NO

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR IMPROVEMENT OF STORM WATER DRAINEGE SYSTEM IN DHAKA CITY (PHASE II)

IN

THE PEOPLE'S REPUBLIC OF BANGLADESH

AUGUST 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

G M
J R
06-172

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR IMPROVEMENT OF STORM WATER DRAINEGE SYSTEM IN DHAKA CITY (PHASE II)

IN

THE PEOPLE'S REPUBLIC OF BANGLADESH

AUGUST 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a basic design study on the Project for Improvement of Storm Water Drainage System in Dhaka City (Phase II) in the People's Republic of Bangladesh and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team from February 11th to March 13th, 2006.

The team held discussions with the officials concerned of the Government of Bangladesh, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Bangladesh in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

August 2006

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

August 2006

Letter of Transmittal

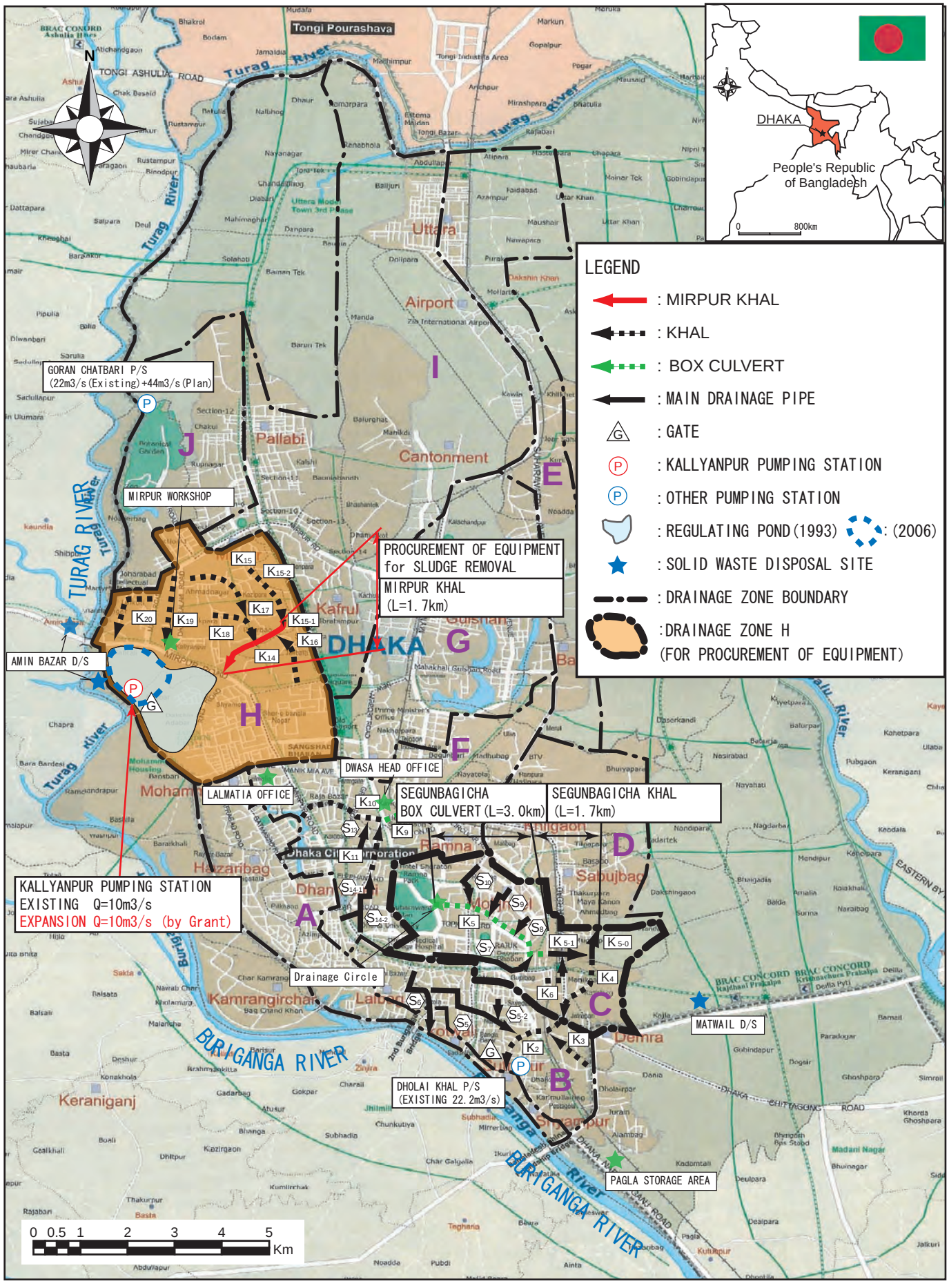
We are pleased to submit to you the basic design study report on the Project for Improvement of Storm Water Drainage System in Dhaka City (Phase II) in the People's Republic of Bangladesh.

This study was conducted by the CTI Engineering International Co., Ltd., Japan under a contract to JICA, during the period of 7.0 months from February to August 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Bangladesh and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to the further promotion of the project.

Very truly yours,

Toshiaki Tokumasu
Project manager,
Basic design study team on
The Project for Improvement of Storm Water Drainage System in Dhaka City (Phase II), in the People's Republic of Bangladesh
CTI Engineering International Co., Ltd.



LOCATION MAP

Perspective of the Kallyanpur Pumping Station

(White part on the roof is the structure of Additional Pumping Station)

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

ABBREVIATIONS

A/P	Authorization to Pay
ADB	Asian Development Bank
ADP	Annual Development Program
B/A	Banking Arrangement
BWDB	Bangladesh Water Development Board
CDST	Customs Duty and Sales Tax
CIF	Cost, insurance and Freight
DEMEF	Department of Environment, Ministry of Environment & Forest
DESCO	Dhaka Electric Supply Company Ltd.
DMD	Deputy Managing Director
DMDP	Dhaka Metropolitan Development Plan 1995-2015
DPP	Development Project Proposal
DWASA	Dhaka Water Supply and Sewerage Authority
E/N	Exchange of Notes
ECNEC	Executive Committee of National Economic Council
EIA	Environmental Impact Assessment
EOJ	Embassy of Japan in Bangladesh
ERD	Economic Relation Division, Ministry of Finance
FAP	Flood Action Plan
FOB	Free on Board
FY	Fiscal Year
GOB	Government of Bangladesh
GOJ	Government of Japan
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
L/A	Loan Agreement
LGD	Local Government Division, Ministry of Local Government, Rural Development and Cooperation
M/M	Man Months
MD	Managing Director
MLGRD&C	Ministry of Local Government, Rural Development and Cooperation
MT	Metric Ton
N/V	Note Verbal
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
ODA	Official Development Assistance

PQ	Pre-Qualification
R/D	Record of Discussions
RAJUK	Rajdhani Unnayan Kartripakkha
RPD	Division of Research/Planning/Development of DWASA
Tk	Bangladesh Taka
TOR	Terms of Reference
UNCHS	United Nation Center for Human Settlements

SUMMARY

With an area of 147,570 square kilometers, the People's Republic of Bangladesh occupies a unique geographic location spanning a stretch of land between the mighty Himalayan mountain chain on the north and the open ocean on the south. It is virtually the only drainage outlet of a vast river basin made up of the international rivers and their networks. Bangladesh has the highest population density in the world with about 850 inhabitants per square kilometer. The total population is estimated at 138 million with an annual growth rate of 1.7 percent. The climate of Bangladesh is classified as tropical monsoon type, characterized by three seasons: monsoon, post-monsoon and pre-monsoon. The monsoon season is normally from May to October. Ninety percent (90%) of the annual rainfall (approx. 2,000mm) in Dhaka City occurs during the monsoon season.

Dhaka City, the capital of the People's Republic of Bangladesh, is located on the flat delta of three (3) major international rivers, Ganges, Brahmaputra and Meghna, surrounded by their tributaries. Due to its geological characteristics of low flat plain, the low-lying areas of the city are often flooded by river overflow and heavy rainfall in the rainy season and received serious damage from the floods in 1988, 1989, 1998 and 2004. Considering the rate of population growth and rapid urbanization, it is anticipated that flood damage in the city will increase and flooding problems will bring a more serious impact on social, economic and industrial development activities.

Under the background given above, The Study on Storm Water Drainage System Improvement Project in Dhaka City that was conducted by Japan International Cooperation Agency (JICA) in 1987 and related studies have been approved and adopted in the Dhaka Metropolitan Development Project (DMDP) by RUJUK, an entity under the Ministry of Housing and Public Works. In this connection, aiming at the improvement of the urban environment in line with the city development, Dhaka Water Supply and Sewerage (DWASA) also prepared the "Concept Notes on Strategic Development Plan (2004-2010)" that contain the proposed DWASA policies with the year 2010 as the target year. Urban drainage is one of the most important tasks of the DWASA, and in this Concept Notes "to ensure efficient storm water drainage" is defined as one of its main objectives.

In response to the request of the Government of the People's Republic of Bangladesh (GOB), JICA conducted the Study on Storm Water Drainage System Improvement Project in Dhaka City in 1987 and also another study to update the previous JICA study considering the 1988 flood and the ongoing relevant projects in 1990. JICA carried out the above updating study from July 1989 to February 1990 and reviewed the previously proposed project consisting of two (2) phases whose total project cost was revised to TK 5.08 billion (JPY 19.6 billion). Moreover, the Priority Project consisting of the construction of pumping station, channel (*khal*) improvement and installation of drainage pipes, with the estimated cost of TK 1.52 billion (JPY 5.85 billion), was proposed to be implemented in two (2) phases, Phase I and Phase II, for the central city area of 49.46 km^2 (for Priority Drainage

Zones B, C, F and H). Later on, in order to comply with the request of the GOB, the Government of Japan (GOJ) decided to extend TK 0.53 billion (JPY 2.05 billion) under Japan's Grant Aid Program for the Project for Drainage Zones F and H (hereinafter referred to as the "Phase-I Project"), including the construction of Kallyanpur Pumping Station (50% of total capacity) and improvement of drainage channels but excluding the planned and ongoing drainage improvement projects by GOB. Despite the above, the expansion of Kallyanpur Pumping Station and the improvement of drainage channels are required to be implemented, and flood damage mitigated, because serious flooding problems have taken place due to the decrease of retention capacity in the city and the flow capacity of drainage channels, which have been brought due to recent rapid urbanization and no effective land use management by GOB.

Under the circumstances mentioned above and after the implementation of the Phase I Project in July 2002, the GOB officially made a request for technical and financial cooperation in connection with the implementation of "The Storm Water Drainage System Improvement Project – Phase II" (hereinafter referred to as "the Project"), aiming to improve the function of the existing drainage facilities, as well as urban health and safety conditions in the high priority drainage areas of Drainage Zone C and Drainage Zone H. In response, JICA dispatched a Preliminary Study Team (PS Team) in August 2005 to confirm the need for Japan's Grant Aid.

The PS Team had studied the appropriateness of the necessity and urgency of the Project. As a result, the PS Team had recognized the necessity and urgency of enhancing the present pumping capacity, as well as the effectiveness and maintenance condition of Kallyanpur Pumping Station. The PS Team had also recognized the necessity and urgency of the procurement of sludge removal equipment considered as the first step of gradual upgrade of drainage canals, box culverts and drainage pipes under Japan's Grant Aid to mitigate the occurrence of devastating floods.

Therefore, the GOJ decided to conduct the Basic Design Study, and JICA dispatched the Basic Design Study Team (BD Team) from 11 February to 13 March 2006. In the Basic Design Study, the urgency and necessity of the requested project were again recognized. The content and size of the Project, as well as its appropriateness and effect have been discussed and proposed in the draft of the Basic Design Study Report, which was explained to the Bangladesh side by an explanation team dispatched to Bangladesh from July 8 to 15, 2006. Both sides had agreed on the contents and the finalization of the Basic Design Study Report.

To achieve the objective of improving the function and operation of the existing drainage facilities as well as urban health and safety condition in the high priority drainage area of Drainage Zone H, Japan's Grant Aid shall consist of the following works to reinforce the drainage capacity of the Kallyanpur Pumping Station constructed in Phase I and the sludge removal work in open channels and drainage pipes in Drainage Zone H.

(1) Construction of Facility: Expansion of Kallyanpur Pumping Station (Drainage Capacity: $10m^3/s$)

(2) Procurement of Equipment: Procurement of Sludge Removal Equipment (4 types, 6 units)

In the basic design study, the following basic design policies/points have been considered in the construction of facilities and the procurement of equipment.

Considerations for Basic Design	
Item	Policies / Points of Consideration
Construction of Kallyanpur Pumping Station	More than 10 years has passed after submission of the previous JICA Master Plan. The existing hydrological design criteria including design rainfall and rainfall pattern were confirmed useful for the basic plan of drainage facilities in the Project through the review and updating of the past hydrological studies.
	The area in and around the pond has been developed rapidly by residents and private companies, and has become about $1.0km^2$ corresponding to about half of the one designed in the Master Plan, appropriate capacities of the additional pumping station and the regulation pond is to be reviewed in view point of cost-effectiveness. In this connection, the design drainage capacity of the new pumping station has been reviewed in consideration of the remaining area of the regulating pond and the capacity of the pump.
	The new pumping station is to be constructed at the northern vacant space ($A=370m^2$) nearby the existing Kallyanpur Pumping Station (Drainage Capacity: $10m^3/s$). Therefore, the new pumping station and the existing one shall function as a unit after construction and easy maintenance shall be required so that operators can easily manage both pumps.
	The new station shall have a coherent, similar structure and design with the existing one, which has reinforced concrete columns and beams with brick wall suitable to the scenery of the site and the Islamic design.
	The vertical axial flow pump is selected, as in the JICA master plan study, since it has a relatively simple pump equipment, good and economical performance, and, besides, this is the type installed in the existing pumping station on which DWASA has experience in operation, maintenance and management.
	Basically, construction materials and equipment will be procured in Bangladesh. However, some construction materials and equipment shall be procured in third countries or in Japan, because such materials, equipment and facilities are not produced in Bangladesh. As for the pump equipment and facilities, the supplier shall be able to provide a total system of installation and O&M for mechanical and electrical equipment, including incidental equipment and spare parts, as well as their assembly and installation at the site. As a result of the study, the pump equipment and facilities will be procured from Japan.
Procurement of Sludge Removal Equipment	Sludge removal equipment/facilities and quantities were determined, based on the results of the sludge amount survey conducted by BD Team in this Basic Design Study and the review of the Action Plan provided by DWASA.
	The GOJ advocates, as much as possible, the importance of self-help effort by DWASA to sustain the effectiveness of Japan's Grant Aid. Consequently, equipment/facilities procured under the Japan's Grant Aid shall be limited to equipment not commonly used as well as the effect on sludge removal work.

	Basically, sludge removal equipment for the Project will be procured from Japan on the following considerations: • The manufacturer of the body (chassis frame) of vehicles has to have a local branch or a service branch easily available for after-sales service. • For the Project, Japanese vehicles are of the right hand drive type and shall be procured in principle because they are adaptable to the driving condition in Bangladesh. • Existing sludge removal equipment owned by DWASA is available. However, it will be inconvenient for DWASA to carry out the sludge removal work because the jetting machine and the vacuum loader has some problem for the works. In this connection, the equipment procured has to satisfy the specifications for ordinary sludge removal work. • There are more than three (3) competitive manufacturers of equipment in the Japanese market. • The Bangladesh side had requested the procurement of Japanese equipment and facilities.
Environmental and Social Considerations	According to the Initial Environmental Examination (IEE) of the Project executed by DWASA, all the possible adverse impacts are not significant, therefore, it was confirmed that no Environment Impact Assessment (EIA) is necessary for the Project. In this connection, Department of Environment (DOE) issued the Environmental Clearance Certificate (ECC) for the Project on 31 August 2006. For the construction of the new Kallyanpur Pumping Station and selection of equipment, several mitigation measures shall be considered and conducted based on the recommendations of the IEE and ECC.

Based on the above considerations, the agreed facility and equipment have been identified through the field survey in Bangladesh and the technical examination in Japan. As for the procurement of sludge removal equipment, on the basis of the idea of promoting the self-help efforts of DWASA that will lead to the promotion of long-term effects of assistance, it was decided to procure equipment and facilities that are limited to special equipment and materials for dredging sludge in Drainage Zone H, which are thought to be difficult for DWASA to procure on its own as stated in the table above. Summaries of the facility design and the equipment design are given in the tables below.

Summary of Facility Design

Facility	Expansion of Kallyanpur Pumping Station
Civil Works Facilities	Intake Structure, Surge Tank, Box Culvert, Intake fore-bay, site path, etc.
Pump House	Ground Floor: Pump Room (114m^2) and Piloti Area on Screen (115m^2); First Floor: Electrical Room (116m^2); (Reinforced Concrete Construction with Brick Wall)
Pump Facility and Equipment	Vertical Axial Flow Pump 1500mm: 5m^3/s x 2 units (Drainage Capacity: 10m^3/s) (With Motor, Railing of Crane, Screen, Pump Inspection Platform, Stop Log, electrical panels and other accessories)

Summary of Equipment Design

Item	Name of Equipment	Quantity	Application
Dredging Equipment	Sludge Vacuum Loader	1	Suction and hauling of sludge in drainage channels and pipes
	High Water Pressure Jetting Machine	1	Removal of sludge in small drainage pipes; Tearing down of solid sludge in drainpipes
Hauling Equipment	Sludge Transportation Truck w/ Crane	1	Removal of sludge from Manholes; Hauling of sludge without leakage (Tailgate: Waterproof type with rubber packing)
	Sludge Transportation Truck	3	Hauling of sludge without leakage (Tailgate: Waterproof type with rubber packing)

As for Drainage Zone C, a more efficient sludge removal plan that was concluded through an integrated evaluation study on the Sludge Removal Action Plan prepared by DWASA is proposed.

The implementation period of this Project is estimated to be 4 months for detailed engineering design including the preparation of bidding documents, and 23 months for equipment procurement, installation and facility construction. The project to be completed under the Japan's Grant Aid scheme is estimated to cost JPY 1,473 million (i.e., Yen 953 million from GOJ and JPY 520 million from GOB).

To be benefited directly with the implementation and realization of the Project are about 870,000 people in Drainage Zone H (about 17.60km^2) where the drainage system improvement is to be implemented. The indirect benefit of the drainage system improvement will be felt by the whole population of about 9.91 million in Dhaka City due to the improvement of traffic and environmental conditions in flood time.

The following direct benefits are expected:

Kallyanpur Pumping Station

(1) Drainage Zone H will be free from 5-year probability rainfall floods. The pumping capacity of 20m^3/s and regulating capacity of 2,000,000m^3 could be secured after the completion of construction of the new Kallyanpur Pumping Station.

(2) Flood damage by more than 5-year probability rainfall will be mitigated (e.g., Flood duration will decrease from 6 days under existing conditions to 3 days after the completion of the Project under the 2004 flood condition.)

