consumption quantities for domestic consumers and non-domestic consumers respectively with applicable water tariff rates in the following formulae:

1) WR = DCR.WR + NDC.WR
2) DCR.WR = DC.BWC x WT/DC
3) NDC.WR = NDC.BWC x WT/NDC

where;

- WR: Water revenue
- DC.WR: Water revenue for domestic customers
- NDC.WR: Water revenue for non-domestic customers
- WCT/DC: Water tariff for domestic customers
- WCT/NDC: Water tariff for non-domestic customers

The current water tariff is used with escalation at 5% per annum every year as allowed under the WASA Act 1996. Collection of billed amounts has been improved and the current records on collection rate show about 97% in average. Assuming further improvement, the financial forecast is made on a 100% collection basis.

The water tariff rates used for the financial forecast are shown in Table 12.2.1.

Table 12.2.1 Water Tariff Rates used for Financial Forecast

Year	Water Tariff for Domestic Customers (BDT/m^3)	Water Tariff for Non-domestic Customers (BDT/m^3)
2012	6.57	18.61
FY 2016	7.61	21.56
FY 2021	9.71	27.52
onward	5% increase every year	

(4) Other revenue

The CWASA's current financial statement shows several other revenues including service connection charges, besides the water revenue. The financial forecast, however, focuses only on the water revenue in order to analyze the revenue and expense structures directly related to the operation of the Phase 1 Project and Phase 2 Project.

Service connection charges are not taken into account, since the current connection charges collected from customers are more than adequate to cover all costs for house connection facility including meters and O&M costs for those facilities, such that income from house connection charges and relevant costs house connections will be self-balanced. As such, the income and expenses related to the house connections are excluded from the financial forecast.

(5) Expenses

The expenses accounted in the financial forecast are those to be incurred for the water production and distribution of the Phase 1and 2 Projects.

The expenses will include:

1) Itemized operating costs for each of the Phase 1 and 2 facilities (labor costs, power and fuel costs, chemical costs, maintenance costs, other administration expenses.); and
2) Depreciation calculated in accordance with the depreciation rates adopted by CWASA.

In view of the CWASA's financial statements, the costs and expenses for the Head Office can be covered by several revenues other than those from the Phase 1 and 2 Projects. Hence the financial forecast does not take such head office expenses into account.

(6) Debt-services of GOB subsidiary loans

The GOB's policy, as stated in Chapter 3, is to provide autonomous/ semi-autonomous bodies and public sector corporations with all funds required for the implementation of their projects in the form of GOB subsidiary loans including re-lending of foreign loans provided for those projects by any external lenders, under the conditions forcing repayment of subsidiary loan proceeds with 15 annual installments within 20 years including 5 years grace period from the initial year of commercial operation and also payment of interest at 4% per annul for local currency loans and 5% per annum for foreign currency loans to be accrued from the initial operation year.

The policy also states that the Government will consider larger equity participation or limited grant by the Government because of public interest in terms of urbanization/human settlements, provided that recovery of full cost (investment and operation) should be justified.

Along with the above policy, the base-line forecast takes into account of debt-services based on the GOB's terms (i.e., (i) repayment of loan proceeds with 15 annual installments for 20 years including a 5 years grace period, and (ii) payment of interest at 5% per annum for the proposed JICA Loan portion and 4% per annum for the GOB fund portion) with provision for no grant and no equity participation by the Government. If the base-line forecast indicates a negative financial structures burden with the GOB's subsidiary loan terms, alternative terms, in particular provision of grant or equity participation by the Government and also relaxation of interest rates are examined in order to seek conditions for enabling the Phase 1 and 2 Projects to be financially sustainable.

12.2.3 Estimates of Inputs for Financial Forecast

As discussed above, there are five inputs for the financial forecast of the Phase 1 and 2 Projects, namely,

(1) Capital Costs and Financing Arrangements
(2) Water revenue
(3) O&M costs
(4) Depreciation
(5) Debt-services

The estimates of these inputs are presented in the subsequent sections.

(1) Capital Costs and Financing Arrangements

The capital costs for Phase 1 Project are estimated on the basis of the actual contract amounts for (a) three contract packages for construction works (i.e., (i) Package 1: Intake Facility and WTP; (ii) Conveyance and Transmission Pipelines and Distribution Main Pipelines; and (iii) Two Water Reservoirs), (b) procurement of meters, saddles and vehicles; and (c) two consulting services (i.e., (i) Engineering Consulting Services and (ii) Institutional Development Consulting Services) and also additional budget for non-contracted items that have been indicated in the Revised Development Project Proposal (RDPP) for the Phase 1 Project approved by the GOB in December 2010.

The capital costs for Phase 2 Project are based on the estimated project costs presented in Chapter 11.

It is noted that the capital costs excludes the costs for service connection works and costs for the procurement of water meters to be used for service connections, since income and expenses related to service connections, as stated in 12.2.2 (4) above, are excluded from the financial forecast.

The capital costs used for the financial forecast of Phase 1 Project are shown in Table 12.2.2.

Table 12.2.2 Capital Costs used for Financial Forecast of Phase 1 Project

Particulars		Project Costs		
		LC (BDT mil.)	FC (JPY mil.)	Combined Total in BDT (mil.)
A.	Land and land development **	Non-disclosure Information		
B.	Construction Works			
B-1.	Building & Civil Construction			
a.	Intake facilities & WTP ##			
b.	Reservoirs & Elevated Tanks ##			
	Sub-total			
B-2.	Plant, Equipment & Pipes			
a.	Intake facilities & WTP: Plant, Equip., etc.##			
b.	Reservoirs & Elevated Tanks: Equipment, tic. ##			
c.	Laboratory Equipment ##			
	Sub-total			
B-3.	Water Pipelines & Network			
a.	Conveyance & transmission pipelines ##			
b.	Distribution pipelines (mains) ##			
c.	Optical Fibre Cable ##			
	Sub-total			
B-4.	CWASA Direct Works, incl. Procurement			
a.	Secondary distribution network **			
b.	Staff Quarters **			
	Sub-total			
B-5.	Construction Works - Total			
B-6.	Physical & Price Contingency (5% of B-5)			
B-7.	Grand Total of Construction Works			
C.	Vehicles ##			
D.	Furniture **			
E.	Consultancy Services			
a.	Engineering Consultants ##			
b.	Institutional Development Consultants ##			
	Sub-total			
F.	Grand Total (A to E) (A to E)			
G.	Taxes			
a.	VAT & Taxes (14.5% of F)			
b.	Import Duties			
	Sub-total			
H.	CWASA Project Management Expenses **			
	Project Costs - Total			

Note: Costs for **Items: Revised DPP
Costs for ##Items: Contract Prices
Currency Exchange Rate: JPY 1 = BDT 0.9

Details of the estimated import duties are shown in Table 12.2.3.

Table 12.2.3 Import Duties for Phase 1 Project

Estimates of Import Duties			
Package 1 Equipment: Pipes Sub-total	Non-disclosure Information	(BDT mil.) (BDT mil.)	NDI
Package 2 DI Pipes Valves, etc. OF Cable Sub-total		(BDT mil.) (BDT mil.) (BDT mil.)	
Package 3 Equipment: Pipes Sub-total		(BDT mil.) (BDT mil.)	
Vehicles		(BDT mil.)	

The JICA Loan for the Phase 1 Project amounts to NDI, of which NDI was disbursed for the procurement of meters and saddles to be used for house connections. The JICA Loan provided for Phase 1 Project, excluding the amounts for the procured meters and saddles, is therefore JPY NDI. The rest of the capital cost shown in Table 12.2.1 is financed by the GOB fund. Thus, the financial forecast for Phase 1 Project is based on the financing arrangements given in Table 12.2.4.

Table 12.2.4 Financing Arrangements used for Financial Forecast of Phase 1 Project

Particulars	FC (JPY mil.)	LC (BDT mil.)	Combined Total in BDT (mil.)
A. JICA Loan	Non-disclosure Information		
B. GOB Fund			
Total			

Note: Exchange Rate: JPY 1 = BDT 0.9

The capital costs used for the financial forecast of Phase 2 Project are shown in Table 12.2.5. This table shows A. Base Capital Costs and B. Capital Costs used for Financial Forecast. The Capital Costs used for Financial Forecast, as stated earlier in this section, are based on the Base Capital Costs with the following adjustments on the items indicated with Remark Nos. in the table:

1) A-3 (f) Service Connections:
   Excluded these costs, as these costs can be covered with service connection charges
2) A-3 (g) Supply for Low Income Communities:
   Excluded 20% of the costs estimated for the Base Capital Costs with the same reason as above, as the Costs for Supply for Low Income Communities include the costs for service connections
3) A-4 (c) Distribution Pipelines:
   Excluded some portion of the costs estimated for the Base Capital Costs with the same reason as above, as the Costs for Distribution Pipelines include the costs for facilities related to the service connections
4) A-5 (a) Water Meters:
   Excluded these costs with the same reason as above
5) D. CWASA Administration Costs:

Table 12.2.5 Capital Costs used for Financial Forecast of Phase 2 Project

		A. Base Project Costs		B. Project Costs used for Financial Forecast		
		LC Portion (BDT mil.)	FC Portion (JPY mil.)	LC Portion (BDT mil.)	FC Portion (JPY mil.)	Combined Total in BDT (mil.)
A.	Construction Works					
A-1.	Building & Civil Construction					
a.	Intake facilities & WTP					
b.	Reservoirs & Elevated Tanks					
	Sub-total					
A-2.	Plant, Machinery & Pipes etc.					
a.	Intake facilities & WTP					
b.	Reservoirs & Elevated Tanks					
	Sub-total					
A-3.	Water Pipelines & Network					
a.	Conveyance & transmission pipelines					
b.	Optical Fibre Cable					
c.	Primary Distribution Pipelines (Mains)					
d.	Monitoring & Control System					
e.	Secondary/tertiary Distribution Network Pipelines					
f.	Service connections **1)					
g.	Supply for Low Income Communities **2)					
	Sub-total					
A-4.	General Requirements & Dispute Board for Construction Works					
a.	Intake facilities, WTP, Reservoirs & Elevated Tanks					
b.	Conveyance & transmission Pipelines					
c.	Primary/secondary/tertiary Distribution Pipelines **3)					
	Sub-total					
A-5.	Procurement of Equipment & Materials					
a.	Water Meters **4)					
b.	Maintenance Vehicles					
c.	Maintenance Equipment					
	Sub-total					
A-6.	Project Implementation Support Unit					
A-7.	Construction Works - Total (A-1 to A-6).	Non-disclosure Information				
A-8.	Price Escalation for Construction Works (FC 2.1% A-7, LC 4.9% of A-7)					
A-9.	Contingency for Construction Works (5% of A-7 & A-8)					
A-10	Grand Total of Construction Works					
B.	Consultancy Services					
B-1.	Engineering Consulting Services					
B-2	Price Escalation (2.1% B-1 FC, 4.9% of B-1 LC)					
B-3	Contingency (5% of B-1& B-2)					
B-4	Consultancy Services - Total (B-1 to B-3).					
C.	Grand Total (A & B)					
D.	CWASA Administration Cost **5)					
E.	Taxes & Charges					
a.	VAT (15% of C+D_ LC)					
b.	Import Duties (30% of A-10 FC)					
c.	Banking Charges					
	Sub-total					
F.	Project Cost - Grand Total (C + D + E)					
G.	Interest during Construction					
a.	Interest during Construction for Construction Works					
b.	Interest during Construction for Consulting Services					
	Sub-total					
	GRAND TOTAL (F + G)					

Note: Exchange Rate: BDT 1 = JPY 0.966 (US$1 = BDT81.7 =JPY79.0)

Included BDT NDI for Financial Forecast out of BDT NDI estimated for the Base Capital Costs, since the overwhelming majority of the estimated costs is the costs that may be incurred for the enhancement of CWASA' s overall administrative organization and activities and the enhancement of organization and activities for water meter reading and water charge billing and collection, and these costs can be covered with the services connection charges and other revenue.

