No.

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR IMPROVEMENT OF

SEWERAGE SYSTEM IN DHAKA CITY

IN

THE PEOPLE'S REPUBLIC OF BANGLADESH

April 2001

Japan International Cooperation Agency

NJS Consultants Co., Ltd.

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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 Sewerage System in Dhaka City and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team from 11 October to 17 November, 2000.

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 Bangladesh for their close cooperation extended to the teams.

April 2001

Kunihiko Saito
President
Japan International Cooperation Agency

April 2001

Letter of Transmittal

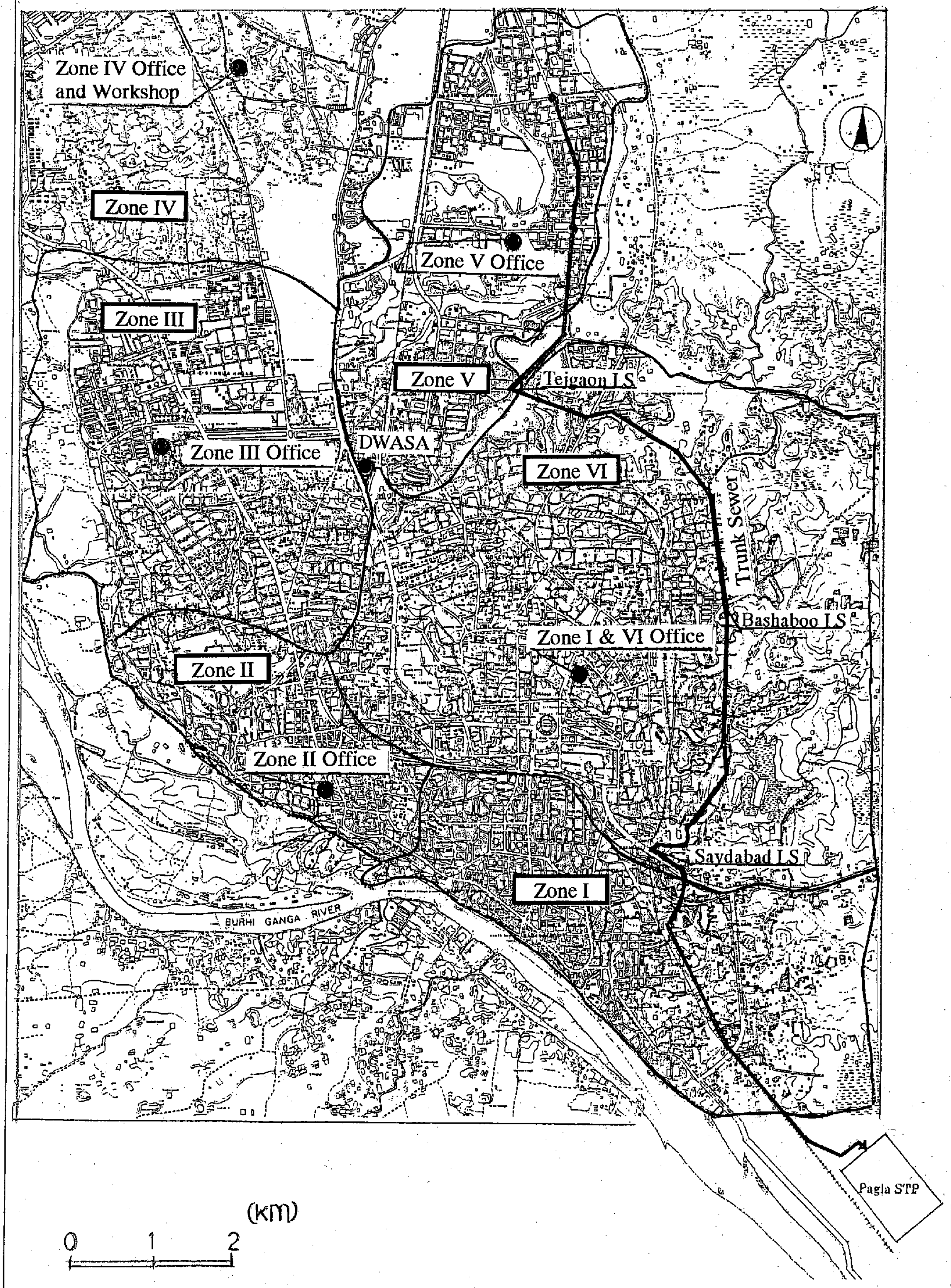
We are pleased to submit to you the basic design study report on the Project for the Improvement of Sewerage System in Dhaka City in the People's Republic of Bangladesh.