Sludge Removal Work

(1) Inundation duration in the flood prone area in Drainage Zone H will decrease from 7 days to 4 or 5 days after the completion of the sludge removal work in the drainage channel and rainfall drainpipes.

(2) Pump drainage will be enhanced by the sludge removal work in the drainage channel and drainpipes upstream of the regulating pond.

In addition, the following indirect effects are expected:

(1) Traffic interruptions due to floods will be minimized.

(2) The prevalence of waterborne diseases in the rainy season in Drainage Zone H will be prevented because the environmental conditions will be improved due to the mitigation of flooding conditions.

(3) Economic loss due to floods will fall.

(4) The safety of workers in sludge removal can be assured with the procurement of sludge removal equipment and the mechanization of sludge removal in drainage channels and pipes.

The electrical and mechanical equipment and facilities of the existing pumping station had operated correctly and in good condition for 13 years without any big trouble and damage. On the other hand, sludge removal equipment procured with ADB assistance and made in India is available in DWASA, such as a High Water Pressure Jetting Machine (15Mpa) and a Sludge Suction Vacuum Loader ($7m^3$/min). DWASA has been operating and maintaining the equipment properly although it is inconvenient for DWASA to carry out the sludge removal work because the jetting machine could not remove the sludge in pipes as expected and the vacuum loader could not suck sludge from more than 4 meters in depth. Based on the above accomplishment, it was determined that DWASA has built the ability to operate and maintain pumping stations and sludge removal equipment.

In addition, O&M capacity and the technical level of DWASA had been given careful consideration for the selection of equipment required for the Project. It was concluded that DWASA is capable of operating the equipment to be procured with only initial technical guidance provided by the manufacturer's technician, since the appropriate sizes and specifications of the equipment have already been selected.

DWASA had commenced the necessary work to obtain the prompt approval of the Development Project Proposal (DPP) by the end of October 2006, in which all costs/budgets for the Project have sufficiently been included. In addition, DWASA had also implemented the project for the preservation of Kallyanpur Pumping Regulating Pond, and it is anticipated that this project will be completed by July 2007. The Kallyanpur Pumping Station will thus basically secure the safety level of flood control (5-year return period) in Drainage Zone H in the future.

In order to implement the Project smoothly, the following matters should be given urgent consideration and carried out with certainty by the Bangladesh side:

(1) The Development Project Proposal (DPP) of the Project should be approved in October 2007.

(2) Based on the approved DPP, the appropriate number of staff should be assigned to the Project and the personnel should be competent enough to deal with project operation and management.

(3) Based on the approved DPP that should contain a sufficient amount of budget, and the flawless work by the Bangladesh side, the preparatory works for the construction of the New Kallyanpur Pumping Station and the parking lot for sludge removal equipment, as well as the budget for CD&VAT should be completed by the end of August 2007 for the prompt commencement of construction and procurement. Formalities on the Banking Arrangement (B/A) and the Authorization to Pay (A/P) for the detailed design and construction/construction supervision should be completed by the end of November 2006 and the end of August 2007, respectively.

(4) Based on the approved DPP, the sludge removal works for 1.7km of Mirpur Khal and for 60km of drainage pipes in Drainage Zone H shall be implemented after procurement of sludge removal equipment.

(5) In accordance with recommendations of the Environmental Clearance Certificate (ECC) for the Project, DWASA shall comply with the terms and conditions of the ECC through proper monitoring and reporting, and by applying for renewal of the ECC as needed.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF STORM WATER DRAINAGE SYSTEM IN DHAKA CITY (PHASE II)
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

TABLE OF CONTENTS

CHAPTER 1 BACKGROUND OF THE PROJECT

Dhaka City, the capital of the People's Republic of Bangladesh, is located on the flat delta of three (3) major international rivers, Ganges, Brahmaputra and Meghna, surrounded by their tributaries. Due to its geological characteristics of low flat plain, the low lying areas of the city are often flooded by river overflow and heavy rainfall in the rainy season and received serious damage from the floods in 1988, 1989, 1998 and 2004. Considering the rate of population growth and rapid urbanization, it is anticipated that flood damage in the city will increase and flooding problems will bring a more serious impact on social, economic and industrial development activities.

In response to the request of the Government of the People's Republic of Bangladesh (GOB), the Japan International Cooperation Agency (JICA) conducted "The Study on Storm Water Drainage System Improvement Project in Dhaka City" in 1987. In the Master Plan Study for the city area of 137.5 km^2, a three-phased implementation program of urban drainage improvement measures was proposed with the total project cost of TK 3.43 billion. Thence, a priority project with a total cost of TK 2.61 billion (JPY 10.1 billion), consisting of the construction of pumping station and sluice gate, *khal* improvement and drainage pipe construction was recommended to be implemented immediately for the selected priority area of 31.39 km^2.

The worst flood hit Bangladesh in September 1988 and Dhaka City tremendously suffered from flood damage. The GOB, international cooperation organizations and several donor countries carried out a series of studies under the Flood Action Plan (FAP) covering the whole country. One of the FAP studies, the "Master Plan Study for Greater Dhaka Protection Project – FAP 8A" was conducted by JICA in 1991, while "FAP 8B" was executed by the Asian Development Bank (ADB).

On the other hand, the GOB requested the Government of Japan (GOJ) to undertake a study to update the previous JICA study (the Storm Water Drainage System Improvement Project in Dhaka City conducted in 1987), considering the 1988 flood and the ongoing relevant projects. JICA carried out the above updating study from July 1989 to February 1990 and reviewed the previously proposed project consisting of two (2) phases whose total project cost was revised to TK 5.08 billion (JPY 19.6 billion). Moreover, the Priority Project consisting of the construction of pumping station, *khal* improvement and installation of drainage pipes, with the estimated cost of TK 1.52 billion (JPY 5.85 billion), was proposed to be implemented in two (2) phases, Phase I and Phase II, for the central city area of 49.46 km^2 (for Priority Drainage Zones B, C, F and H).

Later on, in order to comply with the request of the GOB, the GOJ decided to extend Japan's Grant Aid of TK 0.53 billion (JPY 2.05 billion) for the Project for Drainage Zones F and H (hereinafter referred to as the "Phase-I Project"), excluding the planned and ongoing drainage improvement projects by GOB. Despite the above, however, the flooding problems have remained unsolved due to the intensification of development in the city and the lack of funds for implementation.

Under the background described above, the GOB officially made a request for technical and financial cooperation for the "Storm Water Drainage System Improvement Project – Phase II" (hereinafter called as the "Project") aiming to improve the functions and operation of the existing drainage facilities, as well as urban health and the safety conditions in the high priority drainage areas, i.e., Drainage Zones C and H, after the implementation of the Phase I Project in July 2002. The contents of the project as requested by the GOB are shown in Table 1.1.

Table 1.1 Project Contents as Requested by GOB

Objective Drainage Zones	Drainage Zones C & H (A=28.52km^2)
Expansion of Pumping Station	Expansion of Kallyanpur Pump Station (Q=10m^3/s)
Upgrade of Segunbagicha Channel (L=1.7km)	Concrete Retaining Wall Canal (B×H=12.5×5.0m, 150m) Culvert Bridge (B×H=5.0×4.7m×2, 60m) Brick-revetment Trapezoidal Canal (B×H=8～18×5.0m, 790m) Culvert Bridge (B×H=4.7×4.7m×2, 60m) Brick-revetment Trapezoidal Canal (B×H=7～17×5.0m, 640m)
Upgrade of Kallyanpur Drainage Channel (L=1.7km)	Culvert Bridge (B×H=4.6×3.9m×2, 45m)、 Brick-revetment Trapezoidal Canal (B×H=3.2～10.2×4.2m, 1,0550m) Culvert Bridge (B×H=3.2×3.4m, 45m) Brick-revetment Trapezoidal Canal (B×H=1.5～8.9×3.7m, 555m)
Provision of Maintenance Equipment	4WD car (1 car: not less than 2,500cc) Pick-Up Truck (2 cars: not less than 2,500cc) Sludge Transportation Truck with Crane (1 car: 8～10t) Sludge Transportation Truck (1 car: 8-10t)

In response to the request, JICA dispatched a Preliminary Study Team (PS Team) in August 2005 to confirm the need for Japan's Grant Aid.

The PS Team had recognized the necessity and urgency of enhancing the present pumping capacity, effectiveness and maintenance condition of Kallyanpur Pumping Station. The PS Team had also recognized the necessity and urgency of improving the flow capacity of the requested existing drainage channels to mitigate the occurrence of devastating floods. However, based the results of preliminary study, certain considerations shall be taken into account with the approval and confirmation of the Government of Bangladesh due to the existing local conditions, project implementation system, maintenance system and the technical ability of the local counterpart personnel, namely; that the requested upgrade of canals shall be taken off from the components of Japanese Grant Aid project because no land acquisition and house relocation programs have been prepared, and that the procurement of sludge removal equipment shall be considered as the first step of gradual upgrade of drainage canals, box culverts and drainage pipes under the Grant Aid.

Under the above situation, the GOJ had decided to conduct the Basic Design Study through JICA, which dispatched the Basic Design Study Team (BD Team) from 11 February to 13 March 2006. In the Basic Design Study, the urgency and necessity of the requested project were again recognized. The content and size of the Project, as well as its appropriateness and effect have been discussed and proposed in the draft of the Basic Design Study Report, which was explained to the Bangladesh side by an explanation team that was dispatched to Bangladesh from July 8 to 15, 2006.

Both sides had agreed on the contents and finalization of the Basic Design Study Report. The transition of components from the first request for Japan's Grant Aid to the results of the Basic Design Study is as shown in Table 1.2.

Table 1.2 Outline of Request and Plan at Each Step

Item		Unit	First Request	Planning at P/S	Confirmation at B/D	Planning at B/D[*1]
Facilities	Expansion of Kallyanpur Pump Station	LS	1	1	1	1
	Upgrade of Mirpur Canal (L=1.7km, H-zone)	LS	1	-	-	-
	Upgrade of Segunbagicha Canal (L=1.7km, C-zone)	LS	1	-	-	-
Procurements	4 WD Car (not less than 2,500cc)	Unit	1	-	-	-
	Pick-Up Truck (not less than 2,500cc)	Unit	2	-	-	-
	Wheel Type Back Hoe	Unit	-	To be confirmed in Basic Design Study	6	-[*2]
	Sludge Transportation Truck with Crane	Unit	1	To be confirmed in Basic Design Study	6	1
	Sludge Transportation Truck	Unit	1	To be confirmed in Basic Design Study	5	3
	Sludge Vacuum Loader	Unit	-	To be confirmed in Basic Design Study	2	1
	High Water Jetting Machine	Unit	-	To be confirmed in Basic Design Study	2	1
	Safety equipment for cleaning (oxygen mask and waterproof jacket)	Set	-	To be confirmed in Basic Design Study	12	-[*2]
Soft Component		LS	-	To be confirmed in Basic Design Study	1	-

Notes: *1: Refer to Chapter 3 regarding the final result and quantity.
*2: GOB shall prepare by self-help effort.
LS: Lump Sum; P/S: Preliminary Study; B/D: Basic Design Study

CHAPTER 2 CONTENTS OF THE PROJECT

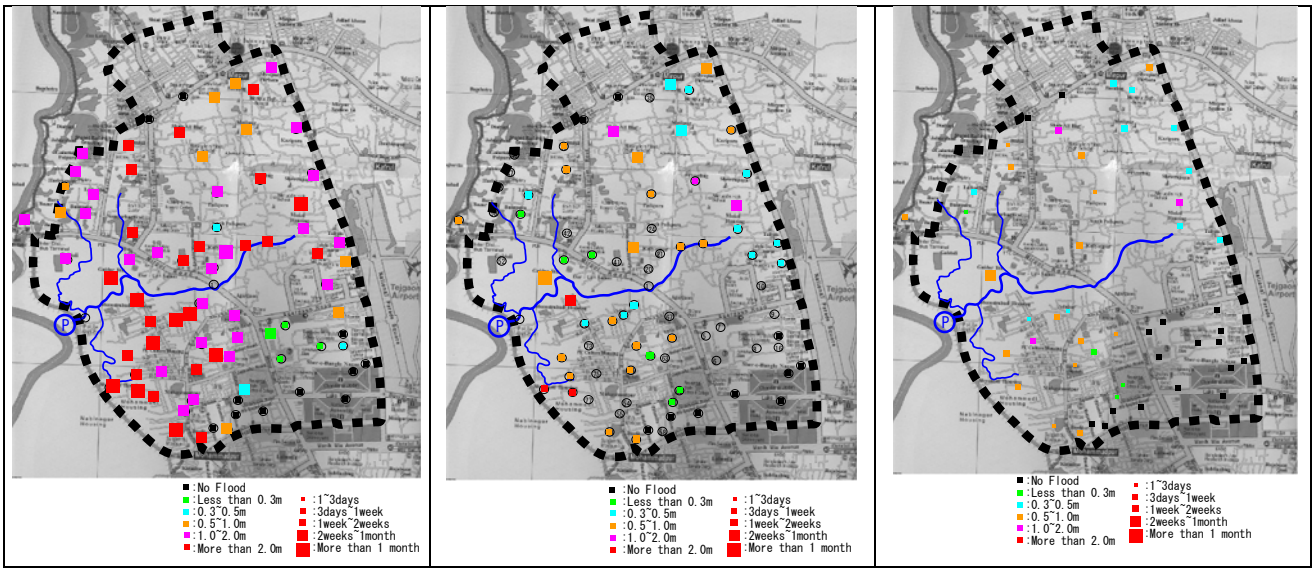
2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Objectives

As described in Chapter 1, Dhaka City is located on the flat delta of three (3) major international rivers, Ganges, Brahmaputra and Meghna, surrounded by their tributaries. Due to its geological characteristics of low flat plain, the low-lying areas of the city are often flooded by river overflow and heavy rainfall in the rainy season and received serious damage from the floods in 1988, 1989, 1998 and 2004. The conditions of recorded floods in Dhaka City are as shown in Table 2.1 and in Fig. 2.1.

Table 2.1 Features of Flood in Dhaka City

Year of Flood	Outline of Flood
1988	It has been reported that the flood was of 70-year return period. Floodwaters covered 85% of the whole city and the depth was 0.3 to 4.5m. As much as 60% of inhabitants were affected and the flood continued for about 20 days.
1998	Due to high tide and heavy rainfall, it took 2 months to drain the floodwater in the city. As much as 56% of the city was inundated.
2004	Like in the 1998 flood, heavy rain and high tide resulted in huge damage by flood. The flood continued from July to August and commercial and industrial establishments in the northwest-side of the city were damaged.



1998 Flood 2004 Flood Every Year

Fig. 2.1 Flooding Conditions in Drainage Zone H

Considering the rate of population growth and the rapid urbanization, it is anticipated that flood damage in the city will increase, and flooding problems will bring a more serious impact on social,

economic and industrial development activities. Under the background mentioned above, the results of the series of studies (hereinafter referred to as the "Master Plan") and their implementation as described in Chapter 1 have been approved and adopted in the Dhaka Metropolitan Development Project (DMDP) by RUJUK, an entity under the Ministry of Housing and Public Works.

In this connection, DWASA also had prepared the "Concept Notes on Strategic Development Plan (2004-2010)" setting the year 2010 as the target year and containing the proposed DWASA policies, aiming at improving the urban environment in line with the city development. In this Concept Notes, the main objectives of DWASA were defined as follows:

- To provide safe and sufficient water for drinking, industrial and commercial use.
- To ensure sanitation and good hygienic conditions through proper disposal of domestic and industrial sewage.
- To ensure efficient storm-water drainage.

As stated above, flood control is one of the most important tasks of the DWASA. Hence, the Project aims to improve the functions and operation of the existing drainage facilities as well as urban health and the safety conditions in the high priority drainage area, namely; Drainage Zone H, after the implementation of the Phase I Project.

2.1.2 Basic Concept of the Project

To achieve the objectives mentioned above, the Project shall consist of works to reinforce the drainage capacity of the Kallyanpur Pumping Station that was constructed in Phase I, and the sludge removal work in open channels and drainage pipes in Drainage Zone H. It is expected that with the implementation of such works, flood damage in Drainage Zone H, which has a population of more than 0.87 million, will be minimized, and the flooding condition and duration improved and shortened respectively.

The following works are to be implemented under the Japan's Grant Aid:

- Construction/Expansion of the Kallyanpur Pumping Station
- Procurement of Sludge Removal Equipment for Drainage Zone H

As for Drainage Zone C, a more efficient sludge removal plan that shall be concluded through an integrated evaluation study on the Sludge Removal Action Plan prepared by DWASA is proposed.

2.1.3 Alternatives from Environmental and Social Considerations

Before the commencement of the basic design study, four (4) alternatives and their mitigation measures including a "zero option" from the environmental and social considerations were assumed, as follows:

- Option-1: The project will not be implemented at all (No option)

  By this option, there is a strong probability of adverse effects to public health and health management in the future, because the drainage capability of pumping station and maintenance activity by DWASA will not be improved and flood damage caused in Dhaka City will not be mitigated.

- Option-2: Upgrade and renewal plan of channels in Zone C and/or Zone H will be implemented to secure a sufficient drainage capability

  By this option, the following negative effects will occur:

  - Land expropriation and involuntary relocation (critical and the most serious negative effect)
  - Environmental pollution such as aerial pollution, water pollution and noise nuisance

- Option-3: The plan for upgrading the volume and space of storm water reservoir will be implemented instead of the capability upgrade of drainage pump

  The same negative effects as Option-2 will happen with the widening of the storm water reservoir.

- Option-4: The plan for capability upgrade of drainage pump and countermeasure to Zone C and Zone H with minimum negative effects will be implemented instead of the upgrade of drainage channel (selected plan)

  Critical and largest negative effects will be solved and other considerable negative effects will also be reduced.

As a result, the components of the basic design (the fourth option described above) were selected because of more slight adverse impacts on the present natural and social environment as one of the key selection items of the Project components.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Design Policy on the Construction of Kallyanpur Pumping Station

(1) Policy on Drainage Plan

The basic drainage plan for the Kallyanpur Pumping Station, as one of the high priority structures for the mitigation of flood damage in the Master Plan and the urgent program, was prepared in the JICA Study in 1986-1991 and the construction of Kallayanpur Pumping Station (Drainage Capacity: 10 m^3/s corresponding to 50% of the Master Plan)

and the other drainage facilities was carried out under a Japan's Grant Aid from 1991 to 1993. Hence, the Project presently being considered is an extension of the former project, to achieve the targets of the Master Plan (Drainage Capacity: $20m^3/s$) as requested by the Government of Bangladesh (GOB)

Fundamentally, the basic plan of the Project shall adhere to the Master Plan prepared in the previous JICA study. However, the final plans of drainage and facilities shall be implemented based on the review and updating of past studies, because changes in environmental, social and economic factors have taken place.