6) Adjustment of incidental costs:
Adjusted price escalation, contingencies, VAT, import duties, banking charges, interest during construction along with the above cost adjustment

Whereas the financing plan for the Phase 2 Project, as shown in Table 12.1.2, proposes to be JPY NDI by a JICA Loan and BDT NDI by the GOB fund, the financial forecast for the Phase 2 Project is based on the financing plan formulated on the basis of the Capital Costs adjusted for the financial forecast, as shown in Table 12.2.6.

Table 12.2.6 Financing Plan used for Financial Forecast of Phase 2 Project

Particulars	FC Portion (JPY mil.)	LC Portion (BDT mil.)	Combined Total in (BDT mil.)
A. JICA Loan	Non-disclosure Information		
B. GOB Fund			
Total			

Note: Exchange Rate: BDT 1 = JPY 0.966 (US$1 = BDT81.7 =JPY79.0)

(2) Water Revenue

Water revenue for the Phase 1 and 2 Projects is estimated on the basis of the methodology and assumptions stated in 12.2.2 (2). Table 12.2.7 shows the estimated water revenue.

Table 12.2.7 Water Revenue Estimated for Phase 1 & 2 Projects

Fiscal Year	Water Tariff Rate (BDT/m³)		Phase I Project									Phase 2 Project								
			Available Water Volume (mill m³)	NWR %	Billed Water Volume (mil m³)			Water Revenues (BDT million)				Available Water Volume (mill m³)	NWR %	Billed Water Volume (mil m³)			Water Revenues (BDT million)			
	Dom.	Non-Dom.			Dom.	Non-Dom.	Total	Dom.	Non-Dom.	Total				Dom.	Non-Dom.	Total	Dom.	Non-Dom.	Total	
2016	7.61	21.56	41.76	33%	22.63	5.35	27.98	172.21	115.35	287.56		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2017	7.99	22.64	44.37	30%	24.93	6.13	31.06	199.19	138.78	337.97		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2018	8.39	23.77	46.98	27%	27.27	7.03	34.30	228.80	167.10	395.90		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2019	8.81	24.96	49.59	25%	29.13	8.06	37.19	256.64	201.18	457.82		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2020	9.25	26.21	52.20	23%	31.49	8.70	40.19	291.28	228.03	519.31		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2021	9.71	27.52	52.20	20%	32.99	8.77	41.76	320.33	241.35	561.68		41.76	0.20	28.14	5.27	33.41	273.24	145.03	418.27	
2022	10.20	28.90	52.20	19%	33.40	8.88	42.28	340.68	256.63	597.31		44.37	0.19	30.07	5.87	35.94	306.71	169.64	476.35	
2023	10.71	30.35	52.20	18%	33.55	9.25	42.80	359.32	280.74	640.06		46.98	0.18	32.28	6.24	38.52	345.72	189.38	535.10	
2024	11.25	31.87	52.20	17%	34.13	9.20	43.33	383.96	293.20	677.16		49.59	0.17	34.12	7.04	41.16	383.85	224.36	608.21	
2025	11.81	33.46	52.20	16%	35.38	8.47	43.85	417.84	283.41	701.25		52.20	0.16	35.38	8.47	43.85	417.84	283.41	701.25	
2026	12.40	35.13	52.20	15%	35.05	9.32	44.37	434.62	327.41	762.03		52.20	0.15	35.05	9.32	44.37	434.62	327.41	762.03	
2027	13.02	36.89	52.20	15%	35.05	9.32	44.37	456.35	343.81	800.16		52.20	0.15	35.05	9.32	44.37	456.35	343.81	800.16	
2028	13.67	38.73	52.20	15%	34.60	9.77	44.37	472.98	378.39	851.37		52.20	0.15	34.60	9.77	44.37	472.98	378.39	851.37	
2029	14.35	40.67	52.20	15%	34.15	10.22	44.37	490.05	415.65	905.70		52.20	0.15	34.15	10.22	44.37	490.05	415.65	905.70	
2030	15.07	42.70	52.20	15%	33.70	10.67	44.37	507.86	455.61	963.47		52.20	0.15	33.69	10.68	44.37	507.71	456.04	963.75	
2031	15.82	44.84	52.20	15%	33.55	10.82	44.37	530.76	485.17	1,015.93		52.20	0.15	33.54	10.83	44.37	530.60	485.62	1,016.22	
2032	16.61	47.08	52.20	15%	33.55	10.82	44.37	557.27	509.41	1,066.68		52.20	0.15	33.54	10.83	44.37	557.10	509.88	1,066.98	
2033	17.44	49.43	52.20	15%	33.55	10.82	44.37	585.11	534.83	1,119.94		52.20	0.15	33.54	10.83	44.37	584.94	535.33	1,120.27	
2034	18.31	51.90	52.20	15%	33.55	10.82	44.37	614.30	561.56	1,175.86		52.20	0.15	33.54	10.83	44.37	614.12	562.08	1,176.20	
2035	19.23	54.50	52.20	15%	33.55	10.82	44.37	645.17	589.69	1,234.86		52.20	0.15	33.54	10.83	44.37	644.97	590.24	1,235.21	
2036	20.19	57.23	52.20	15%	33.55	10.82	44.37	677.37	619.23	1,296.60		52.20	0.15	33.54	10.83	44.37	677.17	619.80	1,296.97	
2037	21.20	60.09	52.20	15%	33.55	10.82	44.37	711.26	650.17	1,361.43		52.20	0.15	33.54	10.83	44.37	711.05	650.77	1,361.82	
2038	22.26	63.09	52.20	15%	33.55	10.82	44.37	746.82	682.63	1,429.45		52.20	0.15	33.54	10.83	44.37	746.60	683.26	1,429.86	
2039	23.37	66.24	52.20	15%	33.55	10.82	44.37	784.06	716.72	1,500.78		52.20	0.15	33.54	10.83	44.37	783.83	717.38	1,501.21	
2040	24.54	69.55	52.20	15%	33.55	10.82	44.37	823.32	752.53	1,575.85		52.20	0.15	33.54	10.83	44.37	823.07	753.23	1,576.30	
2041	25.77	73.03	52.20	15%	33.55	10.82	44.37	864.58	790.18	1,654.76		52.20	0.15	33.54	10.83	44.37	864.33	790.91	1,655.24	
2042	27.06	76.68	52.20	15%	33.55	10.82	44.37	907.81	829.69	1,737.50		52.20	0.15	33.54	10.83	44.37	907.54	830.46	1,738.00	

(3) O & M Costs

The O & M costs comprise the following cost components:

A. Variable Costs
  a. Power cost
  b. Fuel cost
  c. Chemical cost
    i) Chlorine
    ii) Alum
    iii) Lime

B. Fixed Costs
  a. Personnel cost
  b. Welfare and administration cost
  c. Maintenance cost

Table 12.2.8 shows O&M Variable Costs for Phase 1 and Phase 2 Projects estimated as those as of the year 2012.

Table 12.2.8 O&M Variable Costs (as of 2012) estimated for Phase 1 & 2 Projects

Particulars		Unit Cost (BDT)	Phase 1			Phase 2		
			Unit Consumption in 100% operation	Cost /day (BDT)	Cost/Year (BDT)	Unit Consumption in 100% operation	Cost /Day (BDT)	Cost/Year (BDT)
A.	Variable Cost							
A-1	Power Cost							
a.	Intake							
	Energy Charge *1)	5.61 /kWh	650 kW/h	83,578	30,505,890	650 kW/h	83,578	30,505,890
	Demand Charge *2)	45.00 /kWh	975 kW/h		526,500	975 kW/h		526,500
b.	WTP							
	Energy Charge	5.61 /kWh	1,950 kW/h	250,733	91,517,669	1,950 kW/h	250,733	91,517,669
	Demand Charge	45.00 /kWh	2,900 kW/h		1,566,000	2,900 kW/h		1,566,000
c.	Nashirabad Reservoir							
	Energy Charge	5.61 /kWh	752 kW/h	96,693	35,292,968	752 kW/h	96,693	35,292,968
	Demand Charge	45.00 /kWh	1,575 kW/h		850,500	1,575 kW/h		850,500
Total					160,259,527			160,259,527
	(Power Cost per m^3)				3.07			3.07
A-2	Fuel (Diesel Oil) *3)							
a.	Intake	60.00 /l	176 l/h	11,405	4,162,752	176 l/h	11,405	4,162,752
b.	WTP	60.00 /l	527 l/h	34,150	12,464,604	527 l/h	34,150	12,464,604
c.	Nashirabad Reservoir	60.00 /l	203 l/h	13,154	4,801,356	203 l/h	13,154	4,801,356
Total					21,428,712			21,428,712
	(Fuel Cost per m^3)				0.41			0.41
A-3	Chemicals							
a.	Chlorine (Cl_2)	25,000 /ton	0.6 ton/d	15,000	5,475,000	0.6 ton/d	15,000	5,475,000
b.	ALUM	24,000 /ton	3.15 ton/d	75,600	27,594,000	3.15 ton/d	75,600	27,594,000
c.	LIME	12,000 /ton	0.75 ton/d	9,000	3,285,000	0.75 ton/d	9,000	3,285,000
Total					36,354,000			36,354,000
	(Chemicals Cost per m^3)				0.70			0.70
A-4	Variable Cost - Total (A1+ A2 + A3)				218,042,239			218,042,239
	(Variable Cost per m^3)				4.18			4.18

*1) Energy Charge: - Cost/day: Unit Cost x Consumption/h x 95.5% x 24hrs.
- Cost/year: Daily cost x 365 days

*2) Demand Charge: - Cost/month: Unit Cost x Monthly demand volume
- Cost/year: Monthly cost x 12 months

*3) Fuel (Diesel Oil) Cost: - Cost/day: Unit Cost x Daily power Cons. x .0.27 l/kWh x 4.5%
- Cost/year: Daily cost x 365 days

The structure of variable costs (as of the year 2012) given in the above is represented in terms of unit costs per m^3 of the produced water as follows:

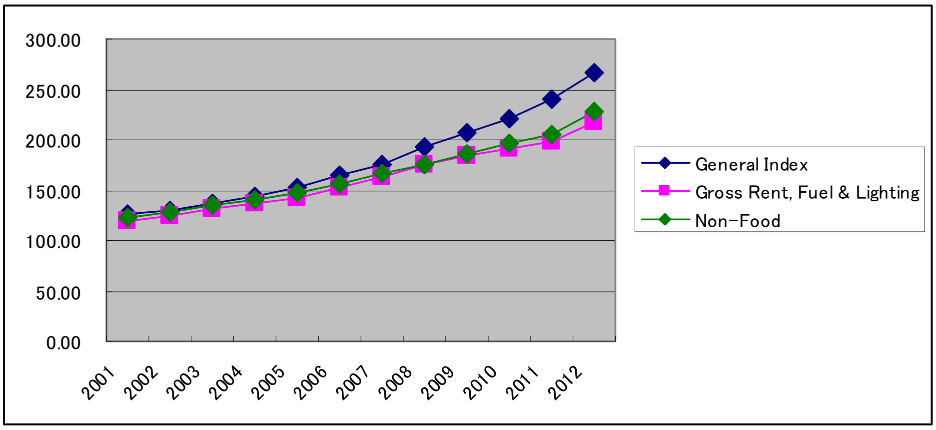
Cost Items	Unit Cost per m^3 of Produced Water	Composition (%)
Power Cost	3.07	73.44
Fuel Cost	0.41	9.81
Chemicals Cost	0.70	16.75
Variable Cost - Total	4.18	100.00

As power and fuel costs account for 83.25% of the total variable costs, it can be assumed that future prices of the variable costs may be dependent upon the energy prices in Bangladesh. Table 12.2.9 shows the Price Index in Bangladesh for 11 years from 2001 to 2012.