This study was conducted by NJS Consultants Co., Ltd., under a contract to JICA, during the period from October 2000 to April 2001. 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 further promotion of the project.

Very truly yours,

Masuomi Hiroyama
Project Manager,
Basic Design Study Team on
the Project for Improvement of
Sewerage System in Dhaka City,
NJS Consultants Co., Ltd.



Location Map of the Study Area

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List of Acronyms and Abbreviations

Implementation Agency and Development Plan

DCC	:Dhaka City Corporation
DMDP	:Dhaka Metropolitan Development Program
DWASA	:Dhaka Water Supply and Sewerage Authority
JICA	:Japan International Cooperation Agency
RAJUK	:Rajdhani Unnayan Kartripakkha

Country

Bangladesh	:People's Republic of Bangladesh

Technical Words, Facilities and Others

BHN	:Basic Human Needs
E/N	:Exchange of Note
GDP	:Gross Domestic Product
GNP	:Gross National Product
LLDC	:Least among Less Develoed Countries
LS	:Lift Station
MODS	:Maintenance Operation Distribution Circle
P/S	:Pumping Station
PTO	:Power Take Off
PVC	:Polyvinyl Chloride
RC	:Reinforced Concrete
STP	:Sewage Treatment Plant

Units

Tk	:Taka, Currency Unit of Bangladesh
Kpa	:Kilo Pascal
mm	:Milimetre
KN	:Kilo Neuton
Mpa	:Mega Pascal

Summary

Summary

The development of sewerage system in Dhaka City, the national capital of Bangladesh, was commenced in some 80 years ago and such old fashioned primary facilities have been deteriorated not only by the usage beyond the service life, but also by frequent flood damage and disposal of domestic garbage into sewer manholes by local residents, resulting breakage and clogging of sewer lines. The existing sewerage system together with water supply system is currently owned and managed by Dhaka Water Supply and Sewerage Authority (hereinafter referred to as "DWASA").

One of the most important main sewers, so called Asad Gate Truck Sewer, running from the northern part of Gulshan area down to the Saydabad P.S. (hereinafter referred to as L.S.), which is the key sewage pumping station to relay and transmit sewage to the Pagla Sewage Treatment Plant (hereinafter referred to as the "Pagla STP"), is seriously damaged and clogged, and presently leaking collected sewage into nearby lakes and ponds. Tejgaon LS and Saydabad Pump Station (hereinafter referred to as "P.S."), which are located on this trunk main, are also encountering difficulty in their operation, due to 1998 flood damage and less sewage inflow from trunk main. Thus, discharged sewage in the northern Gulshan area is not properly conveyed to the Pagla STP. Only sewage collected in the south Dhaka area is coming into the Saydabad L.S. through the Narinda P.S. The present sewage inflow to the Pagla STP is less than half of the design treatment capacity (96,000 cu.m/day at daily average basis). Field investigations carried out during the basic design study revealed that most of lateral sewers connected to this trunk main is mostly clogged and are not performing required performance.

In view of necessity to urgently improve the deteriorating living environment, the Government of the People's Republic of Bangladesh (hereinafter referred to as "the Government of Bangladesh") decided to launch "the Emergency Sewer Construction Project in North Dhaka" and "the South Dhaka Urgent Sewer Cleaning Project" in order to collect sewage being discharged around the Gulshan Lake and transmit it smoothly to the Pagla STP as well as cleaning and desludging of existing sewer network, and requested the grant aid assistance to the Government of Japan for realization of these projects.