(a) Review of Hydrological Factors (Design Rainfall and Water Level)

Design rainfall (5 years probable 2-day rainfall and hyetograph) and design water level (5-year probable water level) shall be reviewed by hydrological analysis in consideration of the new rainfall and water level data from 1986 to 2004 of the Dhaka Rainfall Gauging Station and the Mirpur Water Level Gauging Station.

(b) Review of Pump Capacity

Basically, the required design capacity of the new pumping station shall be $10m^3/s$ since the drainage capacity of the existing Kallayapur Pumping Station is $10\ m^3/s$, corresponding to 50% of the Master Plan. The entire drainage plan ($20m^3/s$) shall be designed with a large regulating pond (the Kallyanpur Regulating Pond, Required Area: $2.08km^2$) to reduce the required pump capacity. Recently, however, the area in and around the pond has been developed rapidly by residents and private companies, and has become about $1.0km^2$ corresponding to about half of the one designed in the Master Plan. Therefore, the regulating capacity of the pond will only be $1,000,000m^3$ (about 50% of the required design) under the existing regulating rule of water level in the pond.

DWASA had implemented a project to secure the area of the pond for managing and controlling the water level for drainage control. This project will be continued and be achieved with the cooperation of entities concerned such as Dhaka City and RUJUK.

In this connection, the design drainage capacity of the new pumping station has been reviewed in consideration of the remaining volume of the regulating pond and the capacity of the pump. In this basic design study, the following three (3) alternative plans were considered:

PLAN A – To construct the $10m^3/s$ expanded pumping station in accordance with the original design and the Master Plan.

PLAN B – To construct the 10m^3/s pumping station as requested, but the water level control in the regulation pond shall be planned.

PLAN C – To construct a big capacity pumping station (e.g., installation of new 20m^3/s pumps).

Condition of Southern Protected Lowland of Pump Station before the First Construction (1990)

Condition of Southern Protected Lowland of Pump Station taken at the Time of Site Survey (2006)

Photo 2.1 Vicinity Condition of Pumping Station in 1990 and 2006

(2) Policy on Structural Design

(a) Location of Pump Station and Geological Foundation

The new pumping station is to be constructed at the northern vacant space (A=370m^2) nearby the existing Kallyanpur Pumping Station (Drainage Capacity: 10m^3/s) and the surface soil condition of the construction location is silt or clay, which continuously exists at 10m in depth from the existing ground level.

According to the boring log, the ground is silt layer with an N-value of 5 to 11 and is moderately consolidated, so that it does not have a sufficient bearing capacity as the direct foundation of the pumping station. Therefore, pile foundation, as in the existing station, shall be adopted as the foundation of the new station and the bearing layer of pile should be set on consolidated fine sand layer with the N-value of 25 and over. In addition, it will be necessary to apply the sheathing method by steel sheet pile as temporary works in the construction of the underground structure.

(b) Structural Connecting Method with Existing Pumping Station

The following three (3) alternatives have been studied for the optimum structural design and relation between the new and the existing pump stations from the construction and economical aspects:

SA): Integrated Construction Plan

SB): Closed Construction Plan

SC): Separate construction Plans

(c) Basic Structural Design Concept

The design concept of the new pumping station is as follows:

- The new pumping station shall be constructed close to the existing one.
- The new pumping station and the existing one shall function as a unit after construction and easy-maintenance shall be required so that operators can easily manage both pumps.
- The new station shall have a coherent, similar structure and design with the existing one, which has reinforced concrete columns and beams with brick wall suitable to the scenery of the site and the Islamic design.

(3) Policy on the Electrical Design of Facilities

The type and number of pumps to be installed were proposed in the previous JICA Master Plan Study as two (2) vertical axial flow pumps. Their specifications were reviewed comprehensively including the review on discharge head of pumps, discharge volume, economic aspect, maintenance and safety considerations and past performance. The electrical and mechanical equipment and facilities of the existing pumping station had operated correctly and in good condition for 13 years. Based the operation records of pumps, the annual mean operation time was estimated at 850 hours, 900 hours and 700 hours in 1998, 1999 and 2000 respectively. It is estimated that these figures of Kallyanpur Pumping Station are over 3 times the average in Japan. Despite of these heavy conditions, the existing pumps have operated without any serious breakdown. In this connection, the new pumping station system shall adhere basically to the design of the existing pumping system.

(4) Policy on Construction/Procurement Condition

Based on the condition from both sides (Bangladesh and Japan), the basic policy on construction and procurement methods for the Kallyanpur Pumping Station are set, as follows:

(a) Procurement Method of Materials for Construction Works

In view of the rapid economic growth in Bangladesh, recent developments such as the construction of public facilities, private buildings, factories, hotels and so on have increased. Hence, it is now possible to procure basic construction materials such as Portland cement, ready-mixed concrete, reinforcing bars, aggregates, brick, etc., in Bangladesh. Some imported materials such as PVC pipes, asphalt materials, glass, tiles, secondary steel products, electrical wires and cables, lighting fixtures, fans, etc., can be procured easily also in Bangladesh. On the other hand, basic steel materials such as steel sheet piles, H-beams and large-sized materials can be procured in Singapore, Thailand or in other third countries, as well as in Japan.

(b) Procurement Policy on Construction Machinery

It is possible to procure basic construction equipment and facilities in Bangladesh. However, some construction equipment shall be procured in third countries or in Japan by the lease system.

(c) Procurement Policy on Pump Equipment and Facilities

Vertical axial flow pumps, squirrel cage, valves, motors, electrical and control panels, cables and screens will be procured under the Project. The equipment and facilities to be procured may have their origin in Japan or in other third countries such as China and the European countries, because such equipment and facilities are not produced in Bangladesh. The selection of equipment and facilities shall take into consideration not only cost and quality but also their usefulness and the satisfaction of the recipient

(5) Policy on Management/Maintenance Ability of Implementing Agency

The operation system of the existing Kallyanpur Pumping Station is three (3) shifts based on 8-hour work per day, as follows:

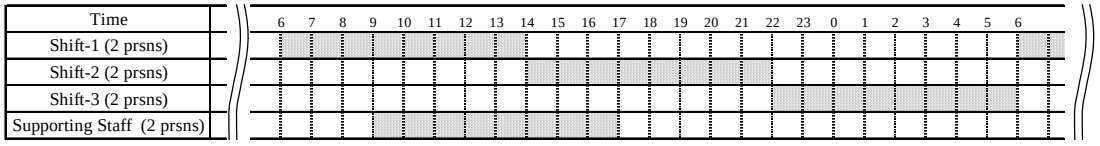


Fig. 2.2 Work Time Schedule of Maintenance Staff of Kallyanpur Pumping Station

Each operator maintains a manually recorded daily weather, starting and stopping time of pump, power meter, total operation time as well as percentage of opening of valves, pressures, pump axis temperature, ampere, power voltage, and water levels in every rainy season. In connection with this recording system, the digital recording system is proposed for easier data filling.

In addition to the general operation and maintenance system, the DWASA outsource maintenance work for the existing pumps. The contractors check, inspect and clean the pumps and accessories annually and support the daily operation at all hours in the rainy season. DWASA pays for electrical charges for pump operation and costs of such maintenance and support system. The following table shows the costs in the past 5 years.

Table 2.2 Maintenance Fee and Electrical Charges for Kallyanpur Pumping Station

(Taka)

Year	Maintenance Fee	Electrical Charges
2001	910,363	1,170,460
2002	346,702	1,533,518
2003	241,092	1,603,798
2004	146,530	2,185,660
2005	421,595	1,823,549
Ave.	413,256	1,663,397

As mentioned above, DWASA have kept the existing pump and facilities in good condition. This good system may be sustained without the necessity of reinforcing the number of staff after the completion of the new pumping station since the new pumping system follows the existing system. However, the O&M cost will increase due to the annual increment of electrical usage and the increase in the number of pumps from 3 to 5 pumps. (Refer to Section 2.5.)

(6) Policy on Environmental and Social Considerations

An Initial Environmental Examination (IEE) was carried out for the Project based on the EIA Guidelines for Industry, 1997 and the Guidelines for Environmental Assessment of Water Management (Flood Control, Drainage and Irrigation) Projects, 2005.

According to the IEE results, the possible adverse impacts requiring consideration on mitigation measures are i) noise mainly by concrete batching, and other construction activities; ii) noise and dust by generators and construction vehicles, etc.; iii) dust by haulage/transport of construction materials (sand, etc.); iv) water contamination and wastes by discharging of fuel and washing of construction equipment; and, v) solid waste by excavated soil.

However, all of the possible adverse impacts are not significant. Therefore, it was confirmed that no Environment Impact Assessment is necessary for the Project.

In this connection, Department of Environment (DOE) issued the Environmental Clearance Certificate (ECC) on 31 August 2006.

For the construction of the new Kallyanpur Pumping Station, the following mitigation measures shall be considered and conducted based on the recommendations of the IEE and ECC:

- Construction work with equipment that emits excessive noise shall not be conducted during the night.
- Vehicle movement to and from the site shall be managed properly to ensure that minimum disturbance is caused to people living in the surrounding area.
- Construction materials shall be covered properly while being hauled and stored, and roads properly cleaned and water-sprayed to minimize the concentration of dust in the air.
- Waste/wastewater (e.g., human waste from labor camps, fuel and wash-water from equipment/materials) shall be disposed appropriately, so that they do not find their way into adjacent water bodies.
- The excavated soil shall be disposed of in a designated place.

All of the above measures are not specific ones and are general measures for the construction work. For the formulation of the construction plan, the above general measures, which were recommended in the IEE report and conditions of the ECC, shall be done based on the related Bangladesh Environmental Regulations.

In addition, it is a basic concept that the DWASA shall properly conduct the above measures and the monitoring work and apply for renewal of the ECC periodically as needed.

2.2.1.2 Policy on Sludge Removal Equipment

(1) Purpose of Procurement

Initially, DWASA requested assistance from the Government of Japan (GOJ) for the improvement of the Segunbagicha and Mirpur *khals* in 2002. In the preparatory study stage, however, the request was diverted to the procurement of sludge removal equipment for *khals* and the Segunbagicha Box Culvert and drainage pipes in Drainage Zones C and H with the approval of the Bangladesh and Japanese sides in 2005. In the field survey of the Basic Design Study in February 2006, DWASA requested in the Action Plan a number of sludge removal equipment including a variety of equipment, as shown in the Table 2.3.

Table 2.3 Components and Quantities of Equipment Requested by DWASA

Requested Components	Preliminary Study		Basic Design	
	Qty	Priority	Qty	Priority
2. Procurement of Facilities				
2.1 Sludge Removal Track (with Crane)	Depending on the result of Basic Survey	B	5	B
2.2 Sludge Removal Track (without Crane)		B	6	B
2.3 Backhoe (Wheel Type)		B	6	B
2.4 High Water Pressure Jetting Machine		B	2	B
2.5 Sludge Vacuum Loader		B	2	B
2.6 Washing Tools for Culvert (Oxygen Mask with Cylinder and Waterproof Jacket)		B	12	B

The equipment and facilities in the table above have been reviewed from the effectiveness and validity aspects of the Project.

(2) Basic Policy on the Determination of Sludge Removal Equipment/Facilities and Quantities

Sludge removal equipment/facilities and quantities were determined, based on the results of the sludge amount survey in this Basic Design Study and the review on the Action Plan. The determination was also based on the following policies:

(a) Policy on the Selection of Equipment for the Project

- Equipment procured under Japan's Grant Aid shall be utilized not only for maintenance work but also for the incremental improvement of flow capacity to mitigate flood damage in the drainage zone.
- Manual labor (labor-intensive work) shall be utilized for sludge removal work and in work done using equipment and facilities.
- Equipment and facilities selected shall be at minimum from the viewpoint of high work efficiency, durability and operability.
- Equipment and facilities shall be selected not only for Drainage Zones C and H but also for the other zones.
- The original schedule prepared for the Action Plan is for one (1) year construction work only. Concerning the construction term for sludge removal work, multi-year work is recommendable in consideration of project feasibility.

(b) Policy on the Selection of Equipment for Grant Aid

Based on the result of the study on equipment and quantities for sludge removal work in the Project, equipment and quantities to be procured through Japan's Grant Aid shall be determined, as follows:

- GOJ advocates, as much as possible, the importance of self-help effort by DWASA to sustain the effectiveness of Japan's Grant Aid. Consequently, equipment/facilities procured under the Japan's Grant Aid shall be limited to equipment not commonly used.
- The number of equipment and facilities procured under Japan's Grant Aid should be commensurate with the number of personnel and management ability of the Drainage Circle as the implementation organization.
- The number of equipment and facilities procured under Japan's Grant Aid should be commensurate with the capacity to secure parking spaces with garage without excessive burden on the Drainage Circle.
- The number of equipment and facilities procured under Japan's Grant Aid should be absolutely commensurate with the allowable budget for operation and maintenance of the Project.

(3) Policy on Natural Conditions regarding the Procurement of Sludge Removal Equipment

(a) Climatic Condition

Climate of the project area is classified as the tropical monsoon type, characterized by three seasons: monsoon, post-monsoon and pre-monsoon. The monsoon season is normally from May to October. During the monsoon season, 90% of the annual rainfall occurs (approx. 2,000mm).

Under such climatic conditions, the sludge removal work shall be executed mainly during the dry season (November to April), in principle, because it would be counterproductive to execute the sludge removal work during the rainy season.

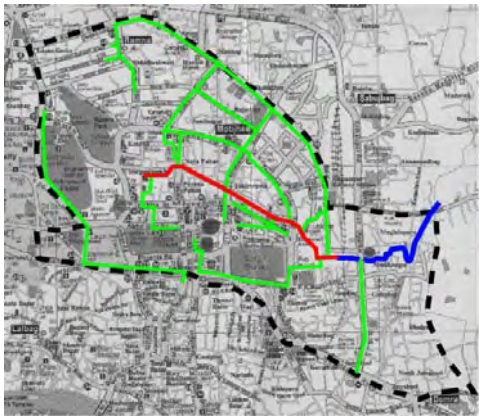
(b) Condition of Sludge Sedimentation in Drainage Channels, Box Culverts and Drainage Pipes

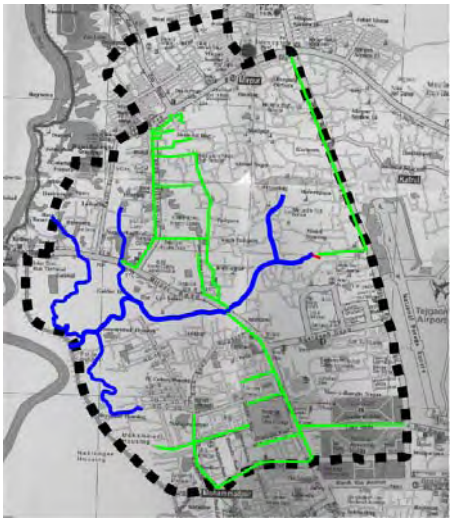
As understood from the results of the sludge sedimentation survey, a massive amount of sludge had accumulated in target facilities, as shown in Table 2.4. The sludge had decreased the flow capacity of channels, box culverts and drainage pipes, and had induced stagnant floodwaters in low-lying residential areas. The results of

the sludge sedimentation survey were one of the reference data for evaluation of the Action Plan and the determination of sludge removal procedure.

Table 2.4 Accumulated Sludge Survey Results at Drainage Facilities

Rainwater Drainage Facility	Flow Area	Length (km)	All Inner Volume (m^3)	Accum. Sewage (m^3)	Remaining Inner Volume (m^3)	Inhibition Rate of Flow (%)
Zone C (Open Channel)	$10m^2$~ $100m^2$	1.7	47,500	18,500	29,000	(18,500/47,500) x 100 = 38.9
Zone C (Culvert)	B4.0mxH3.0m ~ B6.0mxH4.0m	3.0	47,800	36,400	11400	(36,400/47,800) x 100 = 76.2
Zone C (Drainage Pipe)	ϕ450mm ~ ϕ1850mm	60.0	47,400	14,300	33,100	(14,300/47,000) x 100 = 30.4
Zone H (Open Channel)	$10m^2$~ $50m^2$	1.7	44,500	15,700	28,800	(15,700/44,500) x 100 = 35.3
Zone H (Rainwater Conduit)	ϕ450mm ~ ϕ2600mm	60.0	46,600	7,100	39,500	(7,100/46,600) x 100 = 15.2





Drainage Zone-C | Drainage Zone-H

Fig. 2.3 Main Drainage Network in the Objective Area

(4) Policy on Socioeconomic Conditions

Right-hand drive equipment and facilities shall be procured for the Project in accordance with the transportation system in Bangladesh.

(5) Policy on Procurement and Transportation Plan

As explained above regarding the sludge volume in drainage facilities, the volumes are quite enormous. Therefore, high performance equipment is required due to the massive amount of sludge and sediment, as requested by the Bangladeshi side. The equipment and facilities to be procured may have their origin in Japan or in other third countries such as India and the European countries, because such equipment and facilities are not produced in Bangladesh. The selection of equipment and facilities shall take into consideration not only cost and quality but also their usefulness and the satisfaction of the recipient. Japanese or third country products are to be delivered by ship to the Chittagong Port.

(6) Management/Maintenance Ability of Implementing Agency

The Drainage Circle owns some equipment and facilities for sludge removal work. They are being maintained at the narrow parking space of the Drainage Circle and mainly utilized for the cleaning of drainage pipes in Dhaka City. For the sludge removal work in open channels and box culverts, the Drainage Circle performs its task by outsourcing. Drainage Circle-owned equipment and facilities are as listed in Table 2.5.

Table 2.5 Drainage Circle-Owned Equipment and Facilities

No.	Name	Donor	Year	Specification	Qty.	Status
1	Sludge Removal Vacuum Loader	ADB	1998		1	Good
2	High Water Pressure Jetting Machine	ADB	1998		1	Good
3	Engine Pump	ADB	1998	Q=1.7m^3/s; 5.1m^3/s	9	Trouble
4	Dump Truck	JICA	1992	Loading capacity: 4t	1	Good
5	Dump Truck w/Crane	JICA	1992	Loading capacity: 3.5t, Crane: 7.2t	1	Good
6	Pick-up Car	GOB	2005		2	Good
7	Cleaning Equipment	JICA	1992	Sludge Sucker (DA-1)	5	Good
8				Sludge Sucker (DA-2)	5	Good

Under the present situation, securing parking spaces for new equipment and facilities should be considered for project implementation. In this connection, DWASA operates a workshop for DWASA-owned equipment, facilities and vehicles at Mirpur and, in addition, it proposes a new parking space at the Lalmatia Office or the Pagla Stockyard. The implementation plan was thus formulated based on these conditions.