Table 12.2.9 Price Index in Bangladesh (2001 – 2012)

Fiscal Year	National						Urban					
	General Index		Gross Rent, Fuel & Lighting		Non-Food		General Index		Gross Rent, Fuel & Lighting		Non-Food	
2001	126.72		119.41		122.25		125.70		110.91		118.61	
2002	130.26	2.79%	124.95	4.64%	127.89	4.61%	129.92	3.36%	115.60	4.23%	124.19	4.70%
2003	135.97	4.38%	131.20	5.00%	135.13	5.66%	134.49	3.52%	119.51	3.38%	130.40	5.00%
2004	143.90	5.83%	136.19	3.80%	141.03	4.37%	142.54	5.99%	122.56	2.55%	135.80	4.14%
2005	153.23	6.48%	141.43	3.85%	147.14	4.33%	151.29	6.14%	126.31	3.06%	141.90	4.49%
2006	164.21	7.17%	152.02	7.49%	156.56	6.40%	161.39	6.68%	131.07	3.77%	149.20	5.14%
2007	176.06	7.22%	162.32	6.78%	165.79	5.90%	172.73	7.03%	138.41	5.60%	157.17	5.34%
2008	193.54	9.93%	174.70	7.63%	176.26	6.32%	189.65	9.80%	147.54	6.60%	166.69	6.06%
2009	206.43	6.66%	184.46	5.59%	186.67	5.91%	201.49	6.24%	148.24	0.47%	174.69	4.80%
2010	221.53	7.31%	191.49	3.81%	196.84	5.45%	216.98	7.69%	152.58	2.93%	183.40	4.99%
2011	241.02	8.80%	197.92	3.36%	205.01	4.15%	232.81	7.30%	155.01	1.59%	190.87	4.07%
2012	266.61	10.62%	218.26	10.28%	227.87	11.15%	260.01	11.68%	165.44	6.73%	211.82	10.98%
Ave.1		7.02%		5.66%		5.84%		6.86%		3.72%		5.43%
Ave.2		7.00%		5.64%		5.82%		6.83%		3.70%		5.41%
Ave.3		8.41%		6.21%		6.46%		8.27%		3.96%		6.01%

Ave.1: Average % from 2002 to 2012
Ave.2: Annual Average % from 2001 to 2012
Ave.3: Annual Average % from 2006 to 2012
Source: Bangladesh Bureau of Statistics



The price index of gross rental, fuel and lighting sector in urban areas indicates an increase of 3.7% per annum on average for the 11 years from 2001 to 2012 and 4.0% per annum on average for the six years from 2006 to 2012, even though there were significant increases of 6.6% in 2008 and 6.73% in 2012. Taking the average price trend of the gross rental, fuel and lighting sector in the past 11 years, the variable cost is assumed to increase at annual rate of 3.7%.

Personnel costs for the Phase 1 and Phase 2 Projects are estimated on the basis of the O & M personnel requirements presented in Chapter 9 and CWASA's current payroll structures. The CWASA follows the payrolls approved by LGRD&C for each class of officer and staff, which fix the base salary rates and annual increase rates. Table 12.2.10 shows the base salary scale including, annual increases approved by LGRD&C in 2009 and currently adjusted by CWASA.

Table 12.2.10 Base Salary Scale

Class of Engineers /Officers / Staff	Base Salary Scale (Effective in 2009 onward)	Adjusted Salary Base	Monthly Incr.
A Superintendent Engineer			
B Exclusive Engineer / Chemist			
C Engineer			
D Assistant Engineer			
E Sub-assistant Engineer	Non-disclosure Information		
F Technician / Plumber			
G Operator / Assistant Staff			
H Clarks			

Table 12.2.11 shows the personnel costs for O & M of the Phase 1 Project and the Phase 2 Project, with the costs for the Phase 1 Project as in the first operation year of FY 2016 and those for the Phase 2 Project as in the first operation year of FY2021.

Table 12.2.11 O & M Personnel Costs for Phase 1 & 2 Projects

Department	Section	Function		Class of Engr/ Officer/ Staff	No. of Persons			Phase 1		Phase 2	
					Ph. 1	Ph. 2	Total	1st Year (FY2016)	Annual Increase	1st Year (FY2021)	Annual Increase
A. KWS System Division	Monitoring & Control	A1.	Division General Manager	A	0	1	1	Non-disclosure Information			
		A2.	Assistant G.M.	B	1	0	1				
		A3.	Chief	C	1	0	1				
		A4.	Officer	D	0	1	1				
		A5.	Staff	E	1	1	2				
	Data Processing & Analysis	A6.	Chief	C	0	1	1				
		A7.	Staff	D	0	1	1				
	General Assistance	A8.	Clarks	H	6	2	8				
	Sub-total				9	7	16				
B. O&M for Intake Facility, Water Treatment Plant & Transmission Pipeline		B1.	Department Manager	B	1	0	1				
		B2.	Process Engr	C	1	0	1				
		B3.	Mechanical Engineer	C	1	0	1				
		B4.	Electrical Engr	C	1	0	1				
		B5.	Instrumentation Engr	C	1	0	1				
	1.Intke Facility	B6.	Section Chief	D	1	0	1				
		B7.	Technicians	F	1	1	2				
		B8.	Operators	G	2	2	4				
	2.Water Treatment	B9.	Section Chief	C	1	0	1				
		B10.	Technicians	F	2	3	5				
		B11.	Operators	G	5	5	10				
	3.Sludge Treatment	B12.	Section Chief	D	0	1	1				
		B13.	Technicians	F	1	1	2				
		B14.	Operators	G	3	3	6				
	4.Laboratory	B15.	Section Chief	C	1	0	1				
		B16.	Assistant	G	2	2	4				
	5.Pipeline Maintenance	B17.	Section Chief	D	1	0	1				
		B18.	Plumbers	F	2	2	4				
	General Assistance	B19.	Clarks	H	10	8	18				
	Sub-total				37	28	65				
C. O&M for Distribution Facilities		C1.	Department Manager	B	0	1	1				
		C2.	Mechanical Engineer	C	0	1	1				
		C3.	Electrical Engr	C	0	1	1				
		C4.	Instrumentation Engr	C	0	1	1				
	1.Reservoir/ Elevated Tank	C5.	Section Chief	C	1	0	1				
		C6.	Technicians	F	2	1	3				
		C7.	Operators	G	4	3	7				
	2.Main Pipe/Sector Chamber & DMA	C8.	Section Chief	C	1	0	1				
		C9.	Leakage Monitoring Team (composed of 3 groups)	E	1	2	3				
				F	1	2	3				
				G	3	6	9				
		C10.	Investigation & Repair Team	E	1	1	2				
				F	1	1	2				
				G	3	3	6				
	3.Water Meter Maintenance Centre	C11.	Centre Manager	C	1	0	1				
		C12.	Water Meter Maintenance Staff	D	0	1	1				
				E	1	1	2				
				F	2	2	4				
				G	5	8	13				
	General Assistance	C13.	Clarks	H	10	8	18				
	Sub-total				37	43	80				
Grand Total					83	78	161				

Table 12.2.12 shows the annual O & M personnel costs for the Phase 1 and Phase 2 Projects based on the annual increase rates for salaries, which are fixed for the different classes of officers and staff.

Table 12.2.12 Estimated O & M Personnel Costs for Phase 1 & 2 Projects

Phase 1 Project		Phase 2 Project	
Year	Amount	Year	Amount
2016	12,504,000	2021	11,529,600
2017	13,012,080	2022	11,999,640
2018	13,520,160	2023	12,469,680
2019	14,028,240	2024	12,939,720
2020	14,536,320	2025	13,409,760
2021	15,044,400	2026	13,879,800
2022	15,552,480	2027	14,349,840
2023	16,060,560	2028	14,819,880
2024	16,568,640	2029	15,289,920
2025	17,076,720	2030	15,759,960
2026	17,584,800	2031	16,230,000
Av. Inc/Yr.	3.47%	Av. Inc/Yr.	3.48%

Based on the above estimated personnel costs, the O & M personnel costs for the Phase 1 and 2 Projects are assumed to increase at 3.5% per annum. Welfare and administration expenses are estimated at 50% of the personnel costs (i.e., 20% for welfare expenses and 30% for administration expenses).

The annual maintenance cost is estimated as BDT NDI per year as in 2012 respectively for Phase 1 Project and Phase 2 Project.

The welfare and administration expenses are assumed to increase at 3.5% per annum following the increases in the personnel costs, while the maintenance cost is assumed to increase at 2% per annum following the current price trends of international machinery costs.

Table 12.2.13 shows the estimated O & M costs for the Phase 1 and 2 Projects, and Table 12.2.14 shows the base costs, as of the year 2012.