This project, among the above requested projects, is focusing on the provision of sewer cleaning equipment to attain increase of sewage flow to the Pagla STP, which had been improved and expanded under the Japan's grant aid during 1988 to 1990.

In response to the request from the Government of Bangladesh, the Government of Japan decided to

conduct a Preparatory Study on the Emergency Sewer Construction Project and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Bangladesh the Preparatory Study Team, headed by Mr. Hisatoshi Okubo, Deputy Director, First Project Management Division, Grant Aid Management Department, JICA from 16th May to 2nd June 2000 for examination of the viability of the requested project. Based on the result of the Preparatory Study, the Government of Japan decided to conduct a Basic Design Study on the Project for Improvement of Sewerage System in Dhaka City (hereinafter referred to as "the project") and entrusted it to JICA. Accordingly, JICA sent a Basic Design Study Team (hereinafter referred to as "the Study Team") from 10th October to 17th November 2000 headed by Mr. Hisatoshi Okubo for the first field survey and from 29th January to 2nd February 2001 headed by Takao Kaihara, Director, First Project Management Division, Grant Aid Management Department, JICA.

Through the Preparatory Study, the Government of Bangladesh finally requested the items as listed below:

(1)	Vacuum cleaner equipped with dehydration mechanism	6 units
(2)	Submergible sand pump	6 units
(3)	Blower	6 units
(4)	Toxic/hazardous gas detector	6 units
(5)	High pressure cleaning equipment	3 units
(6)	Sludge hauling dump truck	3 units
(7)	Service truck	3 units
(8)	Generator	3 units
(9)	High tensile drain hose	3 sets

Based on the above request, the basic design study was carried out in Bangladesh and upon further study in Japan, the basic plan was developed. As the result of basic design study, it was concluded that; sewer cleaning work being undertaken by DWASA is encountering inefficiency and ineffectiveness owing to breakdown of equipment and lack of performance, and therefore cleaning work is not implemented properly. It was also revealed that systematic procedure of sewer cleaning is not taken up throughout MODS (Maintenance, Operation and Distribution Service) Zone Offices of DWASA.

Under these circumstances, a basic plan was developed covering (1) sewer cleaning plan, (2) equipment plan including necessary type, performance and specifications, etc. being required for effective and efficient sewer cleaning, and (3) number of equipment to be required to accomplish the sewer cleaning in the target area within 2 years. In the course of the basic design, the need assessment on the provision of soft component was also conducted to enable DWASA operation and maintenance of cleaning equipment as well as effective and reasonable implementation of cleaning activities from the view points of technical assistance, and necessary scope of soft-component activities was identified and programmed.

The preferential cleaning area for about 57 km of main and sub-main sewers was designated to be cleaned in two-year period, which covers from Gulshan area to the Pagla STP. A set of cleaning equipment consisting of a vacuum cleaner equipped with a dehydration mechanism, a sludge hauling dump truck, a high pressure cleaning machine and a water tanker is identified as a basic system. To conduct preferential cleaning within the designated project period, a total of 3 sets was determined necessary. Size of such cleaning equipment is also determined to be 4 ton-chassis in due consideration of road and traffic conditions in Dhaka City.

For deep manholes, which are beyond the ordinary performance of cleaning equipment, a set of equipment consisting of a sand pump, blower, a generator and a hauling truck equipped with a crane is also considered.

Spare parts are considered for truck mounted cleaning equipment (excluding truck chassis and engines, etc.) and PTO (Power-Take-Out) unit. Quantity of spare parts is determined to cover a total of 3-year operation, considering 2 years of preferential cleaning period and 1 year of subsequent cleaning activity. Content of basic design is shown in Table-1.