		
Lalmatia Office	Pagla Stockyard	Mirpur Workshop

Photo 2.2 Present Management Status of Sludge Removal Equipment

(7) Policy on Environmental and Social Considerations

According to the results of the IEE conducted by DWASA and the site reconnaissance by a member of the Project Team, the possible adverse impacts, which might be necessary for considering any mitigation measure, are: i) noise produced by backhoe, vacuum loader, and other equipment; ii) traffic congestion, noise, and dust caused by the movement of work vehicles; iii) wastes by leaving or hauling of dredged sludge; and iv) water contamination by discharged fuel and the washing of construction equipment.

However, all of the possible adverse impacts are not significant. Therefore, it was confirmed that no Environment Impact Assessment is necessary for the Project. In this connection, Department of Environment (DOE) issued the Environmental Clearance Certificate (ECC) on 31 August 2006.

For the selection of equipment, the review of the Action Plan and the preparation of the work plan for sludge removal work, DWASA shall conduct the following mitigation measures and monitoring activities based on the recommendation in the IEE report and the terms and conditions of the ECC:

Mitigation Measures

- Construction work with equipment that emits excessive noise shall not be conducted during nighttime.
- Traffic control shall be implemented to avoid traffic congestion by work vehicles at the surrounding narrow roads.
- Wastes by excavated soil shall be disposed appropriately at designated locations.
- Wastewater (e.g., human waste from labor camps, fuel and wash-water from equipment/materials) shall be disposed appropriately.

Monitoring

- Necessary arrangements shall be made to monitor possible traffic congestion and drainage congestion related to the project construction activities.

- Disposal of excavated soil and construction wastes shall be carefully monitored to ensure that no adverse impact is produced.

In addition, it is a basic concept that the DWASA shall properly conduct the above measures and the monitoring work.

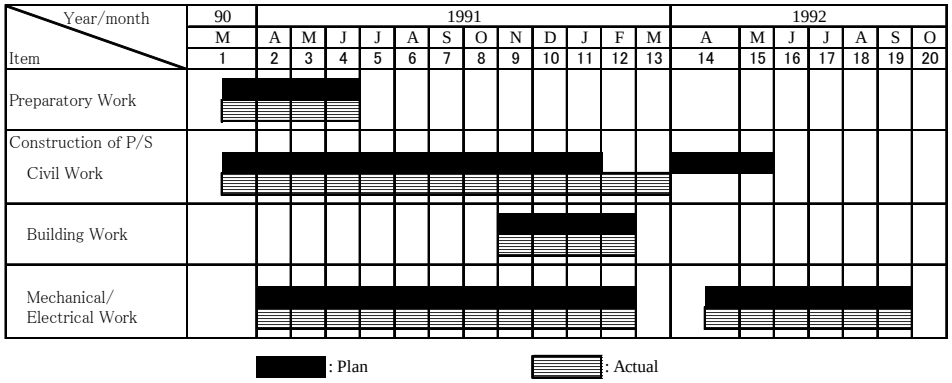
2.2.1.3 Policy on Construction Schedule

(1) Policy on Construction Period

The Japan's Grant Aid Project shall be divided into two (2) major items. One of these items is the construction/expansion of the pumping station and the other one is the procurement of equipment for sludge removal work. In these two major items, the construction work will control the grant aid schedule due to the long construction period.

The construction schedule of the existing Kallyanpur Pumping Station, which was constructed in 1990-1992 under the previous Japan's Grant Aid, is as shown in Table 2.6.

Table 2.6 Construction Schedule of Phase I Project



Since the construction schedule of the new pumping station is based on the above circumstances, a similar procedure and period considering climatic conditions, work volume and work contents shall be adopted.

(2) Points to Remember about Natural Conditions

The monsoon season in Bangladesh, as described in Subsection 2.1.2, has been considered in the construction schedule, as follows:

- The new pumping station will be constructed mainly during the dry season (November to April), in principle, because it is counterproductive to construct the pumping station during the rainy season.
- Finishing works of the building shall be executed in the dry season.

- In the monsoon season, the existing pumping station shall be operated to drain the rainwater. Hence, the new pumping station should be constructed taking operation of the existing pumping station into consideration.
- Underground structures such as water intake, surge tank and box culvert shall be constructed in the dry season.

(3) Points to Remember regarding the Installation of Pump and Accessories

The following shall be taken into account in the pump installation work:

- It will take eight (8) months from the production of pumps up to their arrival at the Chittagong Port, and three (3) months for the installation work.
- The installation of pumps will overlap with the building work. Accordingly, it is necessary to consider the proper arrangement of the schedule for installation work.

(4) Points to Remember regarding the Implementation of the Project in Bangladesh

The new development project proposal (DPP) procedure prepared on 27 March 2005 may be effective for the implementation of projects in Bangladesh. For this Project, prompt approval through proper channels is therefore required. Hence, it is essential and recommendable that the DPP should be approved not later than October 2006 in order to proceed continuously with the implementation of the Project without any interruption.

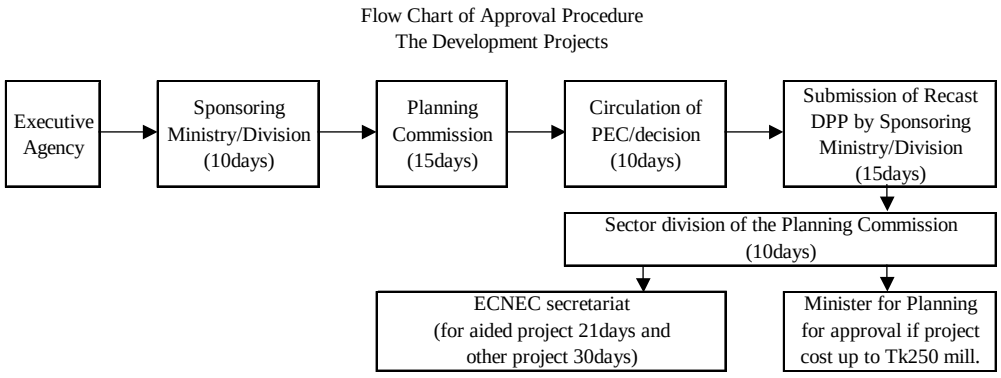


Fig. 2.4 DPP Procedure

(5) Procedure on Grant Aid Projects and Budgetary Execution

The outline of the Japan's Grant Aid for the Project has been explained to the Bangladesh side and it is necessary for them to start the preparation of the DPP immediately. The Exchange of Notes (E/N) on the Japan's Grant Aid is to be executed in two occasions, i.e., the execution of the first E/N should be concluded in November 2006 for the Detailed Design Engineering Services, and the second E/N should be concluded in May 2007 for the construction and procurement work as well as the bidding for the Project. (See Table. 2.35, Implementation Schedule.)

2.2.2 Basic Plan

2.2.2.1 Basic Plan on the Expansion of Kallyanpur Pumping Station

(1) Review (Update) of the Drainage Plan

(a) Design Rainfall and Hyetograph

The updating of 1-day and 2-day rainfalls at the Dhaka Rainfall Gauging Station (Dhaka Station) through probable calculation by adding rainfall data from 1986 to 2005 has not shown any significant difference between the 5-year probable 1-day rainfall (192mm) and the planned 2-day rainfall (245mm) in the current plan, as shown in Table 2.7.

Table 2.7 Updated Results of Design Rainfall in the Objective Area

Study Name	Period	5-Year Rainfall		Method
		1-day	2-days	
JICA Study	1953~1985	192	245	Gumbel
JICA FAP-8A	1953~1991	184	239	Gumbel-Chow
JICA 2006	1953~2005	181	243	Gumbel-Chow

As for the short-term hyetograph in the Master Plan, the average hyetograph of 22 rainfalls of 100mm or more in the daily rainfall at the Dhaka Rainfall Gauging Station, as shown in the figure below, was adopted.

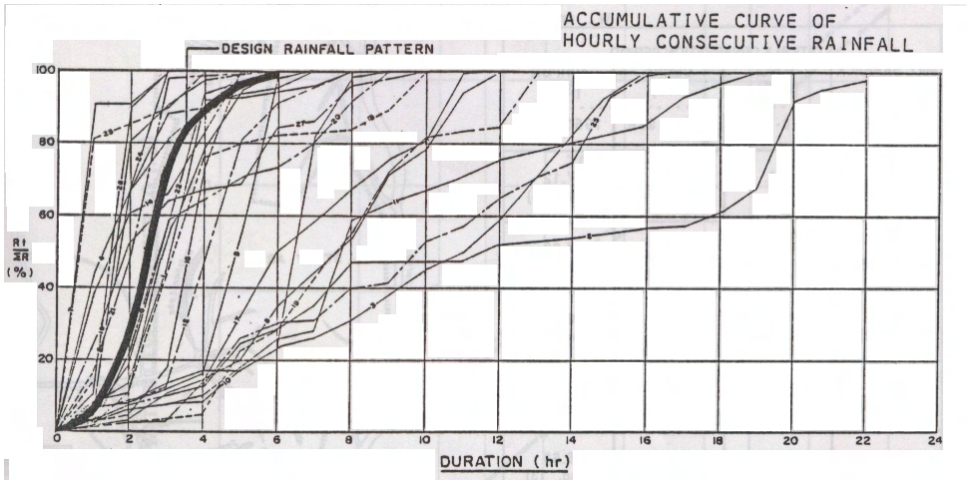
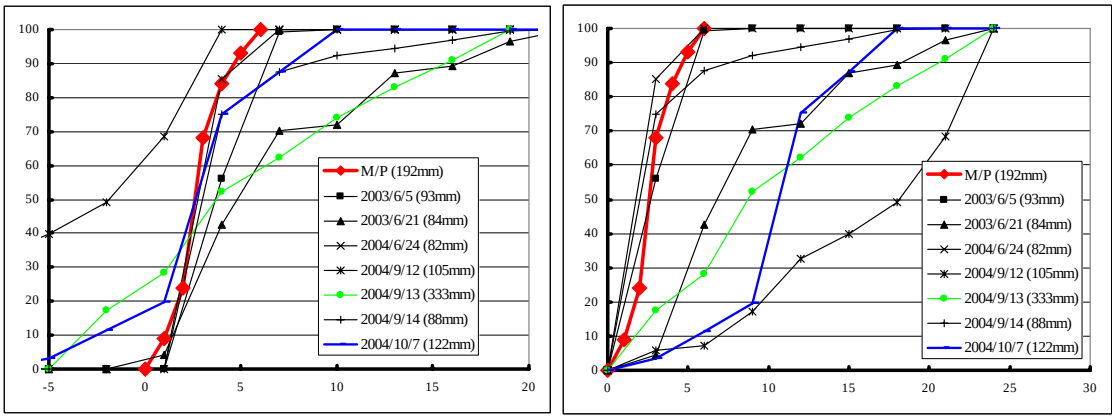


Fig. 2.5 Accumulative Curve of Hourly Consecutive Rainfall in M/P

By superimposing the defined hyetograph as mentioned above with the 3-hour rainfall of which recording started at the Dhaka Rainfall Gauging Station since 2003 (the top 8 rainfalls), the recent rainfalls were shown to have almost the same trend in terms of hyetograph, as presented in Fig. 2.6.



(Fitted with Peak Hour) (Fitted with Rainfall Term)

Fig. 2.6 Comparison of Accumulative Curve of Hourly Consecutive Rainfall

Based on the foregoing, the following point has been verified:

- The 5-year probable design rainfall and design hyetograph for formulating the pump drainage plan, as defined in the JICA Master Plan, need not be adjusted.

(b) Water Level of Turag River

The probability evaluation of water levels of the Turag River to which water is drained from the Kallyanpur Pumping Station, together with the master plan data and the data thereafter, is given in Table 2.8.

Table 2.8 Confirmation Results of Design Water Level in the Objective Area (Drainage Zone H)

Description	Year			Reference
	1988	1998	2004	
Water Level in Turag (GTS)	7.93	7.54	6.87	6.5
Probability Analysis	50	25	7~8	5-year

In relation to the water levels mentioned above, the height of the levee constructed along the Turag River in Drainage Zone H is EL+9m (in GTS), and there was no overflow against the highest high-water level as recorded in 1988. Therefore,

- The external water level for the pump drainage plan and design was defined on the basis of the table above.

Moreover, the water level curves in the initial period and the latter period of floods that affect the operational time of pumps become as in Fig. 2.7 based on the data obtained for 19 years from 1986 through 2004.

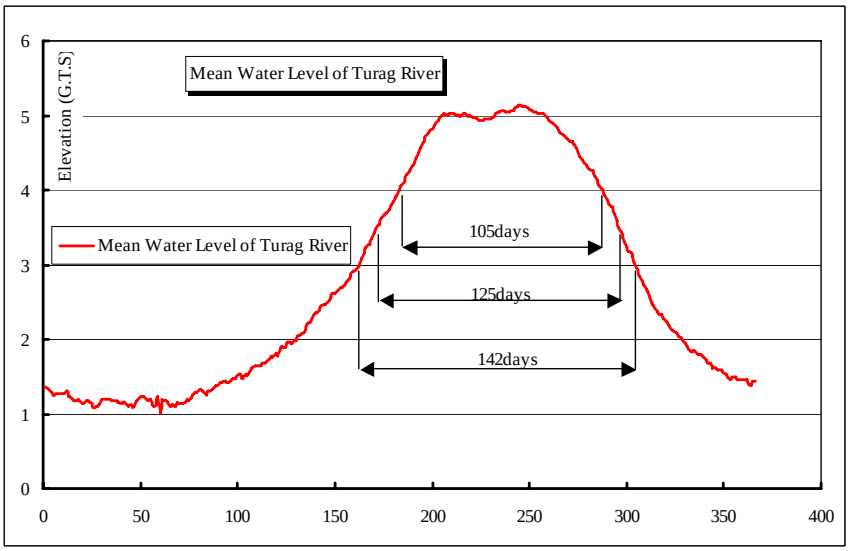


Fig. 2.7 Annual Mean Water Level of Turag River

The expected pump operation time rate for each of the water levels at the start and stop of pump operation in Fig. 2.7 above was calculated on the basis of the rainfall data. The required number of days of pump operations for each of the planned pump operation start and stop water levels is as shown in Table 2.9.

Table 2.9 Pump Operation Period Assumed by the Operation Rule

Description	Water Level in Pond (in GTS)		
	EL+3.0m	EL+3.5m	EL+4.0m
Mean start date of operation	11 Jun	20 Jun	01 Jul
Mean termination date of operation	30 Oct	22 Oct	13 Oct
Mean annual operation dates	142	125	105
Mean rainfall amount during operation	1,413	1,271	1,083
Assumed ratio of operation cost	1.30	1.17	1.00

Based on the above table, if the pump operation start and stop water levels that are now set at EL+4.0m are lowered, it is expected that power consumption will increase by about 30%, with about a 17% increase for each of the levels of EL+3.5m and EL+3.0m.

(c) Design Drainage Discharge of Pump Station

As stated in the “Design Policy”, the following three (3) alternative plans have been proposed in response to the decrease of area of the regulating pond around the pumping station to 50% of that in the master plan:

ALTERNATIVE PLAN-A: A new pumping station of $10m^3/s$ will be constructed in accordance with the request. The operation of the water levels of regulating pond shall also be designed based on the present plan (the regulating capacity is about 50% of that in the master plan).

ALTERNATIVE PLAN-B: A new pumping station of $10m^3/s$ will be constructed in accordance with the request. However, its structure shall be such that the operation of the water levels of regulating pond can be lowered (operation shall be enabled even when water suction level is further decreased by 1m). (The regulating capacity is the same as that in the master plan).

ALTERNATIVE PLAN-C: With the operation of water levels of the regulating pond remaining unchanged (the regulating capacity is 50% as that in the master plan), the shortage of regulating capacity (50% of that in the overall plan) is offset by enhancing the discharge of pumps to be added.

Concerning the above plans, the results of comprehensive comparison of construction cost, O&M cost, measures to be taken in the future, etc., are as shown in Table 2.10.

Table 2.10 Comparison Table of Design Discharge at the New Kallyanpur Pumping Station

Alternative	Alternative Plan-A	Alternative Plan-B	Alternative Plan-C
Design Concept	Capacity: $10m^3/s$; Pond Water Level: EL+4~5m	Capacity: $10m^3/s$; Pond Water Level: EL+3~5m	Capacity: $20m^3/s$; Pond Water Level: EL+4~5m
Explanation	Operation rule for regulating pond will not be changed. Pump capacity is $10m^3/s$ in accordance with original plan.	Normal water level will be lowered from 4m to 3m to sustain the regulating capacity of the Pond.	Operation rule for regulating pond will not be changed. Pump capacity is increased due to decreasing regulating pond capacity.
Construction Cost	The lowest construction cost	Second lowest construction cost	Construction cost is greatly increased.
O&M Cost	O&M cost will increase in all alternatives due to capacity increment.		
	-	Compared to Alternative Plan-A, O&M cost will increase because operation term is prolonged.	Compared to Alternative Plan-A, O&M cost will increase.
Remarks	It will be necessary to construct a third pumping station to achieve it.	Pumping Station can be constructed at original position.	Pumping Station should be widened, but there is no space in existing lot.
Evaluation	Provided that DWASA will promote and complete the preservation project of regulating pond, Alternative Plan-B is necessary without constructing an additional P/S or increasing the capacity of pump. Hence, Plan-B is recommendable.		

As shown in the evaluation column and after going through the comparison study, Alternative Plan-B is chosen as the Optimum Plan. The major reasons are as follows:

- Enhancement by means of pump only (PLAN-C) entails an additional discharge of $10m^3/s$ or more by the enhancement pump resulting in the substantial increase of construction cost and the expenses for operation, maintenance and management. DWASA does not want any pump size that exceeds the requested (planned) size.

- Although PLAN-A is the plan with the lowest investment cost, problems such as consistency with the drainage basic plan, etc., will have to be resolved.
- PLAN-B involves an additional costs of about 10% in pump equipment and materials, and about 5% in construction cost for civil works as compared with PLAN-A, but consistency with the basic plan can be maintained. (No further initial investment is necessary as envisioned in the master plan.)
- With PLAN-B, operation is possible by lowering the start and stop water levels of the regulating pond by 1m. If such operation is put into practice, it follows that after the river water level has reached EL+3.5~4.0m, the gate is closed and pumps are operated to lower the water levels within the regulating pond to EL+3.0m. Consequently, if the pump operation start and stop water levels are set at EL+3.50m, the annual average operation cost will increase by 17% as compared to the case in which the levels are set at EL+4.0m. This cost increase is within the range that does not give trouble to DWASA in the management of pump operation.
- Since the improvement of drainage channels and pipes within the drainage districts are presently insufficient, and also owing to the situation that there are still vacant lands at low altitudes with retarding capacity sporadically located upstream, under the present circumstances the water levels of regulating reservoirs have not risen sharply, as described in the plan. However, such adjustment of retarding capacity in Drainage Zone H is decreasing year after year, and there has been a change in the situation that rainwater now flows immediately into the regulating pond. The construction of a pumping station in Plan-B enables the control water level to be lowered from EL+3.85m, which is the pump operation start and stop water level set by DWASA at present, down to EL+3.0m. This operation rule shall be put into practice after having confirmed the situation of actual pump operation and the water levels of the regulating pond.