Table 12.2.13 Estimated O & M Costs for Phase 1 & 2 Projects

Fiscal Year	Escalation Rate (%)			Unit Cost			Phase 1 Project					Phase 2 Project					Phase 1 & 2 Total Annual O & M Cost (BDT '000)
	Variable Cost	Fixed Cost (A.)	Fixed Cost (B.)	Variable Cost (BDT/m³)	Fixed Cost (A) (BDT '000/y)	Fixed Cost (B) (BDT '000/y)	Ope. Ratio (%)	Annual Production Water Volume ('000 m³)	Annual O & M Cost (BDT '000) Variable Cost	Fixed Cost	Total O& M Cost	Ope. Ratio (%)	Annual Production Water Volume ('000 m³)	Annual O & M Cost (BDT '000) Variable Cost	Fixed Cost	Total O& M Cost	
2012				4.18	18,756												
2013	3.7	3.5	2.0	4.33	19,412												
2014	3.7	3.5	2.0	4.50	20,092												
2015	3.7	3.5	2.0	4.66	20,795												
2016	3.7	3.5	2.0	4.83	21,523		80	41,756	201,841								
2017	3.7	3.5	2.0	5.01	22,276		85	44,366	222,393								
2018	3.7	3.5	2.0	5.20	23,056		90	46,976	244,188								
2019	3.7	3.5	2.0	5.39	23,863		95	49,585	267,287								
2020	3.7	3.5	2.0	5.59	24,698		100	52,195	291,766								
2021	3.7	3.5	2.0	5.80	25,563		100	52,195	302,562			80	41,756	242,049			
2022	3.7	3.5	2.0	6.01	26,457		100	52,195	313,757			85	44,366	266,695			
2023	3.7	3.5	2.0	6.23	27,383		100	52,195	325,366			90	46,976	292,832			
2024	3.7	3.5	2.0	6.46	28,342		100	52,195	337,404			95	49,585	320,532			
2025	3.7	3.5	2.0	6.70	29,334		100	52,195	349,888			100	52,195	349,888			
2026	3.7	3.5	2.0	6.95	30,360		100	52,195	362,834			100	52,195	362,834			
2027	3.7	3.5	2.0	7.21	31,423	Non -disclosure Information	100	52,195	376,259	Non-disclosure Information		100	52,195	376,259	Non-disclosure Information		
2028	3.7	3.5	2.0	7.48	32,523		100	52,195	390,180			100	52,195	390,180			
2029	3.7	3.5	2.0	7.75	33,661		100	52,195	404,617			100	52,195	404,617			
2030	3.7	3.5	2.0	8.04	34,839		100	52,195	419,588			100	52,195	419,588			
2031	3.7	3.5	2.0	8.34	36,058		100	52,195	435,112			100	52,195	435,112			
2032	3.7	3.5	2.0	8.64	37,320		100	52,195	451,212			100	52,195	451,212			
2033	3.7	3.5	2.0	8.96	38,627		100	52,195	467,906			100	52,195	467,906			
2034	3.7	3.5	2.0	9.30	39,979		100	52,195	485,219			100	52,195	485,219			
2035	3.7	3.5	2.0	9.64	41,378		100	52,195	503,172			100	52,195	503,172			
2036	3.7	3.5	2.0	10.00	42,826		100	52,195	521,790			100	52,195	521,790			
2037	3.7	3.5	2.0	10.37	44,325		100	52,195	541,096			100	52,195	541,096			
2038	3.7	3.5	2.0	10.75	45,876		100	52,195	561,116			100	52,195	561,116			
2039	3.7	3.5	2.0	11.15	47,482		100	52,195	581,878			100	52,195	581,878			
2040	3.7	3.5	2.0	11.56	49,144		100	52,195	603,407			100	52,195	603,407			
2041	3.7	3.5	2.0	11.99	50,864		100	52,195	625,733			100	52,195	625,733			
2042	3.7	3.5	2.0	12.43	52,644		100	52,195	648,885			100	52,195	648,885			

Table 12.2.14 Base O & M Costs for Phase 1 & 2 Projects (as of 2012)

	Phase 1	Phase 2
A. Variable Cost	(BDT/m^3)	(BDT/m^3)
a. Power	3.07	3.07
b. Fuel	0.41	0.41
c. Chemicals	0.70	0.70
Total	4.18	4.18
B. Fixed Cost	(BDT'000/yr)	(BDT'000/yr)
a. Personnel	12,504	11,530
b. Welfare & Adm.	6,252	5,765
c. Maint. & Repair	Non-disclosure Information	
Total		

(4) Depreciation

Depreciation for the Phase 1 and 2 Projects is estimated based on the value of fixed assets indicated respectively in the capital costs for the Phase 1 Project in Table 12.2.1 and the Phase 2 Project in Table 12.2.4 and applying depreciation rates used by CWASA against the depreciable asset values, holding 10% as residual value in accordance with the CWASA's financial accounting practice.

Tables 12.2.15 and 12.2.16 show the estimated depreciation for the Phase 1 and Phase 2 Projects respectively.

Table 12.2.15 Depreciation for Phase 1 Project

Particulars	Original Value			Additional (BDT mil.)			Total Asset Value for Dep.** (BDT mil.)	Dep. Rate (%)	Annual Depreciation Amount (BDT mil.)			
	LC (BDT mil.)	FC (JPY mil.)	Combined Total (BDT mil.)	Contingencies	Import Duties	VAT			1st yr -- 5th yr	6th yr -- 17th yr	18th yr – 25th yr	26th yr – 50th yr
A. Buildings and Structures												
a. Intake facilities & WTP												
b. Reservoirs & Elevated Tanks												
B. Plant Equipment												
a. Intake facilities & WTP: Plant, Equip., etc.												
b. Reservoirs & Elevated Tanks: Equipment, etc.												
C. Water Pipelines & Network												
a. Conveyance, transmission & distribution (main) pipelines												
b. Secondary distribution network												
c. Optical Fiber Cables												
D. Other Assets												
a. Staff Quarters												
b. Vehicles												

Non-disclosure Information

*Note: 1) **Residue Value: 10% of Asset Value for Depreciation*

2) Excluding house connection costs and costs for meters, saddles, pipes, etc. for connection pipes, as these costs can be recovered with service connection charges.

Table 12.2.16 Depreciation for Phase 2 Project

Unit: LC; BDT mil. FC; JPY mil.

Particulars		A. Base Cost		B. General Requirement & Dispute Board		C. Base Cost including (B)		D. Price Escalation		E. .Contingency		F. Construction Cost incl. D & E			G.. VAT	H. Import Duties	Total Asset Value for Dep.** (BDT mil.)	Dep. Rate (%)	Annual Depreciation Amount (BDT mil.)			
		LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	Combined Total in BDT (mil.)	LC	LC			1st yr -- 5th yr	6th yr -- 17th yr	18th yr -- 25th yr	26th yr -- 50th yr
A.	Buildings and Structures																					
a.	Intake facilities & WTP																					
b.	Reservoirs & Elevated Tanks																					
B.	Plant Equipment																					
a.	Intake facilities & WTP: Plant, Equip., etc.																					
b.	Reservoirs & Elevated Tanks: Equipment, etc..																					
c.	Water Pipelines & Network																					
a.	Conveyance & transmission pipelines																					
b.	Optical Fiber Cable																					
c.	Monitoring & Control System																					
d.	Primary/secondary/tertiary/distribution network																					
e.	Supply for low income communities																					
D.	Other Assets																					
a.	Maintenance Equipment																					
b.	Maintenance Vehicles																					
	TOTAL																					

Non-disclosure Information

*Note: 1) **Residue Value: 10% of Asset Value for Depreciation*

2) Excluding costs for service connections, water meters and connection pipes, as these costs can be recovered with service connection charges.

(5) Debt-services

The debt-services for the Phase 1 and 2 Projects are estimated based on the financing arrangements for Phase 1 Project in Table 12.2.4 and the financing plan proposed for the Phase 2 Project in Table 12.2.6 and the GOB's subsidiary loan terms, as stated in 12.2.2.(6). Table 12.2.17 shows the thus estimated debt-services for the Phase 1 and 2 Projects.

Table 12.2.17 Debt-services for Phase 1 and Phase 2 Projects

Subsidiary Loan Amount	Phase 1	Phase 2
Foreign Loan (FL) Portion (BDT mil.)	Non-disclosure Information	
Local Loan (LL) Portion (BDT mil.)		
Total Amount (BDT mil.)		

Terms and Conditions of Subsidiary Loan
- Repayment of loans with 15 annual installments after 5 years grace period
- Interest at 5% for Foreign Loan Portion and 4% for BOD Local Loan Portion
- Assuming Phase 1 starts operation in FY2016 and Phase 2 in FY 2021

(In BDT mil.)

Fiscal Year	Phase 1						Phase 2					
	Outstanding of Principal at the Beginning of FY	Repayment during the Year	Outstanding of Principal at the Closing FY	Interest for FL (5%)	Interest for LL (4%)	Interest - Total	Outstanding of Principal at the Beginning of FY	Repayment during the Year	Outstanding of Principal at the Closing FY	Interest for FL (5%)	Interest for LL (4%)	Interest - Total
2016												
2017												
2018												
2019												
2020												
2021												
2022												
2023												
2024												
2025												
2026												
2027						Non-disclosure Information						
2028												
2029												
2030												
2031												
2032												
2033												
2034												
2035												
2036												
2037												
2038												
2039												
2040												
2041												
2042												

12.2.4 Forecast and Analysis of Financial Positions and Structures

(1) Base-line Forecast and Analysis

Based on the assumptions and inputs as stated in 12.2.4 and 12.2.5, the base-line forecast of financial positions and structures is made for the Phase 1 and 2 Projects. Tables 12.2.18 and 12.2.19 show the base-line forecast of operating income (profit/loss) respectively for the Phase 1 and 2 Projects, and Table 12.2.20 shows the forecast of base-line cash/fund flow for the Phase 1 and 2 Projects.

The base-line forecast for the Phase 1 Project indicates that the annual operating income will be a loss every year during the initial 13 years from FY2016 until FY2028 and then turn positive to show a profit in every year from FY2029 onwards, since the water revenue income is adequate to recover the O & M costs but not adequate to recover depreciation until FY2028. Similarly, the base-line forecast for the

Phase 2 Project indicates that the annual operating income will be a loss every year during the initial 18 years from FY2021 until FY2038 and then turn positive to show a profit in FY2039 onward due to the structure being similar to the Phase 1 Project. The main reason for showing a loss over more than the initial ten years is that the current water tariff rates are considerably lower than the break-even level to recover O &M costs and depreciation.

Further to weakness of the financial structure, the GOB's subsidiary loan terms cause a heavy financial burden to the financial positions of the Phase 1 and 2 Projects. The cash/fund flow of the Phase 1 Project indicates a deficit in fund every year during the initial 20 years from FY2016 until FY2035 due to heavy debt-services and turns to a surplus only in FY2036 and onwards. Similarly, the cash/fund flow of the Phase 2 Project indicates a deficit in fund every year during the initial 20 years from FY2021 until FY2040 due to heavy debt-services and turns to a surplus only in FY2041 and onwards.

These financial positions imply that both the Phase 1 and 2 Projects require taking specific measures for strengthening sustainable financial structures.

(2) Discussion on Measures to be taken for Establishing Sustainable Financial Structures

To seek conditions that enable Phase 1 and Phase 2 Projects to maintain sustainable financial structure, several tests on the cash-flow forecasts have been exercised by changing conditions. The outcome of these tests is presented in Supporting Report 12. As a result of these tests, there are three (3) options for possible measures to be taken for strengthening the sustainable financial structures of the Phase 1 and 2 Projects. These are either adopting higher water tariff rates or relaxing the terms and conditions of the GOB's subsidiary loans to be provided for the Phase 1 and Phase 2 Projects.

Option 1 Adopting higher tariff rates to the extent that the Phase 1 and 2 Projects can be financially sustainable

[Specific Measures]

1) To raise the tariff rates in FY2016 to BDT30.22 per m^3 for domestic consumers and BDT85.61 per m^3 for non-domestic consumers by 4.6 times of the rates in FY2012 (i.e., BDT6.57 m^3 for domestic consumers and BDT18.61 per m^3 for non-domestic consumers), and then rise by 3.0% every year until FY2020.
2) To raise the rates in FY2021 by 1.4 times of the FY2020 rates for domestic and non-domestic consumers, and then rise by 2% every year until FY2025.
3) To raise the rates in FY2026 by 10% of the FY2025 rates for domestic and non-domestic consumers.
   No need to raise the rates in FY2027 onwards, unless any external conditions change.

Option 2 Relaxing lending terms of GOB's subsidiary loan to the extent that the Phase 1 and 2 Projects can be financially sustainable

[Specific Measures]

1) To provide grant and/or equity participation for the whole amount of funds required for the Phase 1 Project, which is equivalent to about 30% of the total fund requirements for the Phase 1 and 2 Projects.
2) For Phase 2 Project, relaxing the lending terms as follows:
   a) Repayment of loan with 30 years installments after a 10 years grace period
   b) Interest rate at 1% per annum both for the Foreign and Local Loan Portions
   c) Capitalize interest accrued during the initial 10 years so that annual payment of interest can be released during these years.

Option 3: Intermediate arrangement between Option 1 and Option 2

Table 12.2.18 Base-line Forecast of Operating Income (Profit/Loss) for Phase 1 Project

Fiscal Year	Water Tariff Rate (BDT/m³)		Available Water Volume (mill m³)	NWR %	Billed Water Volume (mil m³)			I. Water Revenues (BDT million)			II. Expenses (BDT million)			III. Gross Operating Income (I. - II.) (BDT mil.)
	Domestic	Non-Dom.			Domestic	Non-dom.	Total	Domestic	Non-Dom.	Total	O&M Cost	Depreciation	Total	
2016	7.61	21.56	41.76	33%	22.63	5.35	27.98	172.21	115.35	287.56	235.27			
2017	7.99	22.64	44.37	30%	24.93	6.13	31.06	199.19	138.78	337.97	256.81			
2018	8.39	23.77	46.98	27%	27.27	7.03	34.30	228.80	167.10	395.90	279.63			
2019	8.81	24.96	49.59	25%	29.13	8.06	37.19	256.64	201.18	457.82	303.79			
2020	9.25	26.21	52.20	23%	31.49	8.70	40.19	291.28	228.03	519.31	329.35			
2021	9.71	27.52	52.20	20%	32.99	8.77	41.76	320.33	241.35	561.68	341.27			
2022	10.20	28.90	52.20	19%	33.40	8.88	42.28	340.68	256.63	597.31	353.62			
2023	10.71	30.35	52.20	18%	33.55	9.25	42.80	359.32	280.74	640.06	366.43			
2024	11.25	31.87	52.20	17%	34.13	9.20	43.33	383.96	293.20	677.16	379.70			
2025	11.81	33.46	52.20	16%	35.38	8.47	43.85	417.84	283.41	701.25	393.45			
2026	12.40	35.13	52.20	15%	35.05	9.32	44.37	434.62	327.41	762.03	407.71			
2027	13.02	36.89	52.20	15%	35.05	9.32	44.37	456.35	343.81	800.16	422.49			
2028	13.67	38.73	52.20	15%	34.60	9.77	44.37	472.98	378.39	851.37	437.80	Non-disclosure Information		
2029	14.35	40.67	52.20	15%	34.15	10.22	44.37	490.05	415.65	905.70	453.68			
2030	15.07	42.70	52.20	15%	33.70	10.67	44.37	507.86	455.61	963.47	470.14			
2031	15.82	44.84	52.20	15%	33.55	10.82	44.37	530.76	485.17	1,015.93	487.20			
2032	16.61	47.08	52.20	15%	33.55	10.82	44.37	557.27	509.41	1,066.68	504.88			
2033	17.44	49.43	52.20	15%	33.55	10.82	44.37	585.11	534.83	1,119.94	523.21			
2034	18.31	51.90	52.20	15%	33.55	10.82	44.37	614.30	561.56	1,175.86	542.20			
2035	19.23	54.50	52.20	15%	33.55	10.82	44.37	645.17	589.69	1,234.86	561.90			
2036	20.19	57.23	52.20	15%	33.55	10.82	44.37	677.37	619.23	1,296.60	582.31			
2037	21.20	60.09	52.20	15%	33.55	10.82	44.37	711.26	650.17	1,361.43	603.47			
2038	22.26	63.09	52.20	15%	33.55	10.82	44.37	746.82	682.63	1,429.45	625.40			
2039	23.37	66.24	52.20	15%	33.55	10.82	44.37	784.06	716.72	1,500.78	648.14			
2040	24.54	69.55	52.20	15%	33.55	10.82	44.37	823.32	752.53	1,575.85	671.70			
2041	25.77	73.03	52.20	15%	33.55	10.82	44.37	864.58	790.18	1,654.76	696.13			
2042	27.06	76.68	52.20	15%	33.55	10.82	44.37	907.81	829.69	1,737.50	721.45			

Table 12.2.19 Base-line Forecast of Operating Income (Profit/Loss) for Phase 2 Project

Fiscal Year	Water Tariff Rate (BDT/m³)		Available Water Volume (mill m³)	NWR %	Billed Water Volume (mil m³)			I. Water Revenues (BDT million)			II. Expenses (BDT million)			III. Gross Operating Income (I. - II.) (BDT mil.)
	Domestic	Non-Dom.			Domestic	Non-dom.	Total	Domestic	Non-Dom.	Total	O&M	Depreciation	Total	
2016														
2017														
2018														
2019														
2020														
2021	9.71	27.52	41.76	20%	28.14	5.27	33.41	273.24	145.03	418.27	278.77			
2022	10.20	28.90	44.37	19%	30.07	5.87	35.94	306.71	169.64	476.35	304.50			
2023	10.71	30.35	46.98	18%	32.28	6.24	38.52	345.72	189.38	535.10	331.76			
2024	11.25	31.87	49.59	17%	34.12	7.04	41.16	383.85	224.36	608.21	360.62			
2025	11.81	33.46	52.20	16%	35.38	8.47	43.85	417.84	283.41	701.25	391.17			
2026	12.40	35.13	52.20	15%	35.05	9.32	44.37	434.62	327.41	762.03	405.34			
2027	13.02	36.89	52.20	15%	35.05	9.32	44.37	456.35	343.81	800.16	420.04			
2028	13.67	38.73	52.20	15%	34.60	9.77	44.37	472.98	378.39	851.37	435.27			
2029	14.35	40.67	52.20	15%	34.15	10.22	44.37	490.05	415.65	905.70	451.06			
2030	15.07	42.70	52.20	15%	33.69	10.68	44.37	507.71	456.04	963.75	467.42			
2031	15.82	44.84	52.20	15%	33.54	10.83	44.37	530.60	485.62	1,016.22	484.39			
2032	16.61	47.08	52.20	15%	33.54	10.83	44.37	557.10	509.88	1,066.98	501.97			
2033	17.44	49.43	52.20	15%	33.54	10.83	44.37	584.94	535.33	1,120.27	520.20			
2034	18.31	51.90	52.20	15%	33.54	10.83	44.37	614.12	562.08	1,176.20	539.09			
2035	19.23	54.50	52.20	15%	33.54	10.83	44.37	644.97	590.24	1,235.21	558.67			
2036	20.19	57.23	52.20	15%	33.54	10.83	44.37	677.17	619.80	1,296.97	578.97			
2037	21.20	60.09	52.20	15%	33.54	10.83	44.37	711.05	650.77	1,361.82	600.01			
2038	22.26	63.09	52.20	15%	33.54	10.83	44.37	746.60	683.26	1,429.86	621.83			
2039	23.37	66.24	52.20	15%	33.54	10.83	44.37	783.83	717.38	1,501.21	644.44			
2040	24.54	69.55	52.20	15%	33.54	10.83	44.37	823.07	753.23	1,576.30	667.87			
2041	25.77	73.03	52.20	15%	33.54	10.83	44.37	864.33	790.91	1,655.24	692.17			
2042	27.06	76.68	52.20	15%	33.54	10.83	44.37	907.54	830.46	1,738.00	717.35			

Non-disclosure Information

Table 12.2.20 Base-line Forecast of Cash/Fund Flow for Phase 1 and Phase 2 Projects

Fiscal Year	Phase 1 Project								Phase 2 Project								Phase 1&2 Combined	
	A. Fund Inflow			B. Fund Outflow			Balance (A.-B.)	Accum. Fund	A. Fund Inflow			B. Fund Outflow			Balance (A.-B.)	Accum. Fund	Annual Cash /Fund Flow Balance	Accum. Fund
	Operating Income	Depr.	Total	Repayment of Loan	Interest Payment	Total			Operating Income (Profit /Loss)	Depr.	Total	Repay -ment of Loan	Interest Payment	Total				
2016	-366.13								0.00									
2017	-337.26								0.00									
2018	-302.15								0.00									
2019	-264.39								0.00									
2020	-228.46								0.00									
2021	-195.60								-795.56									
2022	-172.32								-763.21									
2023	-142.38								-731.72									
2024	-118.55								-687.47									
2025	-108.21								-624.98									
2026	-61.69								-552.91									
2027	-38.34				Non-disclosure Information				-529.48				Non-disclosure Information					
2028	-2.44								-493.50									
2029	36.01								-454.96									
2030	77.32								-413.27									
2031	112.72								-377.77									
2032	145.79								-344.59									
2033	339.77								-309.53									
2034	376.70								-272.49									
2035	416.00								-233.06									
2036	457.33								-191.60									
2037	501.00								-147.79									
2038	547.09								-20.90									
2039	595.68								27.84									
2040	647.19								79.50									
2041	769.13								134.14									
2042	826.55								0.00									

It is recommended to consider taking either one of the above three measures in order to make the Phase 1 and 2 Projects financially sustainable.

The financial forecasts examining these options are presented in Supporting Report 12.

12.3 Financial Evaluation of the Project

12.3.1 Methodology and Assumptions

The financial internal rate of return (FIRR) and financial net present value (FNPV) of the Phase 2 Project are computed for the financial evaluation. The FIRR is the discount rate at which the net present value of costs of the Phase 2 Project equals the net present values of its revenues. The FIRR of the Phase 2 Project is computed by using a computation model developed on the basis of the discounted cash-flow method. IRR is shown as a percentage. It shows the rate of the real value of return on the capital investment. The IRR computation formula is defined as follows;

$$0 = \sum_{i=0}^{T} \frac{C_i}{(1 + IRR)^i}$$

where;
C_i = cash flow for the given period
i = positive integral between 0 and T
T = total number of periods

The financial opportunity cost of capital (FOCC) is compared against the FIRR to evaluate the financial viability of the Phase 2 Project. The FOCC is expressed as a percentage. This value represents the opportunity cost of the capital. The computation formula for FOCC is defined as follows;

$$FOCC = \frac{(1 + r_x)}{(1 + r_y)} - 1$$

where;
r_x = Treasury bill rate
r_y = Consumer Price Index (Inflation)

The FNPV is also calculated by using a discount rate equal to the FOCC to evaluate whether the Project can earn adequate FNPV. The NPV calculation formula is defined as follows;

$$NPV = \sum_{i=0}^{T} \frac{C_i}{(1 + r)^i}$$

where;
C_i = cash flow for the given period
i = positive integral between 0 and T
T = total number of periods
r = Opportunity cost of capital (discount rate)

Major assumptions and key parameters for the computation of the FIRR are as follows.

(1) Project life

Years will be Bangladeshi fiscal years, starting in July 1 and ending at June 30 in the subsequent year. Capital investment including consulting services for the Project will start in 2013 and end in 2021. The project life is taken as 30 years from the initial operation year of the completed facilities i.e., from 2021 to 2050. The financial analysis is conducted for a period from 2013, the initial disbursement year through to 2050.

(2) Prices

All the financial estimates are made at constant 2021 prices.

(3) Exchange rate

An exchange rate of 1BDT to 0.966JPY is used at a constant conversion rate over the entire project life.

(4) Project Cost Disbursement

The project cost for the Phase 2 Project include costs for the construction of secondary/tertiary distribution pipelines covering the service areas of both the Phase 1 and 2 Projects, house connection works and the procurement of meters and materials (e.g., saddles, valves, pipes, etc.) to be used for house connections. The cash-flow for computing FIRR is based on water revenue earned through the distribution of water produced by the Phase 2 Project and capital and O&M costs incurred in doing so. Thus, for the computation of cash-flow, the costs for house connection works, the costs for the procurement of meters and materials to be used for house connections, a half of the costs for secondary/tertiary distribution pipelines, as well as ancillary costs related to these cost components are excluded from the project cost of the Phase 2 Project.