(2) Basic Plan of Facilities

(a) Basic Structure and Layout of New Pumping Station

Since the pumping station to be added will be constructed at the northern side adjoining the existing pumping station, the following three (3) alternative plans were chosen with regard to the basic layout and structure of the new and existing pumping stations. Comparison study has been made in terms of construction performance, economic performance and influence on the management building.

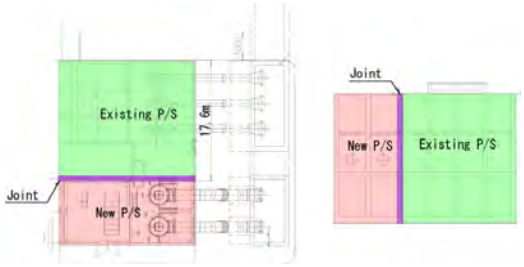
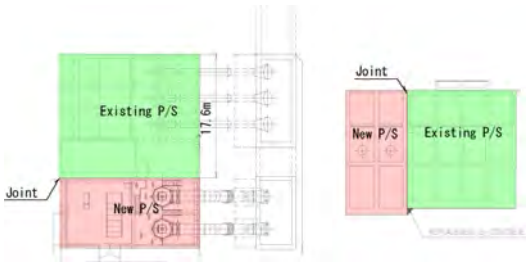
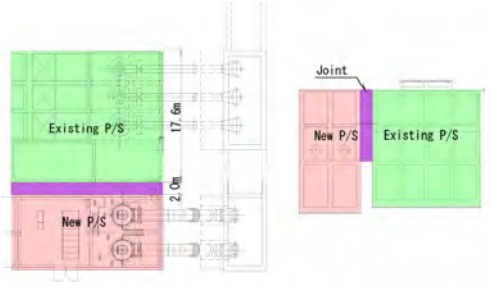
PLAN-SA: The existing and the new pumping station will have a unified structure. The intake structure and building of the new pumping station will be constructed using the sidewalls and columns of the existing pumping station toward the side of the additional pump yard.

PLAN-SB: It is of the existing/new pumping station independent structure type (Type 1), in which the new pumping station will be constructed as a new, independent structure adjoining the existing pump yard.

PLAN-SC: It is of the existing/new pumping station independent structure type (Type 2), in which the new pumping station will be constructed as a new independent structure 2.0m away from the north side of the existing pump yard.

As shown in Table 2.11, PLAN-SC is adopted as the OPTIMUM PLAN, although economic performance is slightly inferior, due to its cut-off performance at the time of construction, high stability in the existing pumping station, and its ability to cope with uneven displacements between the existing and the new pumping station after its completion.

Table 2.11 Dimensions of Kallyanpur Pumping Station

Alternative	Plan-SA	Plan-SB	Plan-SC
Conceptual Figure			
Workability	It is difficult to construct a new pumping station (P/S) when inflow to the site could not be stopped during construction.	It is difficult to construct a new P/S when inflow to the site could not be stopped during construction.	Temporary works (steel sheet piling) can be installed to stop inflow water during construction. Safe construction can be executed.
Economical Aspect	With no temporary works considered, the construction plan is the most economical.	With no temporary works considered, the construction plan is the second most economical. (Concrete volume increases to 120m^3, while excavation volume increases to 130m^3.	Compared to Plan-SA, concrete volume increases to 150m^3 and excavation volume increases to 500m^3.
Relation to Administration Building	The distance from the administration office to the construction site is the farthest (5m).	The distance from the administration office to the construction site is less than Plan-SA (4m).	The distance from the administration office to the construction site is also less than Plan-SA.
Integrated Evaluation	The order of construction cost is SC > SB > SA, although there is not much difference. It is supposed that there are spaces between the bottom slab of the existing pumping station and the soil surface due to soil consolidation for 13 years. This condition may cause heavy flooding in the site during construction, so that temporary works (steel sheet piling) are required. In this connection, Plan-SC is adopted for the design of the new pumping station.		

(b) Design Parameters and Dimensions of Pump Station

In proceeding with the facility plan of the new pumping station and the modification plan of the existing Kallyanpur Pumping Station (civil engineering, architecture, machinery, and electrical equipment), design parameters were planned, as shown in Table 2.12.

Table 2.12 Design Parameters of Kallyanpur Pumping Station

Item	Dimensions		Remarks
Common Criteria			
Pump Type	Vertical Axial Flow Pump		
Elevation of Lot	EL+6.35		
Elevation of P/S	EL+6.50		
H.H.W.L. (Riverside)	EL+8.35		Maximum recorded
Drainage Plan	2 days consecutive rainfall with 5-year frequency		In accordance with the Master Plan (M/P)
Design Criteria for New Pumping Station			
Diameter of Pump	1,500mm		
No. of Pumps	2 pumps		
Type of Intake Structure	Opened Tank with turbulent prevention concrete		
Drainage Capacity	$5m^3/s \times 2 = 10m^3/s$		
Water Level	Intake Side	Outlet Side	
H.W.L.	EL+5.00	EL+6.50	
L.W.L.	EL+3.00	EL+3.00	
L.L.W.L.	EL+2.50		
Criteria for Existing Pumping Station			
Diameter of Pump	1,200mm		
No. of Pumps	3 pumps		
Type of Intake Structure	Existing (Opened Type) will be improved by Opened Tank with turbulent prevention to lower the intake water level		
Drainage Capacity	$3.3m^3/s \times 3 = 9.9m^3/s$		
H.W.L.	EL+5.00	EL+6.00	
L.W.L.	EL+3.50	EL+4.00	Lower by 50cm
L.L.W.L.	EL+3.00		

(3) Plan of Civil Design

(a) Planning and Design Criteria

Plane views, cross-sectional views and the structures (dimensions, thickness, depth, width and length) of the intake structure, discharge water surge tank and pumps, which are the civil engineering facilities of the pumping station, were planned in accordance with the criteria as specified in Table 2.13.

Table 2.13 Design Criteria

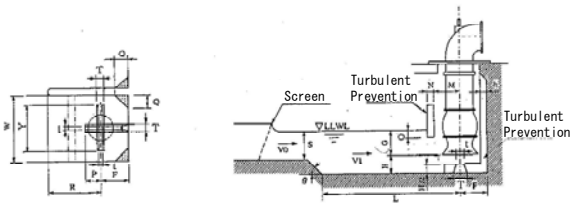
Item	Standard / Criteria
Design for Planning	Manual for Technique and Design of Pump Equipment and Facilities in Japan
Design for Structure	Bangladesh Building Code 1993; Manual for River Works in Japan; Specifications for Highway Bridges, Road Association of Japan; Design Handbook for Pile Foundation

(b) Dimensions of Structure, Section and Plan

The shape of the intake structure in the pumping station can be determined automatically from the above criteria, if the design overall drainage (pump type, diameter, number of units), the aforesaid hydraulic conditions and the type of the intake structure have already been determined. Since the new pumping station will use discharge sluices in common with the existing pumping station, the shapes were designed to match the existing ones. The shapes are as arranged Table 2.14.

Table 2.14 Shape of Intake Structure

Discharge	W	F	H	F	M	N	O	h	L	S
4.25~5.42 (m^3/s)	4,000	1,650	1,100	More than 2,250	1,500	450	450	350	4,500	2,700



Also, although the existing intake structure is of the open type construction with the lowest suction water level of EL+4.0m in the water level of the regulating pond, if simple ebb current prevention plates are installed, it will be possible to set the lowest water level at EL+3.5m. Therefore, as stated in the above item (a), the existing pump facilities shall also be equipped with ebb current prevention plates, thereby improving them into facilities where drainage can be done at the water level of EL+3.5m.

(4) Plan for Architectural Design

(a) Layout Plan

The building of the new pumping station is to be constructed in the lot of the existing Kallyanpur Pumping Station. It shall be built in the upper part of the intake structure and planned as a unit with the existing building structure for the efficient operation of both pumping facilities. Therefore, in the existing pumping station, the brick wall adjoining the additional pumping station, which will not affect structural performance, shall be demolished. The height of the building of the new

pumping station will be about 12m, which is as high as the elevation of the existing building, because the new pumping station will share the girder crane with the existing one.

(b) Floor and Section Plan

The plane plan of the existing pumping station and the first floor portion of the building involved in the installation of the pump main bodies and the screen of the intake structure shall be carefully considered.

The first floor of the building will have an area of 114m^2 for the pump room while the second floor will be 116m^2 for electrical room, or 220m^2 in total for efficient operation. To fit it with the existing pumping station and taking economic performance into account, the first floor structure of the screen area shall be of the semi-outdoor pilotis-type (115m^2). Personnel movement between the pump room on the first floor and the electrical room on the second floor as well as operational performance shall also be considered. The role of each floor shall be clearly defined to minimize useless circulation lines.

(c) Finishing Plan

To provide a sense of unity with the existing pumping station, the finishing plan shall also be devised according to the design of the existing pumping station.

Finish on major structures shall be as follows:

Outer Wall: Mortar applied by using a trowel and sprayed with tile finish.

Window: Aluminum-made sliding sashes with overlapping stiles

Entrance Hall Fixture: Aluminum screen

Roof: Waterproofed with asphalt

Interior Finish: (Floor) Lightweight concrete; (Wall) Mortar with emulsion paint applied by using a metal trowel; (Ceiling) Exposed concrete finish with emulsion paint applied for repairing.

(d) Structural Plan

The same criteria as those for civil engineering facilities shall be adopted.

(e) Facilities Plan of Building

<u>Power Supply Equipment</u>

In the building equipment as well, the existing supply equipment shall be utilized based on the following descriptions, which were determined in the pump equipment policy: (i) the power receiving voltage shall not be upgraded to 33KV, but 11KV shall be used; and, (ii) the electrical control panel shall be installed on the second floor in the same manner as in the existing pumping station.

Power Outlet Equipment

Power outlets shall be provided in necessary places as power supply for small electrical appliances, etc.

Lighting Equipment

Light sources for lighting apparatus to be installed in the operation room shall be fluorescent lamp apparatus of the embedded type, as a general rule. Although natural lighting shall be considered for the pump room, mercury lamps shall be installed thereat, since the room will be of the well-hole structure up to the second floor and for operation during the night.

Lightning Arrester Equipment

Lightning arrester equipment shall be provided on the rooftop for preventing lightning hazard.

Water Supply, Drainage and Hygienic Equipment Plan

These shall not be installed in this project, since such equipment is included in the equipment of the former project. However, since the existing water supply and drainage pipes are buried in the site of the new pumping station, the extension of piping materials and disposition of buried pipes will be required.

(5) Mechanical Equipment Plan

Mechanical equipment in the additional pumping station shall consist of pump, motors, and other auxiliary machinery, installed in the additional pump room to be provided adjoining the existing pump room.

(a) Pumping Equipment

Concerning the type of additional pumps, comparison studies have been carried out among the three (3) types (vertical axial-flow pump, horizontal axial-flow pump, and submerged pump) that can be used in the entire pump head (4.9m). The vertical axial-flow pump is selected, as in the JICA master plan study, since it has a relatively simple pump equipment, good and economical performance, and, besides, this is the type installed in the existing pumping station on which DWASA has experience in operation, maintenance and management.

The number of new pumps shall be 2, or 5 in total including the existing pumps, considering the diffusion of risks in case of malfunction. Therefore, it is determined that pump drainage capacity shall be $5m^3/s$ per unit, and the diameter shall be ϕ1500mm. Pump equipment shall include, aside from the pump main body, 2 units each of discharge valves, flap valves for preventing reverse flow, and piping materials (roof flanges and flexible expansion joints).

(b) Electric Motor

Squirrel cage induction motor shall be used. This type of motor is used in the existing pump equipment, without any trouble for 13 years, on which the DWASA operators are used to operate, maintain and manage.

(c) Ceiling Crane

Regarding the ceiling crane required for the maintenance, inspection and servicing of pump equipment, the ceiling crane installed in the former project shall be utilized, considering cost reduction. As planned, only the rail for running the crane at the additional pumping station will be installed.

(d) Screen Equipment, Stop Log, and Chain Block

In the same manner as in the existing pumping station, 2 units of manual steel screens shall be installed as dust removing equipment. In addition, 2 sliding timbers (stop logs) to be used at the time of repair work inside the intake structure shall be installed, and a lift (manual chain block), which will be used when removing deposits, shall be provided.

(e) Pump Inspection Platform

This platform shall be made of steel deck and steel stairs for use during inspection of pumps and electric motors and for entering the electrical room on the second floor. It shall be manufactured of channel steel, angle steel, checkered steel plates, etc., and connected with the pump floor on the first floor by steel stairs.

(f) Spare Parts

Spare parts for the mechanical equipment of the additional pumps shall include replacement parts (underwater bearings, sleeves, boost meters, motor bearings) and consumable parts (packing and gaskets, lubricating grease). Their quantities shall be the minimum required as planned.

The annual average operating hours in the existing Kallyanpur Pumping Station is about 1000 hours per year, which is about 3~4 times those in Japan. Therefore, replacement parts of pump machinery wear greatly. Since most of the spare parts supplied in the Phase I Project have been almost used up, a request for additional spare parts shall be made for the proposed Project.

Basically, spare parts shall be obtained by self-help effort as a general rule, but as a result of studies, it is planned that the minimum quantities shall be supplied by limiting the kind of common spare parts for new pumps to the replacement parts that are difficult to obtain locally (underwater bearings and sleeves) as standard spare part kits. On the other hand, DWASA had in the field survey stage requested, additionally, spare parts for the existing pumps. After the detailed studies and considerations, it was planned to purchase the spare parts for the existing pumps

through self-help effort, and it was decided to delete such spare parts from the additional equipment and materials to be supplied under Japan's Grant Aid for the following reasons:

- Spare parts for the existing pumps had already been procured in the former project undertaken by GOJ in 1993.
- Basically, spare parts shall be procured by a recipient country through self-help efforts as the GOJ's policy for the sustainable development of recipient counties.
- It is possible to purchase spare parts for the existing pumps by contacting the Japanese manufacturer/supplier in the former project or by contacting the manufacturer/supplier of the new pumps in the Project.

Table 2.15 List of Mechanical Equipment and Spare Parts

Item No.	Description	Specifications and Quantities	Spare Parts/ Consumables
P-1	Pump	Type: Vertical axial-flow pump; Dia.: 1500mm, 300m^3/min x 4.9m x 295rpm x 400kW; Eff.: more than 83%; Quantity: 2	Underwater bearing, sleeve, boost meters, packing, gasket, grease
P-2	Motor	Type: Squirrel cage induction motors, 400kW x 20P x 3P3W3.3kV x 50Hz; Motor efficiency: more than 90%; Motor factor: more than 58%; Quantity: 2	Bearing
P-3	Discharge Valve	Type: Manual butterfly valve; Dia.: 1500mm; Allowable inner pressure: more than 0.2Mpa (2kgf/cm^2); Quantity: 2	
P-4	Flap Valve	Type: Swing type, 2 pieces; Dia.: 1800mm; Allowable inner pressure: more than 0.2Mpa (2kgf/cm^2); Quantity: 2	
P-5	Pipe	Dia.: 1500mm+1800mm; Allowable inner pressure: more than 0.2Mpa (2kgf/cm^2); Material: JIS SS400 or equivalent; Quantity: 2	
P-14	Screen	Type: Manual; Spacing: 60mm; Dimensions: B4000mm x H7000mm; Material: JIS SS400 or equivalent; Quantity: 1 Lump sum	
P-15	Pump Inspection Platform	Type: Steel platform with checkered plate; Dim: BxWxH=3.95x10x4.4m; Material: JIS SS400 or equivalent; Weight: 6.35tons; Quantity: 1 Lump sum	
P-16	Railing for Crane	Type: Base with Railing; Base: H-beam H350mm x W350mm; Railing: 30kg, Length: 12m x 2sides; Quantity: 1 Lump sum	
P-17	Stop Log	Type: Steel Slide Gate; Dimensions: W4000mm x H1000mm, width: 4000mm x Hoist:7000mm, Chain hoist: Manual type 2.5ton; Railing: I-beam H250mm x W125mm x L9.3m x 1; Quantity: 1 Lump sum	

(6) Electrical Equipment Plan

Among the electrical equipment at the existing pumping station constructed in the former project, the power receiving panel of 11kV, LA panel, YCB panel, and feeder panel equipment were installed taking into account the necessary electrical equipment for the additional pumping station now being considered. Therefore, it is planned that the following electrical equipment shall be laid out, in addition to the aforesaid equipment, in the additional electrical room of the additional pumping station, which will be built adjacent to the existing electrical room.

(a) 11/3.3kV Electric Transformer Panel

This is an electrical equipment to step down the alternating current, 3-phase, 3-wire, 11kV that is drawn from the existing feeder panel to 3.3kV, and is an indoor, self-supporting, and closed power distribution panel with a rated capacity of 1500kVA.

(b) 3.3kV Power Receiving Panel

This is an electrical equipment to receive and distribute the alternating current, 3-phase, 3-wire, 3.3kV, that has been stepped down to 3.3kV, and is an indoor, self-supporting and closed power distribution panel consisting of a circuit breaker, a current transformer, a power transformer, etc.

(c) Main Pump Panel

This is an electrical equipment to run, stop, and protect the 400kVA main pump electric motor (motor), consisting of a high voltage vacuum contactor, a circuit breaker, a current transformer, a power transformer, etc.

(d) Condenser (Capacitor) Panel

This is an electrical equipment to improve the power factor of the 400kVA main pump electric motor (motor), consisting of a capacitor, a series reactor, a terminal box, etc.

(e) Low-Voltage Panel

This is an electrical equipment for running and stopping pump auxiliary equipment, and is an indoor, self-supporting and closed power distribution panel consisting of a circuit breaker, a current transformer, a power transformer, a relay, etc.

(f) Battery and Battery Charger Panel

This is an electrical equipment for running and stopping pump auxiliary equipment, and is an indoor, self-supporting and closed power distribution panel consisting of a circuit breaker, a relay, a charger, etc.

(g) Pump Control Panel (Site Panel)

This is a local panel for running and stopping the main pump, and is an indoor, wall-hung and closed power distribution panel consisting of various types of switches, a terminal block, indication lamps, etc.

(h) Water Level Gauge

This is the equipment intended to measure the internal water level (at the point of inflow to the existing pumping station) and the river water level (at the point of discharge outlet of the existing sluice), which will be the fundamental data for determining the running and stopping of the main pump. Since the pressure type water gauge that was installed in the former project and used for about 13 years no longer function because it has reached the end of its service life, it is planned to replace it with a new one in the Project.