In addition, interest during construction is also excluded from the project cost, since the FIRR is calculated on the basis of net capital costs excluding any financial costs.

Thus the adjusted capital cost of the Phase 2 Project amounts to BDT NDI million. Table 12.3.1 shows the estimated disbursement of the capital cost for the period from FY2013, the initial disbursement year through to FY2020 in which the construction is completed and FY2021 in which consulting services are completed.

Table 12.3.1 Project Cost Disbursement

Fiscal Year	Disbursement (BDT mil.)
2013	Non-disclosure Information
2014	
2015	
2016	
2017	
2018	
2019	
2020	
2021	
2022	

(5) Replacement Costs

The economic life span of civil structures and pipelines is 50 years and these will not be required to be replaced during the financial assessment period.

The mechanical and electrical equipment has an average life span of 15 to 20 years and thus some components will required to be replaced or refurbished after these times. The financial calculation assumes that the replacement cost is in an amount equivalent to 30% of the initial capital cost, which will accrue during the period from 2035 to 2040. Thus the estimated replacement cost amounts to BDT NDI million in 2021 prices. Table 12.3.2 shows the breakdown of the replacement cost estimates.

Table 12.3.2 Breakdown of Replacement Cost Estimates

Replacement Costs	Total Cost	% of total cost	Import Duties	VAT & Taxes	Duties & Taxes	Total Replacement Cost (BDT mil.)
Plant & Machinery LC	Non-disclosure Information					
Plant & Machinery FC						

(6) O & M Costs

The financial computation for FIRR uses the O & M costs for the Phase 2 Project, as presented in Table 12.2.13. The O & M costs are based on 2012 prices and converted to 2021 constant prices by using price escalation factors of 3.7%, 3.5% and 2% per year for Variable Costs, Fixed Cost A (Personnel Cost plus Welfare and Administration Costs), and Fixed Cost B (Maintenance Cost) respectively.

(7) Water Production and Non-revenue Water Rate

The financial calculation for FIRR uses the water production and distribution volumes, NRW rates and billable (accounted-for) water consumption volumes given in Table 12.2.7.

(8) Tariff Rates and Collection Efficiency

The financial calculation of FIRR is based on the same assumptions as stated in 12.2.2 (2) and (3), and the tariff rates in 2021 shown in Table 12.2.1.

(9) Water Revenue

Table 12.3.3 shows the water revenue used for the financial computation of FIRR.

Table 12.3.3 Water Revenue

Fiscal Year	Operation Ratio (%)	Water Production (mil.m³/year)	NRW (%)	Billabe Water Volume (mil.m³/year)		Tariff (BDT/m³)		Water Revenue (BDTmil./year)		Collection Efficiency	Water Revenue (BDTmil.)
				Domestic	Non-Domestic	Domestic	Non-Domestic	Domestic	Non-Domestic		
2021	80%	41.76	20%	25.25	8.15	9.71	27.51	245.22	224.23	100%	469.44
2022	85%	44.37	19%	27.17	8.77	9.71	27.51	263.80	241.22	100%	505.02
2023	90%	46.98	18%	29.12	9.40	9.71	27.51	282.77	258.56	100%	541.33
2024	95%	49.59	17%	31.11	10.04	9.71	27.51	302.11	276.26	100%	578.37
2025	100%	52.20	16%	33.15	10.70	9.71	27.51	321.85	294.30	100%	616.15
2026	100%	52.20	15%	33.54	10.83	9.71	27.51	325.68	297.80	100%	623.48
2027-2049 No change			|	|	|	|	|	|	|	|	|
2050	100%	52.20	15%	33.54	10.83	9.71	27.51	325.68	297.80	100%	623.48

12.3.2 Financial Viability Analysis

The financial opportunity cost of capital (FOCC) was estimated for the financial evaluation, based on the Treasury bill rate of Bangladesh and the inflation rate in Bangladesh. The weighted average yield of a 5-year Bangladesh Government Treasury Bill was 11.48% in July 2012, and the inflation rate of the general CPI was 10.62% in the same month. Thus the real FOCC is 0.78% after adjustment using the formulae [= (1+0.1148)/(1+0.1062)-1].

Table 12.3.4 shows the computation of the discounted cash-flow, FNPV and FIRR for Phase 2 Project, providing in the following indicators:

- FNPV: BDT NDI million (negative)
- FIRR: 7.07% (negative)

The analysis implies that the water revenue is adequate to recover O&M costs but inadequate to recover the capital investment costs due to the current water tariff rates set comparatively lower.

Table 12.3.4 Financial Cash Flow

(BDT million)

Fiscal Year	Capital Investment	Replacement Costs	O&M Cost	Water Revenue	Net Return
2013					
2014					
2015					
2016					
2017					
2018					
2019					
2020					
2021					
2022					
2023					
2024			Non-disclosure Information		
2025					
2026					
2027-2033	No change				
2034					
2035					
2036					
2037					
2038					
2039					
2040					
2041					
2042-2049	No change				
2050					
Total					
FNPV:	Non-disclosure Information	**FOCC:**	**0.78%**	**FIRR:**	**-7.07%**

12.3.3 Sensitivity Analysis of Financial Viability

A sensitivity analysis is conducted to evaluate the possible effect of variances from the base case assumptions. The factors included in the sensitivity analysis are an increase/decrease in the O&M cost by 5% and 10%. The results of the sensitivity analysis are shown in Table 12.3.5 and Figure 12.3.1.

Table 12.3.5 Summary of Financial Sensitivity Analysis

Description	FIRR	FNPV
O&M cost decrease with 10%	-6.55%	Non-disclosure Information
O&M cost decrease with 5%	-6.80%	
Base Case	-7.07%	
O&M cost increase with 5%	-7.35%	
O&M cost increase with 10%	-7.65%	

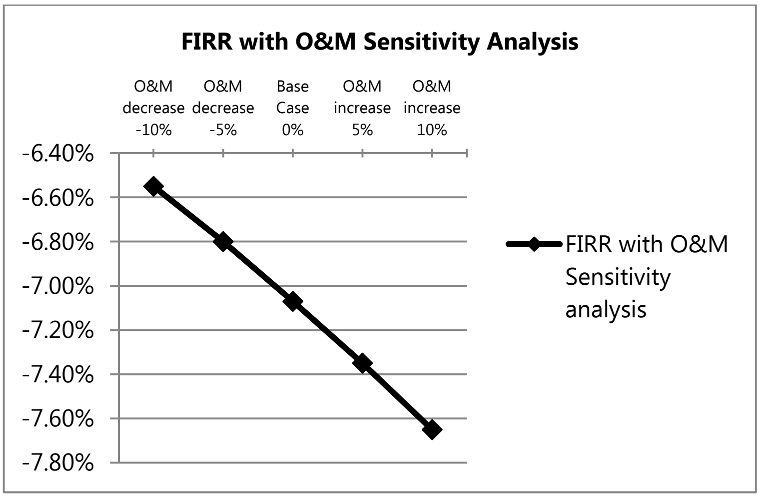


Figure 12.3.1 Graph showing Sensitivity Analysis

The water revenue based on the current tariff levels, as discussed earlier, are adequate to recover O & M costs, but inadequate to recover the capital costs. Thus a key for the Phase 2 Project to earn a reasonable return on investment is to adopt higher water tariff rates. Table 12.3.6 summarizes the sensitivity analysis of FIRR and FNPV based on higher tariff rates.

Table 12.3.6 FIRR & FNPV with Higher Tariff Rates

Description	FIRR	FNPV
Base Case	-7.07%	Non-disclosure Information
Domestic rate in 2021		
9.71BDT/m^3		
Non-Domestic rate in 2021		
27.51BDT/m^3		
Tariff Rate increase with 170%	0.78%	
Domestic rate in 2021		
26.22BDT/m^3		
Non-Domestic rate in 2021		
74.28BDT/m^3		

This analysis indicates that with an increase in the tariff rates by 170% of the 2021 tariff rates to BDT26.22/m^3 for domestic consumers and BDT74.28/m^3 for non-domestic consumers in 2021 constant prices the FIRR and FNPV are BDT25.37 million (positive) at a 0.78% discount rate.

The 2021 tariff rates used for the computation of FIRR are higher by 148% in comparison with the current 2012 rates (i.e., BDT6.57/m^3 for domestic consumers and BDT18.61/m^3 for non-domestic consumers). Should the rates be further increased by another 170%, it becomes to be higher by 252% than the 2012 rates. It seems difficult to adopt such higher tariff rates.

Considering economic benefits that may be brought about by the Project, it is recommended for the Government to consider providing financial support as discussed in 12.2.4 (2) even though gaining inadequate financial returns on investment.

12.4 Economic Evaluation of the Project

12.4.1 Methodology and Assumptions

The economic internal rate of return (EIRR) and economic net present value (ENPV) of the Phase 2 Project are computed to evaluate the economic effectiveness of the Project.

Major assumptions and key parameters used for the computation of the EIRR and ENPV are the same as those used for the computation of the FIRR and FNPV, as stated in 12.3.1. Only the specific factors different from those used for the financial computation are stated hereunder.

(1) Economic Costs

The financial costs are converted into economic cost in 2021 constant prices. The costs for the capital investment and O&M costs are divided into tradable and non-tradable costs. The financial prices of non-tradable components are adjusted using a Standard Conversion Factor (SCF) to convert into economic prices. Tradable components do not need further adjustment. The import duties, taxes and VAT, which are included in the capital investment and O&M costs are considered as transfer payments that are defined as the amounts transferred from one party to another without reducing nor increasing the amount of real resources available to the economy as a whole; hence such costs are not considered as an economic cost.

(2) Standard Conversion Factor

The SCF is an approximation to convert non-tradable components into border prices. The SCF compares the world prices with the domestic prices. Based on similar countries with the same conditions as for the Phase 2 Project, the financial prices are adjusted using an SCF of 0.9 to convert into economic prices[1].

(3) Capital Investment

The capital cost is considered at the constant price level for economic analysis. The capital cost estimates are adjusted to arrive at the true economic value of the project. Such adjustment is considered on account of the imperfections in the local market economy. The foreign currency portion of the capital costs are considered as tradable, while the local currency portion of the capital costs are assumed to include non-tradable, skilled laborers and non-skilled laborers at 90%, 1% and 9% respectively.

These compositions are based on the assumption that 60% of the LC portion is the cost for materials to be procured and 40% is for the contractors' internal costs and profit. Out of the 40%, a half (20% of LC amount) is considered as costs for the contractor, one fourth (10% of LC amount) is the profit for the

[1] Reference: Pakistan Water Sector Strategy Medium Term Investment Plan Volume 3 October 2002, Padma Multipurpose Bridge Project Economic Analysis 2010 RRP BAN 35049-01, Implementation Completion and results Report for the Kerala Rural Water Supply and Environmental Sanitation Project 2009 Report No ICR0000482.

contractors and the remaining one fourth (10% of LC amount) is for labor costs, out of which 1% is for skilled labor and 9% is unskilled labor. The non-tradable cost is converted into economic cost by applying the SCF of 0.9.

The wages for the skilled workers are a non-tradable cost and the SCF of 0.9 will be applied to convert it into economic cost. Wages of unskilled laborers is normally set by the government under a Minimum Wage law to protect the welfare of such workers. For this reason, wages of laborers are valued higher than when it is left to the forces of demand and supply in the free market. Therefore a conversion factor of 0.7[2] is used to correct the over valuation of the wages for the unskilled workers. The SCF rate of 0.9 will be applied and the conversion rate of the financial cost to economic cost will be 0.63 [=0.7 x 0.9].

The import duties, taxes and VAT are excluded from the capital costs, as these elements constitute transfer payments from contractors to the GOB. Table 12.4.1 summarizes the conversion of financial costs to economic costs

The weighted conversion factors for the capital investment are 0.95 as shown in Table 12.4.2.

Table 12.4.2 Conversion Factors

Description	Financial Cost excl. tax (BDT)	% of total cost	Conversion Factor	Economic Cost (BDT)
FC of Construction and procurement	Non-disclosure Information			
LC of Construction and procurement				
Non-Tradable (90% of LC)				
Skilled labor (1% of LC)				
Unskilled labor (9% of LC)				
Consulting Services				
FC				
LC				
Total				

(4) Replacement Costs

The replacement costs comprise of two components, one part is the Plant & Machinery of the FC, which is a tradable component with a conversion factor of 1, and the other part is the Plant & Machinery of the LC which is a non-tradable component with a conversion factor of 0.9. Table 12.4.3 shows the breakdown of the computation of economic replacement costs.

Table 12.4.3 Economic Replacement Costs

(BDT mil.)

Replacement costs	Total Cost	% of total cost	Import Duties	VAT & Taxes	Duties & Taxes	Replacement Cost excl. tax	Conversion Factor	Economic Cost
Plant & Machinery LC	Non-disclosure Information							
Plant & Machinery FC								
Total								

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[2] Reference: SAPROF for Karnaphuli Water supply Project

Table 12.4.1 Conversion to Economic Capital Costs

Particulars		Financial Cost (BDT mil.)	Economic Cost (BDT mil.)
A.	Construction Works	Non-disclosure Information	
A-1.	Building & Civil Construction		
a.	Intake facilities & WTP		
b.	Reservoirs & Elevated Tanks		
	Sub-total		
A-2.	Plant, Machinery & Pipes etc.		
a.	Intake facilities		
b.	Reservoirs & Elevated Tanks		
	Sub-total		
A-3.	Water Pipelines & Network		
a.	Conveyance & transmission pipelines		
b.	Optical Fibre Cable		
c.	Distribution pipelines (mains)		
d.	Monitoring & Control System		
e.	Secondary distribution network		
f.	Service connections		
g.	Supply for low income communities		
	Sub-total		
A-4.	General Requirements & Dispute Board for Construction Works		
a.	Intake facilities, WTP, Reservoirs & Elevated Tanks		
b.	Conveyance & transmission Pipelines		
c.	Primary/secondary/tertiary Distribution Pipelines		
	Sub-total		
A-5.	Procurement of Equipment & Materials		
a.	Water Meters		
b.	Maintenance Vehicles		
c.	Maintenance Equipment		
	Sub-total		
A-6	Project Implementation Support Unit		
A-7.	Construction Works-Total (A-1 to A-6)		
A-8.	Price Escalation for Construction Works (2.1% of A-7 FC, 4.9% of A-7 LC)		
A.9.	Contingency for Construction Works (5% of A-7 & A-8)		
A-10.	Grand Total of Construction Works		
a.	Material cost (60% of A-10)		
b.	Contractor cost (40% of A-10)		
c.	Profit of Contractors costs (10% of A-10 b)		
d.	Taxation on profit (27.5% of A-10 c)		
	Grand Total of A. Construction Works (A-9 - A-9 d)		
B.	Consultancy Services		
B-1.	Engineering Consulting Services		
B-2.	Price Escalation (2.1% of B-1 FC, 4.9% of B-1 LC)		
B-3.	Contingency (5% of B-1 & B-2)		
a.	Consultancy Direct Cost (30% of B-1 to B-3)		
b.	Consultancy Cost (70% of B-1 to B-3)		
c.	Profit of Consultancy costs (10% of B-3 b)		
d.	Taxation on profit (27.5% of B-3 c)		
	Total of B. (B-1 to B-3 – B-3 d)		
C.	Grand Total (A & B)		
D.	CWASA Administration Cost		
E.	Other Charges		
a.	Bank Charges		
	Project Cost-Total		

Conversion factor: 0.95

(5) O & M Costs

O & M costs comprise Power & Fuel, Chemical, Personnel, Welfare and Administration, and Maintenance & Repair costs. Power & Fuel and Chemical costs are assumed as tradable costs, thus using a conversion factor of 1.0. Personnel, Welfare and Administration costs are converted by using a conversion factor of 0.9. The maintenance & repair cost are assumed as non-tradable and converted by using a conversion factor of 0.9. VAT and taxes for O&M costs are excluded. Table 12.4.4 shows the breakdown of the converted economic O&M costs and Table 12.4.5 shows the conversion factors used.

Table 12.4.4 O&M Costs in Constant 2012 Prices

in constant 2012 prices

	Particulars		Unit Cost (BDT)	Taxation (%)	Phase2			
					Daily Consumption in 100% capacity operation	Cost/day (BDT)	Tax	Total Cost/Year excl. tax (BDT)
A.	Variable Cost							
A-1.	Power Cost							
a.	Intake							
		Energy Charge	5.61 /kWh	15%	650 kW/h	83,578	3,979,029	26,526,861
		Demand Charge	45.00 /kWh	15%	975 kW/h		68,674	457,826
b.	WTP							
		Energy Charge	5.61 /kWh	15%	1,950 kW/h	250,733	11,937,087	79,580,582
		Demand Charge	45.00 /kWh	15%	2,900 kW/h		204,261	1,361,739
c.	Nashirabad Reservoir							
		Energy Charge	5.61 /kWh	15%	752 kW/h	96,693	4,603,431	30,689,537
		Demand Charge	45.00 /kWh	15%	1,575 kW/h		110,935	739,565
						Total	20,903,417	139,356,110
						(Power Cost per m^3)	0.40	2.67
A-2.	Fuel (Diesel Oil)							
a.	Intake		60.00 /l	15%	176 l/h	11,405	542,968	3,619,784
b.	WTP		60.00 /l	15%	527 l/h	34,150	1,625,818	10,838,786
c.	Nashirabad Reservoir		60.00 /l	15%	203 l/h	13,154	626,264	4,175,092
						Total	2,795,050	18,633,662
						(Fuel Cost per m^3)	0.05	0.36
A-3.	Chemicals							
a.	Chlorine (Cl_2)		25,000 /ton	15%	0.6 ton/d	15,000	714,130	4,760,870
b.	ALUM		24,000 /ton	15%	3.15 ton/d	75,600	3,599,217	23,994,783
c.	LIME		12,000 /ton	15%	0.75 ton/d	9,000	428,478	2,856,522
						Total	4,741,825	31,612,175
						(Chemicals Cost per m^3)	0.09	0.61
A-4.	Variable Cost-Total (A1+A2+A3)						28,440,292	189,601,947
	(Variable Costperm^3)						0.54	3.63
B.	a. Personnel		12,318 /psn.	10%	78 psns.		1,048,145	10,481,455
	b. Welfare & Administration			10%			524,073	5,240,727
	c. Maintenance & Repair			15%			Non-disclosure Information	
B-2.Fixed Cost-Total (B1.atoB1.c)								

*1) Energy Charge: -Cost/day: Unit Cost x Consumption/h x 95.5% x 24hrs.
-Cost/year: Daily cost x 365days

*2) Demand Charge: -Cost/month: Unit Cost x Monthly demand volume
-Cost/year: Monthly costx12months

*3) Fuel (Diesel Oil) Cost -Cost/day: Unit Cost x Daily power Cons. x. 0.27l /kW x 4.5%
-Cost/year: Daily cost x 365days

Table 12.4.5 O&M Costs Conversion Factors

Description	Financial Cost excl. tax (BDT)	% of total cost	Conversion Factor	Economic Cost
Fuel Cost Variable cost				
Per m^3 cost	0.36	9.89%	1.00	0.36
Electricity Cost				
Per m^3 cost	2.67	73.35%	1.00	2.67
Chemical Cost				
Per m^3 cost	0.61	16.76%	1.00	0.61
Total cost per m^3 cost	3.64	100.00%	1.00	3.64
Personnel Cost	10,481,455		0.90	9,433,310
Welfare & Administration	5,240,727		0.90	4,716,654
Maintenance & Repair	Non-disclosure Information			
Total Fixed Cost				

The O & M costs are based on 2012 prices and converted to 2021 constant prices by using price escalation factors of 3.7%, 3.5% and 2% per year for variable cost, fixed cost A (Personnel Cost and Welfare & Administration) and fixed cost B (Maintenance & Repair) respectively. Table 12.4.6 shows the economic O&M costs in constant 2021 prices used for the computation of economic cash-flow.

Table 12.4.6 O&M cost in Constant 2021 Prices

Fiscal Year	Unit Cost			Ope. Ratio (%)	Annual Production Water Volume (m^3)	Annual O&M Economic Cost (BDT)			
	Variable Cost (BDT/m^3)	Fixed Cost A. (BDT/year)	Fixed Cost B. (BDT/year)			Variable Economic Cost	Fixed Economic Cost A.	Fixed Economic Cost B.	Total O & M Economic Cost
2021	5.05	19,284,948	Non -disclosure Information	80%	41,756,000	210,779,845	19,284,948	Non-disclosure Information	
2022	5.05	19,284,948		85%	44,365,750	223,953,585	19,284,948		
2023	5.05	19,284,948		90%	46,975,500	237,127,325	19,284,948		
2024	5.05	19,284,948		95%	49,585,250	250,301,066	19,284,948		
2025	5.05	19,284,948		100%	52,195,000	263,474,806	19,284,948		
2026-2049 No Change				│	│	│	│		
2050	5.05	19,284,948		100%	52,195,000	263,474,806	19,284,948		

(6) Economic Benefits

There are two categories of economic benefits (namely, direct benefit and indirect benefit) that can be quantified for the Phase 2 Project. The direct benefit is a monetary value of distributed water from the Phase 2 Project that is estimated based on a value of "Willingness to Pay" (WTP), the indirect benefit is a monetary value of water cost saving by consumers that may be benefitted with the supply of water from the Project

1) Direct Benefit (Willingness to Pay Value)

The direct benefit is valued on a basis of "Willingness to Pay" (WTP). According to the socio-economic survey conducted in this Preparatory Survey, 511 responses or 76% out of 672 responses indicated willing to pay up to 1.5 times of the present tariff or more. The water tariffs in 2021 used for financial evaluation are BDT9.71/m^3 for domestic consumers and BDT27.51/m^3 for non-domestic consumers. These tariff rates are 1.48 times of the tariff rates in 2012 (i.e., BDT6.57/m^3 for domestic consumers and BDT18.61/m^3 for non-domestic consumers).

In view of the above, the value of Willingness to Pay (WTP) is deemed to be equivalent to the water tariff rates in 2021 used for the financial evaluation. Thus the value of WTP is equivalent to the Water Revenue amounts used for the financial evaluation.

2) Indirect Benefit (Consumers' Water Cost Saving)

Due to the limited supply of CWASA's piped water, many water consumers use the water supplied by bowsers or pumped from private tube wells. As the consumers spend much higher costs for obtaining water from such sources, the Phase 2 Project benefits such consumers by reduction of expenses incurred for water.

The World Bank Report[3] includes a comparison of water costs of different supply sources, as shown in Table 12.4.7.