(i) Spare Parts

In the same manner as in the procurement of spare parts for mechanical equipment, it is planned that, of the necessary replacement parts for the electrical equipment of the additional pumps (fuses and indication lamps), the minimum required spare parts is to be supplied. The spare parts for the electrical equipment of the existing pump, on which an additional application for procurement has been made, are available locally so that these spare parts should be purchased through self-help effort and, therefore, it was decided to delete such spare parts from the additional equipment and materials to be supplied under grant aid.

Table 2.16 List of Electrical Equipment

Item No.	Name	Specifications and Quantities	Spare Parts/ Consumables
P-6	11/3.3kV Electric Transformer Panel	W2600xH2350xD2600 (mm), 3000(kg), 3P3L, AC11kV 50Hz, 230V, Qty: 1	Indication lamps
P-7	3.3kV Power Receiving Panel	W800xH2350xD2000 (mm) 600(kg), 3P3L, AC3.3kV, 50Hz, 230V, DC110V, Qty: 1	Fuses, Indication lamps
P-8	Main Pump Panel	W800xh2350xd2000 (mm), 800(kg), 3P3C, AC3.3kV, 50Hz, Motor: 3.3kV, 400kW, 230V, DC110V, Qty: 2	Fuses, Indication lamps
P-9	Condenser (Capacitor) Panel	W800xH2350xD2000 (mm), 500(kg), 3P3C AC3.3kV, 50Hz, 230V, Qty: 2	Indication lamps
P-10	Low-Voltage Panel	W700xH2350xD500 (mm), 300(kg), 3P4C, AC400/230V, 50Hz, 230V; Qty: 1	Fuses, Indication lamps
P-11	Battery and Battery Charger Panel	W600xH1950xD800 (mm), 600(kg), 3PL, AC400V, 50Hz, 110V, SID10A, Qty: 1	Fuses, Indication lamps
P-12	Site Panel	W500xH600xD300 (mm), 80(kg), 230V; Qty: 1	Indication lamps
P-13	Water Level Gauge	DC24V, 4-20mA	

2.2.2.2 Basic Plan on the Procurement of Sludge Removal Equipment and Facilities

(1) Review and Evaluation of the Action Plan prepared by DWASA

(a) Overview of the Action Plan

Necessity of Dredging Deposited Sludge

From the experience on the flood in 2004, it has been recognized that, "in recent years, the major reasons of inundation damage within the city are insufficient pump drainage capacity and the sludge that has been deposited in watercourses, closed conduits, and drainage pipes for a long period of time, which has led to a decrease in the capacity of flow, and a prompt dredging of sludge is an urgent matter for decreasing inundation damage." DWASA has been implementing the dredging and cleaning of sludge deposited in these facilities with a subsidy from the central government in the last 3 years, but due to inadequate equipment and facilities procured by the dredging service providers, work was done inefficiently by manpower, requiring a long time to recover the drainage capacity of facilities. Due to such circumstances, it is planned in this Project to procure the equipment and facilities for dredging the deposited sludge and increase the efficiency of work done by the dredging service contractors and thereby shortening the duration of work.

Method of Dredging Open Channels and Necessary Equipment and Facilities

Through the existing roads along the Segunbagicha Open Channel (Drainage Zone C), Mirpur Open Channel (Drainage Zone H), or the temporary access roads to be provided alongside the watercourses, the sludge dredged with self-running tire type hydraulic shovels (wheel-type backhoe) is proposed to be transported by sludge transportation trucks to the sludge dumpsites designated by Dhaka City (Zone C: Matuail Dumpsite; Zone H: Mirpur Dumpsite). With regard to the number of units of equipment and facilities, 6 backhoes and 6 trucks for transporting sludge are required as proposed based on the defined conditions, namely; the quantity of sludge to be dredged (60,350m^3), the dredging and transporting capacity of equipment and facilities (80m^3/day), and the period for dredging work (4 months during the dry season).

Method of Dredging Sludge in Box Culverts and Necessary Equipment and Facilities

In the dredging of sludge deposited in the closed conduit section (3.0km) in the upper reaches of the Segunbagicha Channel in Zone C, the conventional technique shall be employed. The concrete manhole lid will be removed by using a sludge transportation car with crane, and workers will get into the culvert to put sludge into buckets (dredging by manual excavation) and take them out through the manhole. Then, after the sludge has dehydrated and dried at the roadside, it will be transported to the Matuail Dumpsite using the sludge transportation car with crane. With

regard to the number of units of equipment and facilities, 2 sludge transportation trucks with crane are required as proposed based on the defined conditions, namely; the quantity of sludge to be dredged (27,000m^3), the transporting capacity of equipment and facilities (80m^3/day), and the period for dredging work (4 months during the dry season).

Method of Dredging Drainage Pipes and Necessary Equipment and Facilities

With regard to the method of dredging drainage pipes of 800mm or more in diameter, workers will get inside the pipes through the manhole to take out deposited sludge manually. Then, after the sludge has dehydrated and dried at the roadside, it will be transported and disposed at the Matuail or the Mirpur Dumpsite using the sludge transportation track with crane. In the case of rainwater pipes of less than 800mm in diameter, the dredging of deposited sludge in the drainage pipes and cleaning work shall be done by the combination of a high water pressure jetting machine and a sludge suction vacuum loader. With regard to the number of units of equipment and facilities, 3 sludge transportation trucks with crane are required as proposed based on the defined conditions, namely; the quantity of sludge to be dredged (46,975m^3), the transporting capacity of equipment and facilities (80m^3/day), and the period for dredging work (4 months during the dry season). For the dredging and washing of drainage pipes in Zone C and Zone H, it is planned that one (1) high pressure jetting machine and one (1) sludge suction vacuum loader shall be provided for each drainage district.

(b) Present Situation of the Considered Facilities

Drainage Zone C

Box Culvert Section of Segunbagicha Channel (3km)

This is a box culvert of about 3km in length with an inner cavity cross section of BxH=4x3m~6x4m through which rainwater and miscellaneous drainage flows. Its upstream end is located in the intersection point of the frontage street close to the Shiipakala Academy in Segunbagicha District, runs toward the southeast direction while crossing city planning roads such as the Shahid Syed Nazrul Islam Road, DIT Extension Road, Toyenbee Circular Road, etc., and then connects with the open channel section near the railroad at the northern side of the Internal Container Depot of the Kamalapur Railroad Station which forms the boundary. On top and along the whole length of the box culvert are asphalt paved roads of 4~6m in width, which are utilized as roads for business and daily life activities. In the top slab of the box culvert, manholes for cleaning are installed at 48 places at intervals of around 25~140m. The manholes are covered with 2 concrete slabs of 240cm x 110cm (3 slabs in some areas) placed side by side.

		
Upstream End	2+450km	Near Downstream End (nearby Railway Bridge)

Photo 2.3 Present State of the Box Culvert in Segunbagicha Channel

Open Channel Section of Segunbagicha Channel (1.7km)

The Segunbagicha Channel is an open channel of about 5.7km in length, which merges with the Begunbari Channel at the east end of Dhaka City. Its upstream end is located at the water gate provided under the Autish Dipankar Road, the connecting road to the Kamalapur Railroad Station, which gate is closed in the flood season when the flow stops due to the backwater effect associated with the rise of water level in the Begunbari Channel and the channel becomes in the filled up state.

With regard to the water catchment in the upstream closed box culvert side, a pump is installed in a temporary drainage pump station (maximum $6m^3/s$) provided at the upstream side of the water gate to drain water forcibly toward the open channel side thereby seeking to prevent inundation damage within the city. From the upstream end to the section 800m downstream, the land for the watercourse of 80ft (24.384m) in width is owned and managed by DWASA, while, the land of 50ft (15.24m) in width in the section further downstream is owned by the national government but under the management of DWASA.

		
Upstream End	Sta. 0+750km	Sta. 1+250km

Photo 2.4 Present State of the Open Channel Stretch of Segunbagicha Channel

Drainage Pipes (60km)

Drainage pipes are installed at the center or end of the road, and manholes are provided at intervals of about 20~50m. Most of the manhole lids are made of cast iron, having a structure that enables them to be opened and closed easily by manpower. In Zone C, traffic is also heavy, so that a work plan is required that will

not deteriorate traffic jams in the surrounding area in case of introducing work using machinery.

	
Steel Manhole in Zone-C	Internal State of Rainwater Conduit in Zone-C

Photo 2.5 Conditions of Drainage Pipe

Drainage Zone H

Mirpur Open Channel (1.7km)

The Mirpur watercourse is an open channel of about 4.5km that originates in the Shewrapara District and running close to the west side of the Begum Rokeya Sarani Street. With its name changed into the Kallyanpur watercourse after crossing the Mirpur Road, the channel flows through the regulating pond, then down gently toward the southwestern direction to the Kallyanpur Pumping Station, and finally drains into the Turag River. In the Action Plan of DWASA, the section of 1.7km in the upper stretch of the Mirpur Road is given the status of a section requiring dredging with top priority where a request for grant aid is necessary for the required equipment and facilities.

		
Downstream End	Sta. 0+750km	Sta. 1+480km

Photo 2.6 Present State of the Mirpur Channel

Rainwater Pipe Route (60km)

Drainage pipes are installed at the center or end of the roads like in Zone C, and manholes are provided at intervals of about 20~50m. Traffic on the roads is not so heavy as in Zone C, but there are many rickshaws and the road width is relatively small in many roads. Hence, attention has to be paid in the selection of machinery taking into account the working space and transport of machinery.

Conduit in Narrow Street

Internal State of Drainage Conduit in C-area

Photo 2.7 Conditions of Drainage Pipe in Drainage Zone H

(c) Results of Investigation on the Quantity of Deposited Sludge

Based on the results of investigation on the quantity of sludge deposit in the watercourses in Drainage Zones C and H (the Segunbagicha watercourse and the Mirpur watercourse of 1.7km each), in the box culvert (Segunbagicha watercourse: 3.0km), and in the drainage pipes (Zone C: 60km; Zone H: 60km), the quantities of sludge deposit at each facility are quite huge and has hampered flood flow, as shown in Table 2.4 and Table 2.17. The quantities of sludge deposited in the watercourses and drainage pipes are small, being 57% and 45%, respectively, of the quantities of sludge estimated in the Action Plan. However, their quantities account for 35% of flow area in Mirpur Khal and 15% of flow area in drainpipes in Drainage Zone H. Therefore, it is essential to remove the sludge deposited in the watercourses and drainage pipes urgently. On the contrary, in the box culvert of the Segunbagicha watercourse, a large quantity of sludge deposit corresponding to 135% was found. In this connection, the plan for the procurement of equipment and facilities shall be devised based on the quantity of deposited sludge confirmed by measurement.

Table 2.17 Volumes of Accumulated Sludge in the Objective Area

Drainage Facility		Zone C Volume of Sewage (m^3)		Zone H Volume of Sewage (m^3)		Total Volume of Sewage (m^3)	
		Action Plan	Result of Survey	Action Plan	Result of Survey	Action Plan	Result of Survey
Open Channel		37,400	18,454	22,950	15,678	60,350	34,132
Culvert		27,000	36,374	0	0	27,000	36,374
R.W. Conduit	ϕ450~ϕ750	3,360	14,285	3,500	7,049	6,860	21,334
	ϕ600~ϕ2600	20,340		19,775		40,115	
	Sub-Total	23,700	14,285	23,275	7,049	46,975	21,334
Total		88,100	69,113	46,225	22,727	134,325	91,840

In devising a plan for the procurement of equipment and facilities for the dredging of sludge in open channels and box culvert, consideration shall be given to the longitudinal gradient of open channels and box culverts where sludge deposits are found at present. From Fig. 2.8 and Fig. 2.9 below, it can be seen that in the Mirpur Channel sludge is deposited from downstream to upstream of almost the

same gradient as the present riverbed gradient; while, in the Segunbagicha watercourse, sludge is deposited as the effect of the high riverbed altitude in the downstream side. Therefore, the Segunbagicha open channel has longitudinal features of being susceptible to sludge deposition, and it is highly likely that sludge will be deposited soon after it has been removed.

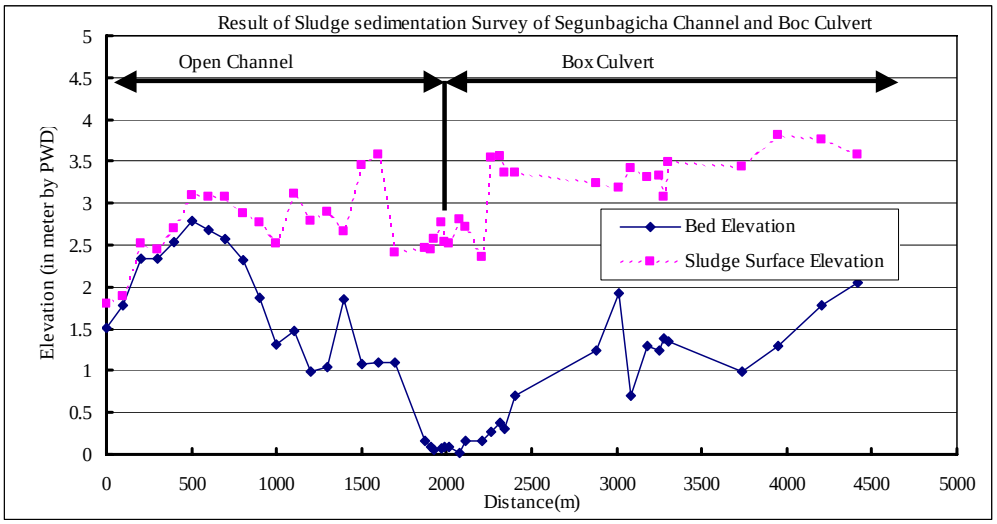


Fig. 2.8 Survey Result of Segunbagicha Box Culvert up to the Open Channel in Zone C

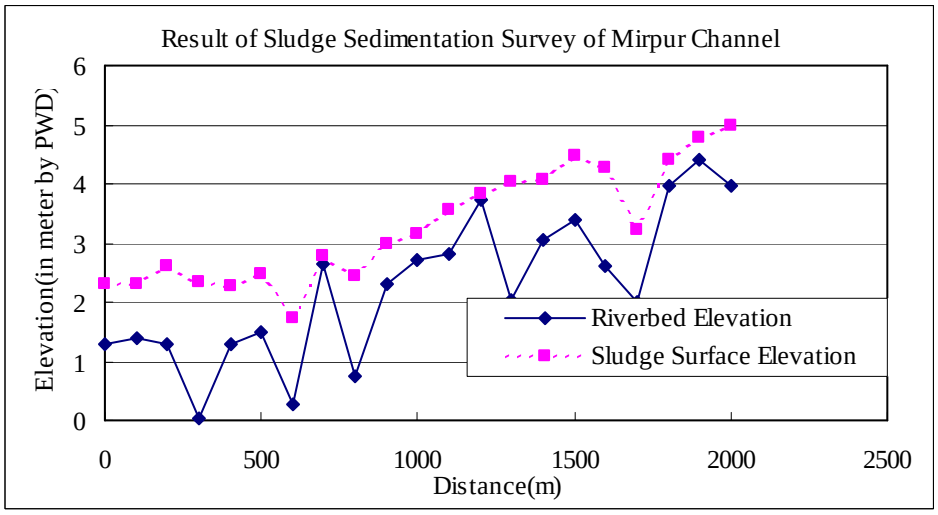


Fig. 2.9 Survey Result of Mirpur Open Channel in Zone H

(d) Selection of Equipment and Facilities for Sludge Removal and Evaluation of Quantities of Equipment and Materials

Based on the results of site reconnaissance, as well as the investigations on the quantities of deposited sludge during the site survey, the method of dredging, types and quantities of equipment and facilities, and the period of dredging proposed in the Action Plan have been evaluated and the following conclusions were reached.

Segunbagicha Open Channel (L=1.7km)

The section being considered for sludge dredging in the Segunbagicha Open Channel (L=1.7km) is located to the east of the eastern temporary levee of Dhaka City, being always subject to the influence of backwater from the Begunbari Channel located downstream during the flood season. Therefore, even if the proposed dredging work is carried out, small inundation damage abating effect in the flood period is expected. Hence, this work was not considered in the study on procurement of equipment and facilities under Japan's grant aid.

Mirpur Open Channel (L=1.7km)

The quantity of sludge that can be carried out per unit of sludge transportation truck in the Action Plan ($80m^3$/unit/day) is too large, and the plan to provide one (1) sludge transportation truck per unit of backhoe is inefficient because the dredging work by the backhoe will be stopped while the sludge is being carried out by the sludge transportation truck. Also, densely built residential houses exist at the upstream section of 560m and no space could be secured for carrying out work with heavy machinery, so that the dredging work shall be changed to manual operation.

As a result of the re-examination stated above, in the section of L=1.14km from downstream to midstream, work with machinery shall be done by providing a temporary access road alongside the watercourse, and work to carry out sludge with high efficiency can be expected by the rotation of three (3) sludge transportation trucks (of a class of $5m^3$ in loading weight) per unit of backhoe (of a class of $0.4m^3$ when loaded flat). The dredging period for the quantity of deposited sludge in this section ($12,000m^3$) is about 90 days as the number of days of actual operation.

Regarding the upstream section of L=0.56km, since houses are densely built along the watercourse, it is judged that work with machinery could not be done, and the work shall be planned to be done manually with about 100 dredging workers and 2 sludge transportation trucks (of a class of $5m^3$ in loading weight). The dredging period for the quantity of deposited sludge in this section ($3,700m^3$) is slightly less than 50 days as the number of days of actual operation. It is possible that the dredging work in the entire section (L=1.7km) will be completed in about 90 days as the number of days of actual operation. Table 2.18 shows the sludge removal plan in the Mirpur Open Channel.

Table 2.18 Sludge Removal Plan of the Mirpur Open Channel

Facilities	Estimated Sludge Volume	Removal, Loading Method	Transportation Method	Description	Sludge Removal Volume per day	Necessary Days for Removal[1)]
Mirpur Open Channel in Zone H L=1.7km	0+000km – 1+140km L=1.14km V=12,000m^3	Wheel type backhoe (bucket capacity:0.4m^3) : 1unit[7)]	Sludge transportation truck (loading capacity: 5m^3) : 3units[7)]	Excavation and loading time of backhoe[2)]: 15munites/time Transportation and unloading time of truck[3)]: 35munites/time Cycle time: 50munites/time Excavation and loading times of backhoe per day[4)]: 8hours/day / 15munites/time = 32times/day Transportation and unloading times of Truck per day: 8hours/day / 50minutes/time = 9times/day Required units of truck: 32times/day / 9times/ day = 3units	5m^3/unit x 9times/day x 3units =135m^3/day	12,000m^3 / 135m^3/day =89days
	1+140km – 1+700km L=0.56km V=3,700m^3	Worker: 100persons Loading[5)]: Wheel type backhoe (bucket capacity:0.4m^3) : 1unit[7)]	Sludge transportation truck (loading capacity: 5m^3) : 2units[7)]	Manual xcavation and loading capability [6)]: 1m^3/persons/8hours =100m^3/100persons/8hours Loading time of bucket of backhoe: 0.4m^3 / 100m^3/8hours = 2munites Loading time of truck: 5m^3/time / 0.4m^3/2munites = 25munites/time Transportation and unloading time of truck: 35munites/time Cycle time: 60munites/time Loading times of backhoe per day: 8hours/day / 25munites/time = 19times/day Transportation and unloading times of truck per day: 8hours/day / 60minutes/time = 8times/day Required units of truck: 19times/day / (8times/ day) = 2units	5m^3/unit x 8times/day x 2units =80m^3/day	3,700m^3 / 80m^3/day =47days
						Total: 136days

Note: 1) The Number of workable days shall be set as 140days between December and May (only dry season for safety) except for Friday and national holidays.

2) Loading time to Truck by Wheel Type Backhoe is calculated as below:

$Q=3,600 \times q \times f \times E/C_m = 3,600 \times 0.392 \times 1.0 \times 0.5/35 = 20$ (m^3/hr)

Where,

- Q: Volume per Hour (m^3/hr)
- q: Excavation Volume per Cycle ($q = q_0 \times K = 0.4 \times 0.98 = 0.392$m^3)
- q_0: Bucket Volume (0.4m^3)
- K: Loading Factor (0.98)
- f: Soil Conversion Factor (1.0)
- E: Working Efficiency (0.5)
- C_m: Cycle Time (180-degree turn, 35seconds)

(Loading Time) = 5/20 = 15minutes/time

3) Round trip transportation time shall be set as follows:

Transportation: 4km (one way) / 20km/hr x 2 = 25munites

Unloading: 10munites Total 35munites

4) Working time for 1day shall be set at 8 hours.

5) After completion of the works above, wheel type backhoe will be utilized for works in upstream sections.

6) Manual excavation volume for 1day shall be set at 1m^3/person/8hrs.

7) Equipment procured by the project.

Segunbagicha Box Culvert (Closed Conduit: L=3.0km)

Since sludge deposits with thickness of around 1.5~3m are found in the entire section of the box culvert, it would be dangerous for workers to enter the closed conduit directly. Also, judging from the size of the manhole lid made of concrete (2.4m x 1.1m x 2) and the depth from the surface of the road to the bottom of the box culvert (4.5~6m), it is expected that by using a backhoe of the wheel type, there will be difficulty in introducing the bucket into the manhole due to the restriction on the movable range of the boom and arm. Therefore, it shall be planned that 50% of the quantity of sludge (18,200m^3) shall be sucked up by a combination of one (1) sludge suction vacuum loader (of a 3m^3 class) and one (1) high pressure jetting machine (of a 3m^3 class), through a hose inserted into the manhole, until the thickness of the deposited sludge reaches one that is possible to work manually. Then the sludge collected will be transferred to two (2) sludge transportation trucks with crane (of a class of 5m^3 in loading weight) and transported to the Matuail Dumpsite. The dredging period required will be about 2.2 years if the work is done in the dry season from December to May in the following year. After that, the remaining quantity of sludge (50% of 18,200m^3) will be dealt with by workers entering the closed conduit to do manual dredging work (a combination of 100 dredging workers and 2 sludge transportation trucks with crane (of a class of 5m^3 in loading weight). Since the manual dredging of the remaining sludge will require 2.2 years like in the dredging by machinery, the work must be continued for a long period of 4.4 years to remove all of the sludge deposited inside the closed conduit. Table 2.19 and Table 2.20 show the sludge removal plan in the Segunbagicha Box Culvert.

Table 2.19 Sludge Removal Plan of the Segunbagicha Box Culvert (by Machine and Equipment)

Facilities	Estimated Sludge Volume	Removal, Loading Method	Transportation Method	Description	Sludge Removal Volume per day	Necessary Days and Years for Removal[1)]
Segunbagicha Box Culvert in Zone C L=3.0km	36,400m^3 x 0.5 =18,200m^3	Sludge vacuum loader (2.5m^3): 1unit[6)] High water pressure jetting machine (2.5m^3): 1unit[6)] Water tank truck (2.5m^3): 1unit[7)]	Sludge transportation truck w/crane (5m^3): 2units[6)]	Vacuum and loading time of vacuum loader[2)]: 34munites/time Transportation and unloading time of truck w/crane[3)]: 70munites/time Vacuum and loading times of vacuum loader per day[4)]: 8hours/day / 34munites/time = 14times/day Transportation and unloading times of truck w/crave per day[5)]: 8hours/day / 80minutes/time = 6times/day Required units of truck w/crane: 14times/day / 6times/day = 2units	5m^3/unit x 6times/day x 2units =60m^3/day	18,200m^3 / 60m^3/day =304days 304days / 290days/year =1.1years

Note: 1) The Number of workable days shall be set as 290days of whole year except Fridays and national holidays because equipment can work in rainy season also.

2) Vacuum and loading time of Sludge Vacuum Loader is calculated as follows:

$T = T_1 + T_2$

$T_1 = V/q \times \sigma/E = 2.5/10 \times 1.2/0.75 = 0.40(hr) = 24(min)$

Where,

T: Vacuum and Loading Time

T_1: Required Time for Tank Filling (min)
T_2: Required Time for Loading to Truck (10min)
q: Sludge Vacuum Ability (10ton/hr, hose length: 20m)
V: Tank Volume (2.5m^3)
σ: Unit Weight of Sludge (1.2ton/m^3)
E: Working Efficiency (0.75)

$T = T_1 + T_2 = 24+10 = 34$min/time

3) Round trip transportation time to Matuail disposal site shall be set as following;
Transportation: 10km (one way) / 20km/hr x 2 = 60munits
Unloading: 10munites Total 70munites
4) Working time for 1day shall be set as 8hours.
5) The time of this work will be 80munites because this work includes the loading time from sludge vacuum loader, 10munites.
6) Equipment procured by the project.
7) Equipment that has been owned by DWASA.

Table 2.20 Sludge Removal Plan of the Segunbagicha Box Culvert (Manual)

Facilities	Estimated Sludge Volume	Removal, Loading Method	Transportation Method	Description	Sludge Removal Volume per day	Necessary Days and Years for Removal[1)]
Segunbagicha Box Culvert in Zone C L=3.0km	36,400m^3 x 0.5 =18,200m^3	Worker: 120persons Excavated sludge in drum (0.1m^3) will be loaded to sludge transportation truck (5m^3) by crane.	Sludge transportation truck w/crane (5m^3): 2units[5)] Sludge transportation truck used at Zone H: 1unit[5)]	Manual excavation and loading capability[2)]: 2m^3/4persons/8hours = 60m^3/120persons/8hours Loading time of truck w/crane: 5m^3/time / 60m^3/8hours = 40munites/time Transportation and unloading time of truck w/crane[3)]: 70munites/time Cycle time: 110munites/times Loading times to truck w/crane by manpower per day: 60m^3/day / 5m^3 =12times/day Transportation times of truck w/crane per day[4)]: 8hours/day / 110munites/times = 4times/day Required units of truck w/crane: 12times/day / 4times/day = 3units	5m^3/unit x 4times/day x 3units =60m^3/day	18,200m^3 / 60m^3/day =304days 304days / 140days/year =2.2years

Note: 1) The Number of workable days shall be set as 140days between December and May (only dry season for safety) except Fridays and national holidays.
2) Excavated sludge shall be taken out by manpower. 1group shall be consisted by 4persons (for excavation and loading: 2, for taking out: 2). Daily treated volume shall be set as 2m^3/4persons/8hr. The number of daily treated manholes shall be set as 30parts.
3) Round trip transportation time to Matuail disposal site shall be set as following;
Transportation: 10km (one way) / 20km/hr x 2 = 60munites
Unloading: 10munites Total 70munites
4) Working time for 1day shall be set as 8hours.
5) Equipment procured by the project.

Dredging Equipment and Facilities for Rainwater Pipe

With regard to the dredging method on drainage pipes, a large number of workers shall be utilized as long as the safety of work permits, and regarding equipment and facilities, the sludge suction vacuum loader and high pressure jetting car (1 unit each) made in India, which are owned by the DWASA Drainage Circle, shall be involved in the work plan. The procurement plan shall be devised by only including the minimum necessary equipment and facilities as newly procured ones that will run short in carrying out the work.

Medium and Large Pipes of 800mm or More in Diameter

A work group shall be formed for each manhole, and workers (Zone C: 100 workers; Zone H: 50 workers) will get inside the pipes, gather deposited sludge toward the manhole, load sludge into buckets with water drainage holes, and lift them up manually onto the ground. On the ground, multiple half-size drums shall be prepared, and the sludge in the buckets shall be emptied into the drums. Then, the sludge shall be loaded by manually lifting the half-size drums up onto the sludge transportation truck (of a class of $5m^3$ in loading weight) (Zone C: 2 units; Zone H: 1 unit), and the sludge shall be transported to the dumpsite. Assuming that the number of days of operation per year is 140 from December to May, the dredging work will require about 2.7 years for both of the drainage districts. Table 2.21 shows the sludge removal plan in the Medium and Large Pipes of 800mm or more in diameter.

Table 2.21 Sludge Removal Plan of the Medium and Large Pipes of 800mm or More in Diameter

Facilities	Estimated Sludge Volume	Removal, Loading Method	Transportation Method	Description	Sludge Removal Volume per day	Necessary Days and Years for Removal[1)]
Zone C L=60.0km (total length including the pipes less than R800mm)	$14,300m^3$ x 0.8 $=11,440m^3$	Worker: 102persons Excavated sludge in drum ($0.1m^3$) will be loaded to truck ($5m^3$) by crane.	Sludge transportation truck w/crane ($5m^3$): 2units[6)]	Excavation and loading capability by manpower[2)]: $1m^3$/3persons/8hours = $34m^3$/102persons/8hours Loading time of truck w/crane: $5m^3$/time / ($34m^3$/8hours) = 71munites/time Transportation and unloading time of truck w/crane[3)]: 70munites/time Cycle time: 141munites/times Loading times to truck w/crane by manpower per day: $34m^3$/day / $5m^3$ =6times/day Transportation times of truck w/crane per day[5)]: 8hours/day / 141munites/times = 3times/day Required units of truck w/crane: 6times/day / 3times/ day = 2units	$5m^3$/unit x 3times/day x 2units $=30m^3$/day	$11,440m^3$ / $30m^3$/day =382days 382days / 140days/year =2.8years
Zone H L=60.0km (total length including the pipes less than R800mm)	$7,100m^3$ x 0.8 $=5,680m^3$	Worker: 51persons Excavated sludge in drum ($0.1m^3$) will be loaded to truck ($5m^3$) by crane.	Procured sludge transportation truck w/crane ($5m^3$): 1unit[6)]	Excavation and loading capability by manpower: $1m^3$/3persons/8hours = $17m^3$/51persons/8hours Loading time of truck w/crane: $5m^3$/time / $17m^3$/8hours = 142munites/time Transportation and unloading time of truck w/crane[4)]: 35munites/time Cycle time: 177munites/times Loading times to truck w/crane by manpower per day: $17m^3$/day / $5m^3$ =3times/day Transportation times of truck w/crane per day[4)]: 8hours/day / 177munites/times = 3times/day Required units of truck w/crane: 3times/day / 3times/ day = 1units	$5m^3$/unit x 3times/day x 1unit $=15m^3$/day	$5,680m^3$ / $15m^3$/day =379days 379days / 140days/year =2.7years

Note: 1) The Number of workable days shall be set as 140days between December and May (only dry season for safety) except Fridays and national holidays.

2) Excavated sludge shall be taken out manually. 1group shall be consist of 3persons (for excavation and loading: 1, for taking out: 2). Daily treated volume shall be set as $1m^3$/3persons/8hr. The number of daily treated manholes shall be set as 34points (Zone C) and 17points (Zone H).

3) Round trip transportation time to Matuail disposal site shall be set as follows:
Transportation: 10km (one way) / 20km/hr x 2 = 60munits

Unloading: 10munites Total 70munites

4) Round trip transportation time to Mirpur disposal site shall be set as follows:

Transportation: 4km (one way) / 20km/hr x 2 = 25munits

Unloading: 10munites Total 35munites

5) Working time for 1day shall be set as 8hours.

6) Equipment procured by the project.

Small Pipes of Less than 800mm in Diameter

In the case of small pipes of less than 800mm in diameter, or even those of 800mm or more, if the state of clogging of pipes by deposited sludge is remarkable and manual collection is impossible, the hose of the high pressure jetting car (of a $3m^3$ class) (Zone C: 2 units, 1 unit of which is the existing one; Zone H: 1 unit) shall be inserted into the pipe to collect the sludge toward the manhole by high pressure water spouted from the nozzle installed at the end of the hose, which will then be sucked by the sludge suction vacuum loader (of a $3m^3$ class) (Zone C: 2 units, 1 unit of which is the existing one; Zone H: 1 unit), and the jetting car itself will transport the sludge to the dumpsite (Zone C: Matuail; Zone H: Mirpur) Assuming that the number of days of operation per year is 140 from December to May, the dredging work will require 1.0 year for Zone C and 0.7 years for Zone H, thus completing the work in a short period. Hence, it is judged that, regarding the number of sludge vacuum loader and high water pressure jetting machine to be supplied for the dredging of rainwater pipes, only one (1) unit each will suffice for both Zones C and H. Table 2.22 shows the sludge removal plan in the Small Pipes of less than 800mm in diameter.

Table 2.22 Sludge Removal Plan of the Small Pipes of Less than 800mm in Diameter

Facilities	Estimated Sludge Volume	Removal, Loading Method	Transportation Method	Description	Sludge Removal Volume per day	Necessary Days and Years for Removal
Zone C L=60.0km (total length including the pipes more than R800mm)	$14,300m^3$ x 0.2 $=2,860m^3$	Sludge vacuum loader ($2.5m^3$): 2units[6] High water pressure jetting machine ($2.5m^3$): 1unit[6] 1unit[7] Water tank truck ($2.5m^3$): 1unit[7]		Vacuum time of sludge vacuum loader: 36munites/time Transportation and unloading time of sludge vacuum loader: 70munites/time Cycle time: 106munites/times Vacuum, transportation and unloading times of sludge vacuum loader per day: 8hours/day / 106munites/times = 4times/day	$2.5m^3$/unit x 4times/day x 2units $=20m^3$/day	$2,860m^3$ / $20m^3$/day =143days 143days / 140days/year =1.0years
Zone H L=60.0km (total length including the pipes more than R800mm)	$7,100m^3$ x 0.2 $=1,420m^3$	Procured sludge vacuum loader ($2.5m^3$): 1unit[6] High water pressure jetting machine ($2.5m^3$): shared with Zone C[6] Water tank truck ($2.5m^3$): shared with Zone C[7]		Vacuum time of sludge vacuum loader: 36munites/time Transportation and unloading time of sludge vacuum loader: 35munites/time Cycle time: 71munites/times Vacuum, transportation and unloading times of sludge vacuum loader per day: 8hours/day / 71munites/times = 6times/day	$2.5m^3$/unit x 6times/day x 1unit $=15m^3$/day	$1,420m^3$ / $15m^3$/day =95days 95days / 140days/year =0.7years

Note: 1) The Number of workable days shall be set as 140days between December and May (only dry season for safety) except

Fridays and national holidays.

2) Work capability of Sludge Vacuum Loader is calculated as follows:

$T = V/q \times \sigma/E = 2.5/10 \times 1.2/0.5 = 0.6(hr) = 36(min)$

Where,

T: Required Time for Tank Filling (min)
q: Sludge Vacuum Ability (10ton/hr, hose length: 20m)
V: Tank Volume ($2.5m^3$)
σ: Unit Weight of Sludge ($1.2ton/m^3$)
E: Working Efficiency (0.5)

3) Round trip transportation time to Matuail disposal site shall be set as follows:

Transportation: 10km (one way) / 20km/hr x 2 = 60munits
Unloading: 10munites Total 70munites

4) Round trip transportation time to Mirpur disposal station shall be set as follows:

Transportation: 4km (one way) / 20km/hr x 2 = 25munits
Unloading: 10munites Total 35munites

5) Working time for 1day shall be set as 8hours.
6) Equipment procured by the project.
7) Equipment that has been owned by DWASA.

Safety Equipment

There is poor ventilation inside the drainage pipes and box culverts, and the oxygen concentration is low due to the consumption of oxygen by the dirty water flowing in and the decay of sludge. Also, the environment is where toxic hydrogen sulfide is likely to be produced. Therefore, it is required that before workers enter the pipes, the concentration of oxygen and hydrogen sulfide shall be measured and appropriate equipment and supplies be put in place to ensure minimum safety.

The Drainage Circle of DWASA has no safety equipment and under the present circumstances, cleaning workers enter the pipes with no protection at all. In the Action Plan, the workers had expressed their concern about human casualties inside the pipes that are still being extended rapidly, and a request for support was made for 12 sets each of air cylinder type air supply masks and waterproof working jackets, which may be enough for half of the number of cleaning workers in the Drainage Circle. Although the number of equipment and facilities may be appropriate, the type to be procured should be the manual air blow type hose masks and chest waders.

Results of Re-examination and Evaluation of the Action Plan

After having re-examined the Action Plan prepared by DWASA, the optimum equipment and facilities for dredging sludge deposits, as well as their specifications and quantities, shall be as listed in Table 2.23 and Table 2.24.

Table 2.23 Optimum Sludge Removal Equipment by Facility

Facility	Zone	DWASA Action Plan			Proposed by this Study		
		Equipment	Spec	Qty	Equipment	Spec.	Qty
Open Channel	Zone C: Segunbagicha Open Ch.	Wheel type Backhoe	0.6m^3 Class	6	Removal		
		Sludge Transportation Truck	5m^3 Class	6			
	Zone H: Mirpur Open Ch.	Wheel type Backhoe	0.6m^3 Class	Shared with above	Wheel type Backhoe	0.6m^3 Class	1
		Sludge Transportation Truck	5m^3 Class	Shared with above	Sludge Transportation Truck	5m^3 Class	3
Box Culvert	Zone C: Segunbagicha Box Culvert	Sludge Transportation Truck with Crane	5m^3 Class	2	Sludge Transportation Truck with Crane	5m^3 Class	2
					Sludge Vacuum Loader	2.5m^3 Class Tank	1
					High Water Jetting Machine	2.5m^3 Class Tank	1
Drainage Pipe	Zone C	Sludge Transportation Truck with Crane	5m^3 Class	3	Sludge Transportation Truck with Crane	5m^3 Class	2
		Sludge Vacuum Car	2m^3 Class at least	1	Sludge Vacuum Loader	2.5m^3 Tank	1
		High Water Jetting Machine	2m^3 Class at least	1	High Water Jetting Machine	2.5m^3 Tank	Shared with above
	Zone H	Sludge Transportation Truck with Crane	5m^3 Class	Shared with above	Sludge Transportation Truck with Crane	5m^3 Class	1
		Sludge Vacuum Car	2m^3 Class at least	1	Sludge Vacuum Loader	2.5m^3 Tank	Shared with above
		High Water Jetting Machine	2m^3 Class at least	1	High Water Jetting Machine	3m^3 Class Tank	Shared with above
Box & Pipes	Zone-C&H	Oxygen Mask	None	12 sets		30m	12 sets
		Jacket	None	12 sets		26cm	12 sets

Table 2.24 Optimum Sludge Removal Equipment by Equipment

No	Name of Equipment	Request by Action Plan	Proposed by this Study		
			Zone-C	Zone-H	Total
1	Sludge Transportation Truck with Crane	5	4	1	5
2	Sludge Transportation Truck	6	3		3
3	Wheel type Backhoe	6	-	1	1
4	High Water Jetting Machine	2	1		1
5	Sludge Vacuum Loader	2	1	1	2
6	Oxygen Mask & Jacket	12	12	-	12

(2) Selection of Procured Equipment and Facilities

As stated above, the Action Plan prepared by DWASA has been reviewed and an appropriate plan for equipment and facilities after the re-examination and evaluation of the results of various types of site surveys has been proposed. The dredging of deposited sludge is essentially the work to be carried out as part of the maintenance and management that should be performed throughout the year. Among the equipment and facilities being proposed for procurement as shown in Table 2.23 and 2.24, equipment and facilities with high versatility are also included, such as wheel type backhoe, which should be procured by the self-help effort of DWASA.