Table 12.4.7 Comparison between Water Tariff with Cost of alternative Water Sources (2009)

	Piped Water by CWASA	Water purchased by 10 m^3 capacity bowser	Water purchased by 6 m^3 capacity bowser	Average cost of water from Private tube well (licensed)*	Average cost of water from Private tube well (not licensed)*
Cost (BDT/m^3)	5.7	65	75	110	15

* Exclude initial capital cost

The spot survey conducted by the JICA Preparatory Survey Team showed that the cost of Bowser Tank water has been constant since 2009, while the cost from the private tube wells has increased slightly mainly due to increases in fuel and electricity prices between 2009 and 2012. Table 12.4.8 summarizes the results of the spot survey.

Table 12.4.8 Spot Survey Results of Water Comparison

	Piped Water by CWASA	Water purchased by 10 m^3 capacity bowser	Water purchased by 6 m^3 capacity bowser	Average cost of water from Private tube well (licensed)*	Average cost of water from Private tube well (not licensed)*
Cost (BDT/m^3)	6.57/m^3	BDT.650.00/10m^3 BDT. 65.00/m^3 Emergency Rate: BDT.1300.00/10m^3 BDT. 130.00/m^3	BDT.450.00/6m^3 BDT. 75.00/m^3 Emergency Rate: BDT.900.00/6m^3 BDT.150.00/m^3	119.73/m^3	Not Available

* Exclude initial capital cost

From the above data, a weighted average cost of water obtained from sources other than CWASA's piped water is estimated as BDT109.6/m^3 in 2009 prices as shown in Table 12.4.9.

Table 12.4.9 Average Cost for Water obtained from Other Sources

Alternative water source cost	Cost (BDT/m^3)	Weight	Annual Increase
Bowser Tank 10m^3	65	0.5%	0%
Bowser Tank 6m^3	75	0.5%	0%
Private Tube Well	110	99%	3.7%
Average cost	109.6	100%	

The 2021 price costs for water obtained from sources other than CWASA's piped water is estimated by increasing the above cost at an escalation rate of 3.7% per annum, which is the annual average increase rate of Gross Rent, Fuel and Lighting in the Bangladesh CPI from 2001 to 2012, as given in Table 12.2.8.

[3] Reference: "Project appraisal document on Chittagong Water Supply Improvement and Sanitation Project", World Bank, 27 May 2010, Report No: 54697-BD

The next assumption is the quantity of water that can be transferred from other supply sources to the use of CWASA's piped water when water is supplied from the Phase 2 Project.

Table 12.4.10 shows the estimate of the water quantity to be transferred from other sources when there is a supply from the Phase 2 Project.

Table 12.4.10 Volume of Water to be transferred from Other Sources

A	Existing Water Connections		25,000
B	Estimated Water Connections required for Phases 1 & 2 Service Areas		59,300
C	Connections to be Increased by Phase 2 project	(B-A)/2	17,150
D	Estimated Water Consumption for Phases 1 & 2 (m^3/year)		88,400,000
E	Estimated Water Consumption/connection for Phases 1 & 2 (m^3/year)	D/B	1,490.725
F	Estimated Volume attributed by the Project for Cost Saving Benefit	C*E	25,565,936

The distribution of water from Phase 1 and Phase 2 Projects require about 59,300 house connections. As there are about 25,000 existing house connections in the service areas of the Phase 1 and Phase 2 Projects, about 34,300 additional connections are needed, of which a half (i.e. 17,150 connections) are considered as additional for the distribution from the Phase 2 Project. As the total consumption volume of water from the Phase 1 and Phase 2 Projects is estimated as 88.4 million m^3 per annum, an average consumption volume per connection is estimated to be about 1,490.73m^3/year. Assuming an additional 17,150 connections will stop using other supply sources, the volume of water to be transferred is estimated at 25,565,936 m^3 per annum.

The quantity of water to be transferred from private tube wells and bowser tanks is estimated. Table 12.4.11 shows the basis for the estimate of the quantity of the water volume, which is transferred from bowser water.

Table 12.4.11 Composition of Estimated Bowser Tank Water Volume in Service Area

Entire Chittagong Area			
A.	Total Water Billed m^3 (May 2012)	4,518,135	
B.	Total Bowser Water Sold m^3 (May 2012)	20,614	
C.	Percent of Total Water	0.46%	C=B/A
Service Area			
D.	Estimated Water Saving Volume m^3	25,565,936	
E.	Bowser Water Sold m^3	123,683	E=B*12*0.5
F.	Percentage of Total Water	0.48%	F=E/D

The total volume of bowser water which was sold in May, 2012 was 20,614 m^3, accounting for about 0.46% of the total water distributed by CWASA in the same month. Assuming that a half of the bowser tank water is distributed in the service areas of the Phase 1 and 2 Projects, the ratio of the bowser tank water distributed in the service areas accounts for 0.48% of the total estimated volume of water transferred from other sources (i.e., 25,565,936m^3). For the estimation of economic benefits brought about by the water cost saving of consumers, it is conservatively estimated that 99% is due to transfer from private tube well water and 1% from bowser tank water, which is sub- divided into 0.5% from 10m^3 capacity bowser tanks and 0.5% from 6m^3 capacity bowser tanks, as the costs of water from bowser tanks is lower than the cost from private tube wells.

Table 12.4.12 shows the estimated economic benefit brought about by the water cost saving of consumers that can be realized by transferring from the use of water from private tube wells and bowser tanks.

Table 12.4.12 Benefit of Consumers' Water Cost Saving derived from the Project

Water saving volume (m^3/year)	Alternative water source 1 price (BDT/m^3)	Alternative water source 2 price (BDT/m^3)	Alternative water source 3 price (BDT/m^3)	Average Cost of alternative water source (BDT/m^3)	Average Tariff Rate (BDT/m^3)	Cost Saving (BDT/m^3)	Total Economic Benefit (BDT)
25,565,936	65.00	75.00	170.11	169.11	14.05	155.06	3,964,254,036

The average cost to be paid by consumers for water to be obtained from other sources is estimated as BDT 169.11/m^3 and the cost to be paid by them for CWASA's piped water is BDT 14.05/m^3 both in 2021 constant prices, which means that consumers can benefit by an amount of BDT 155.06/m^3. Thus an economic benefit of BDT 3,964,254,036 is estimated on the basis of 25,565,936m^3 of water being transferred from other supply sources.

12.4.2 Analysis of Economic Return on Investment

Table 12.4.13 shows the EIRR and ENPV computed for the Phase 2 Project.

Table 12.4.13 Economic Cash Flow

(BDT mil.)

Year	Capital Investment	Replacement Costs	O&M Cost	Willingness to Pay (WTP)	Indirect Benefit	Net Benefit
2013			-	-	-	
2014			-	-	-	
2015			-	-	-	
2016			-	-	-	
2017	Non -disclosure Information		-	-	-	
2018			-	-	-	
2019			-	-		
2020			-	-	-	
2021			240.35	469.44	3,964.25	
2022			253.53	505.02	3,964.25	Non -disclosure Information
2023			266.70	541.33	3,964.25	
2024			279.87	578.37	3,964.25	
2025			293.05	616.15	3,964.25	
2026			293.05	623.48	3,964.25	
2027-2033 No Change			|	|	|	
2034			293.05	623.48	3,964.25	
2035			293.05	623.48	3,964.25	
2036			293.05	623.48	3,964.25	
2037	Non -disclosure Information		293.05	623.48	3,964.25	
2038			293.05	623.48	3,964.25	
2039			293.05	623.48	3,964.25	
2040			293.05	623.48	3,964.25	
2041		-	293.05	623.48	3,964.25	
2042-20			|	|	|	
2050		-	293.05	623.48	3,964.25	
Total			8,659.70	18,297.33	118,927.62	
ENPV:	NDI		**EOCC:**	**10%**	**EIRR:**	**11.87%**

It indicates the following results:

- EIRR: 11.87%

- ENPV: BDT NDI million at 10% discount rate

The economic opportunity cost of capital (EOCC) for water projects is normally estimated at between 10% and 12%.

In light of the EIRR and ENPV vs. EOCC, the Phase 2 Project is evaluated to have a justifiable economic return on investment.

12.4.3 Sensitivity Analysis of Economic Return

A sensitivity analysis on the economic return is conducted to evaluate the possible effect of variances in the assumptions. The factors to be included in the sensitivity analysis are an increase/decrease in the O&M cost, Direct Benefit (Willingness to Pay: WTP) and Indirect Economic Benefit (IEB) by 5% and 10%.

The results of the sensitivity analysis are shown in Table 12.4.14 and Figure 12.4.1.

Table 12.4.14 Summary of Economic Sensitivity Analysis

Description	EIRR	ENPV
O&M cost decrease with 10%	11.94%	Non -disclosure Information
O&M cost decrease with 5%	11.91%	
Base Case	11.87%	
O&M cost increase with 5%	11.84%	
O&M cost increase with 10%	11.81%	
WTP decrease with 10%	11.82%	
WTP decrease with 5%	11.85%	
Base Case	11.87%	
WTP increase with 5%	11.90%	
WTP increase with 10%	11.93%	
EB decrease with 10%	10.84%	
EB decrease with 5%	11.36%	
Base Case	11.87%	
EB increase with 5%	12.37%	
EB increase with 10%	12.85%	

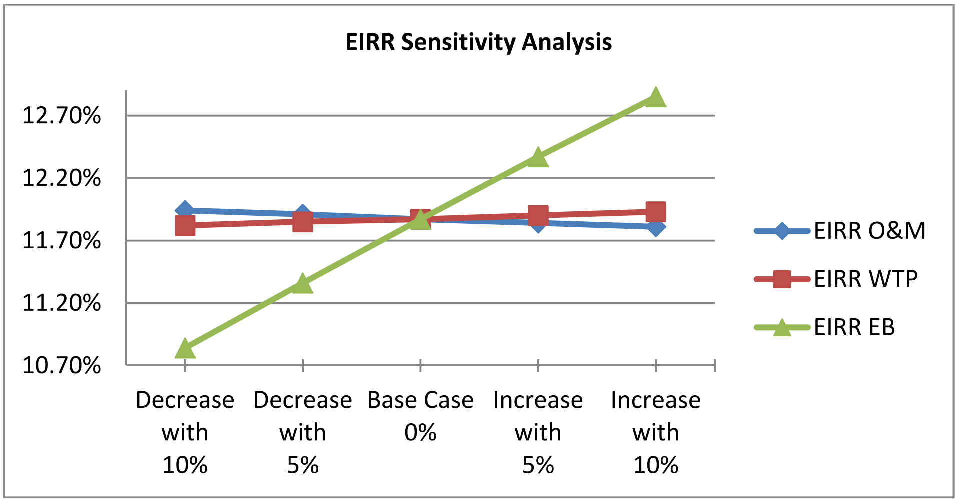

Figure 12.4.1 Sensitivity of EIRR

The sensitivity analysis indicates that the EIRR is higher than 11% even with a 10% increase in O&M costs, being higher than 11% even with a 10% decrease in Willingness to Pay (WTP), and being higher than 10% even with a 10% decrease in Indirect Economic Benefit (IEB). Thus the economic effectiveness of Phase 2 Project is quantitatively justifiable.

12.4.4 Overall Evaluation of Economic Benefit

Adequate supply of quality water is essential to meet the increasing water demand in Chittagong. The Phase 2, as well as the Phase 1Project will contribute significantly in responding to public needs for an improved water supply and in particular in the improvement of the sanitary environment and health of the people.

In view of the quantitative economic return on investment and these qualitative effects, the Phase 2 Project is strongly justifiable, although the financial position is difficult.