As for Drainage Zones C and H where the procurement of equipment and facilities is being considered, it is still unknown as to what extent the effect of sludge dredging is expected with the Kamlapur temporary pump (maximum capacity: 6.0m^3/s) installed at the downstream end of the box culvert, which is the main watercourse (3.0km). Rather than this, conspicuous dredging effect can be expected by the dredging of sludge out of the box culvert by linking the project with the Kamlapur Pumping Station construction plan now being planned under the World Bank assistance.

In Drainage Zone H, by dredging the deposited sludge in the Mirpur Open Channel, namely, the main facility and the drainage pipes, the functions of the Kallyanpur Pumping Station could be demonstrated to the fullest.

In addition, considering the present situation of the personnel of DWASA, maintenance and management budget, as well as storage facilities, it is difficult to procure all equipment and facilities for dredging sludge for these two drainage districts, and it cannot be said to be an appropriate choice.

Therefore, on the basis of the idea of promoting self-help efforts of DWASA that will lead to the promotion of long-term effects of assistance, it is planned to procure equipment and facilities that are limited to the following special equipment and materials for dredging sludge in Drainage Zone H, which are thought to be difficult for DWASA to procure on its own.

Table 2.25 Procurement List for Sludge Removal Work

No.	Name	Specification and Quantities	Spare Parts
E-1	Sludge Vacuum Loader	GVW: 10ton-class; Tank capacity: 2.5m^3 or more, Air volume: 21m^3/min or more; Hose: D100mm x L20m or more; Qty: 1	V-belt, ball valves, inner kit, packing, hose, filters, universal joint, spare tires, maintenance kits
E-2	High Water Pressure Jetting Machine	GVW: 10ton-class; Tank capacity: 2.5m^3 or more; Water pressure: 180lit/min or more; Hose: D3/4-7/8inch x L100m or more; Qty: 1	
E-3	Sludge Transportation Truck w/ Crane	GVW: 13-14ton class; Body: watertight; Loading capacity: 6ton or more; Crane capacity: 2.93ton x 2.6 or 2.7m; Qty: 1	spare tires, maintenance kits
E-4	Sludge Transportation Truck	GVW: 11-12ton class, Body: watertight; Loading capacity: 6ton or more; Qty: 3	spare tires, maintenance kits

It should be noted that among the aforesaid equipment and facilities to be supplied under Japan's Grant Aid, the sludge suction vacuum loader and the high water pressure jetting car for Drainage Zone H are also planned for use in the dredging and cleaning of drainage pipes in Drainage Zone C. Besides, the high water pressure jetting machine is further planned for the dredging of box culverts in Drainage Zone C. Also, the sludge transportation truck with crane may be used in the dredging of box culverts and drainage pipes in Drainage Zone C, when the dredging in Drainage Zone H is in progress.

2.2.2.3 Project Components

In accordance with the Basic Plan described above, the components of the Project and the equipment to be procured under the Japan's Grant Aid shall be as listed in Table 2.26 below.

Table 2.26 Project Components

Item No.	Component		Quantity	
			GOB Requested	GOJ Grant Aid
1.	Construction of Drainage Facilities		Drainage Zone H	Drainage Zone H
1.1	Expansion of Kallyanpur Pumping Station		1 Structure	1 Structure
	Capacity		10 m^3/s	10 m^3/s
	Pump Diameter		1,500 mm	1,500 mm
	Number of Pumps		2 units	2 units
	Pump Head		2.5 m	3.5 m
2.	Procurement of Sludge Removal Equipment		Drainage Zone C&H	Drainage Zone H
2.1	Sludge Transportation Truck with Crane		5 units	1 unit
2.2	Sludge Transportation Truck		6 units	3 units
2.3	Wheel Type Backhoe		6 units	None
2.4	High Water Jetting Machine		2 units	1 unit
2.5	Sludge Vacuum Loader		2 units	1 unit
2.6	Safety Facilities	Oxygen Mask	12 sets	None
		Waterproof Jacket	12 sets	None
3.	OJT or Soft Component			
3.1	Technical Transfer of O&M for Pumping Station and Sludge Removal Work		Subject to Basic Design Study	None

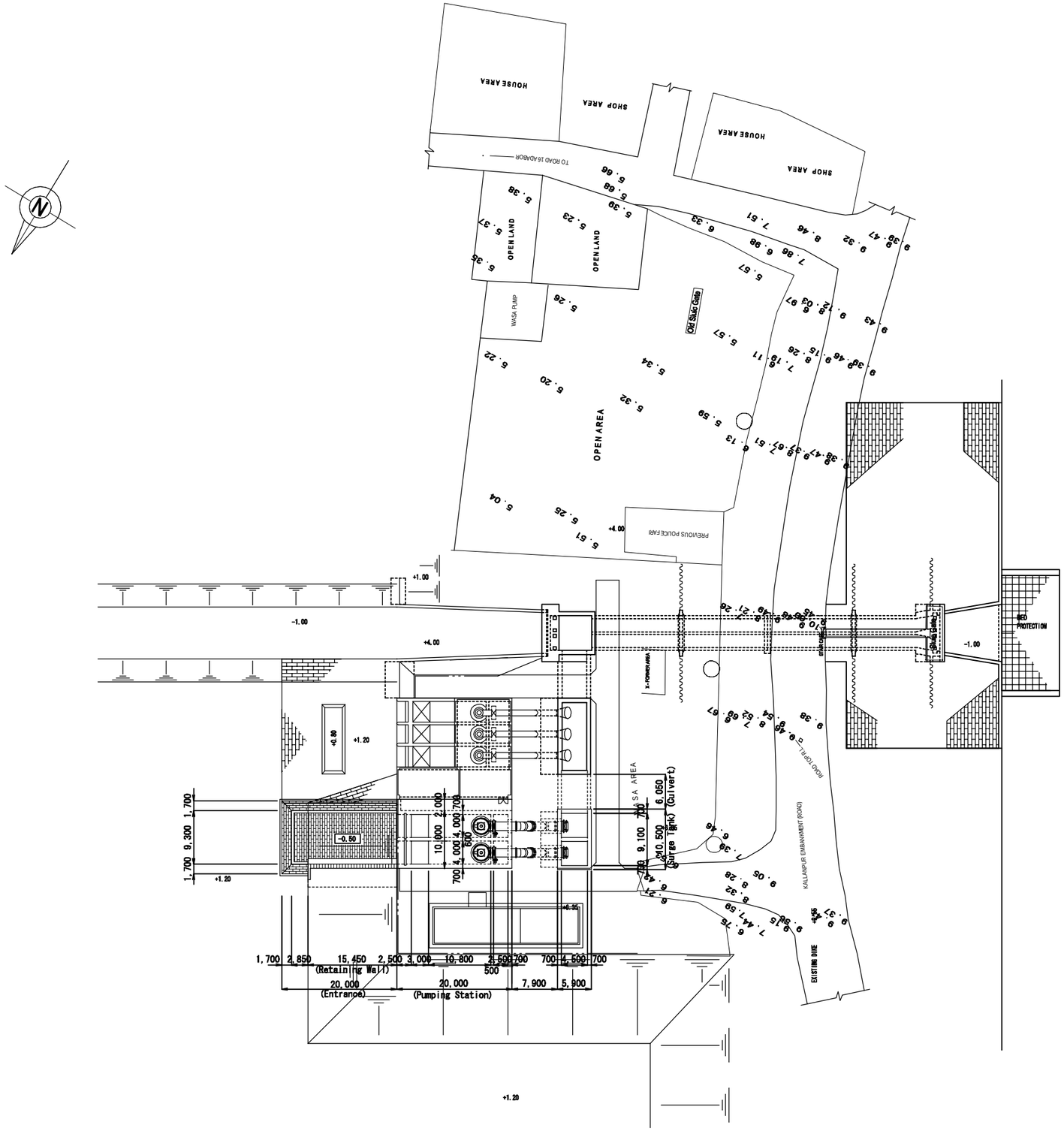
2.2.3 Basic Design Drawing for the Expansion of Kallyanpur Pumping Station

The basic design drawings of the pumping station are as listed in Table 2.27.

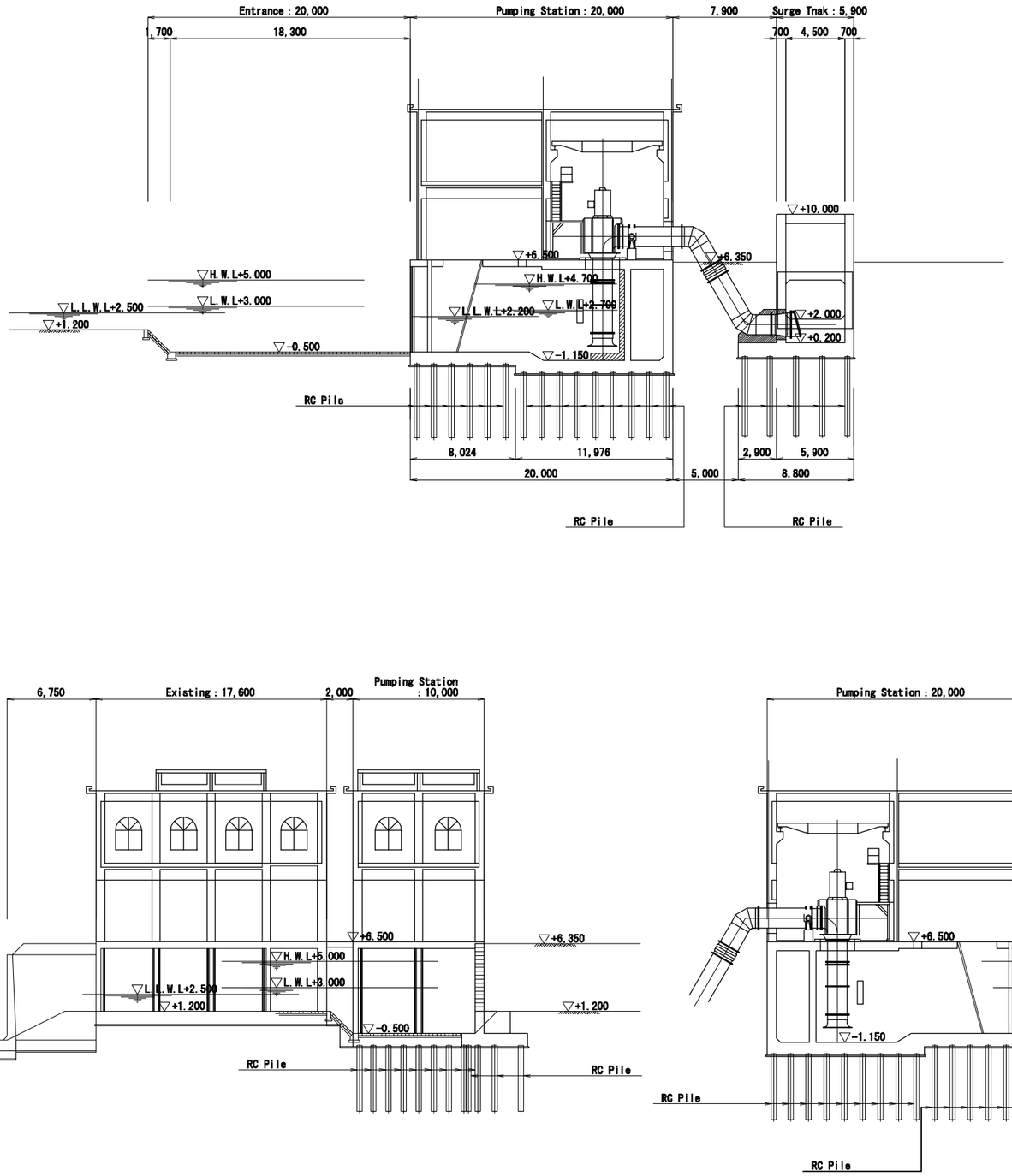
Table 2.27 List of Basic Design Drawings of the Pumping Station

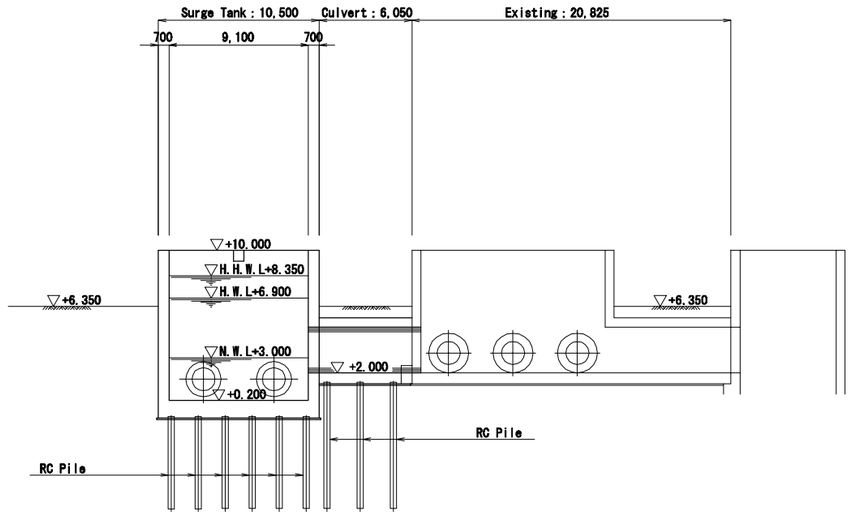
Fig. No.	Title	Scale
Fig. 2.10	General Plan of Pumping Station	1/800
Fig. 2.11	Typical Section of Pumping Station	1/400
Fig. 2.12	Pumping Station (1)	1/200
Fig. 2.13	Pumping Station (2)	1/200
Fig. 2.14	Surge Tank	1/200
Fig. 2.15	Retaining Wall	1/200
Fig. 2.16	General Elevation of Pumping Station	1/200
Fig. 2.17	Detail of Floors	1/200
Fig. 2.18	Plan of Facility and Equipment of Pumping Station	1/200
Fig. 2.19	Elevation of Facility and Equipment of Pumping Station	1/200
Fig. 2.20	Control Panels of Pumping Station	1/20
Fig. 2.21	Single Line Diagram	-

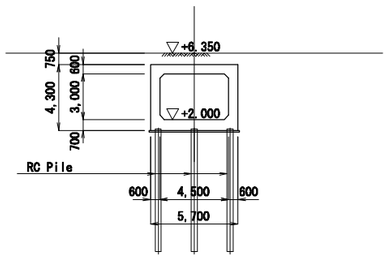
The above-described drawings are shown on the following pages.

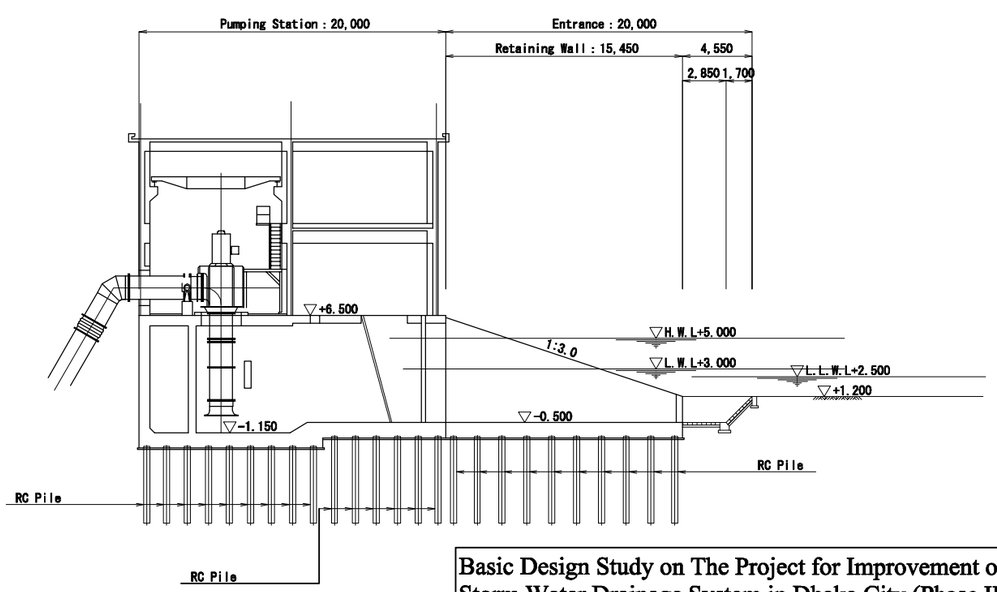


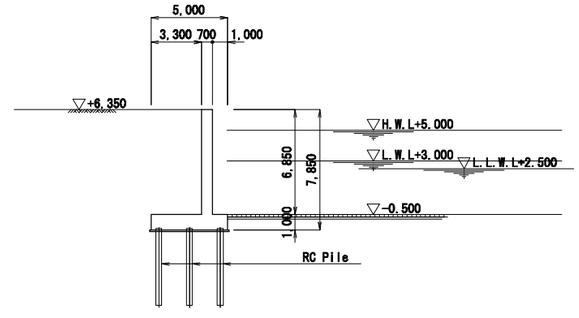
Basic Design Study on The Project for Improvement of Storm Water Drainage System in Dhaka City (Phase II) CTI Engineering International Co., Ltd	Drawing No. Fig.2.10 GENERAL PLAN OF PUMPIMG STATION











Basic Design Study on The Project for Improvement of Storm Water Drainage System in Dhaka City (Phase II) CTI Engineering International Co., Ltd	Drawing No. Fog. 2.11 TYPICAL SECTION OF PUMPIMG STATION