The required project period is then programmed to be; 4 months for detailed design, 8 months for procurement, 6 months for implementation of soft component activity, and 2 years for preferential cleaning to be undertaken by DWASA.

An overall objective of the project is to clean up main and sub-main sewers in Dhaka City, which are clogging in many locations and to reactivate principal function of sewer network. Through implementation of this project, the sewage inflow to the Pagla STP will be increased and leakage of sewage into lakes and ponds will be decreased. In other word, living environment for local population of about 1.12 million (as of 1999) residing in sewerage service area will be improved and inundation by gushing out of sewage from manhole will be solved. Those which expected benefit through implementation of the project is assumed as follows:

- Appropriate cleaning work of sewer network becomes available corresponding to sewer diameters, depth of installation, accumulation of sludge, etc.
- Efficient implementation of sewer cleaning becomes possible.

Table-1 Outline of Basic Design

No.	Name of Equipment	Quantity	Remarks
Sewer Cleaning Equipment			
1	Truck-mounted Vacuum Cleaner equipped with Dehydration Mechanism	3 units	• Dehydration mechanism is considered for effective and continuous operation. • 3 units are deemed necessary to cater for preferential cleaning area in 2-year implementation period.
2	Truck-mounted High Pressure Cleaning Machine	3 units	• High pressure cleaning of sewer pipe. • 3 units are deemed necessary to cater for preferential cleaning area in 2-year implementation period.
3	Water Tanker	3 units	• Required to ensure continuous operation of high pressure cleaning machine.
4	Sludge Hauling Dump Truck	3 units	• Required to ensure continuous operation of vacuum cleaner. • Hauling of dehydrated sludge to dumping site.
5	Deep Manhole Cleaning Equipment - Sand pump, 1 unit, - Control panel, 1 unit, - Generator, 1 unit - Lighting equipment, 1 unit - Gas detector, 1 unit, - Blower, 1 unit, - Service truck with crane (4 tons), 1 unit	1 set	• Required to cater for deep manholes and sewer lines with more than 6 m depth, which are not capable by ordinary cleaning equipment. • Blower and gas detector are included to ensure safe working conditions. • Service truck equipped with crane is considered.
6	Spare Parts	3 year operation	• Spare parts are considered for truck-mounted equipment of vacuum cleaner and high pressure cleaner and PTO. • Quantity is determined to meet with 2-year preferential cleaning and 1-year succeeding activity.
Initial Training			
1	Initial Training	1 set	• One technician from supplier of equipment for 1 month. • Initial operation and maintenance training.
Soft-Component (Technical Assistance)			
1	Technical Assistance	1 set	• Two consultants specialized in planning and operation of sewer cleaning work for 6-month period

- Knowledge and skills of DWASA personnel will be improved on sewer cleaning and overall sewerage system.
- Provision of effective and efficient technique and know-how can be available.
- Periodical maintenance of sewer network becomes possible.
- Sewage inflow to the Pagla STP will increase near to the design treatment capacity, when the proposed Emergency Sewer Construction Project is implemented simultaneously.

For continuous implementation of sewer cleaning work, DWASA itself shall posses planning skill of sewer cleaning work and appropriate techniques in field operations. Although, DWASA has sufficient manpower and financial capability, technical know-how, equipment and institutional arrangement is yet insufficient. In this respect, technical assistance in the form of soft component is deemed indispensable.

Upon implementation of the project, considerable scale of benefits is expected and directly contributing to the BHN of citizens in Dhaka City. Likewise, the project has due appropriateness and necessity as well as feasibility. It shall be noted, however, the following points for furtherance of the project:

- Formulation of sewer cleaning project team in DWASA
- Provision of appropriate space to store equipment and spare parts
- Provision of appropriate budget for O&M of sewer cleaning equipment and cleaning work
- Provision of the Emergency Sewer Construction Project prior to the target year of this project

Chapter 1

Chapter 1 Background of the Project

The Government of Bangladesh had started the improvement of existing sewerage system through its executing agency, DWASA, with utilizing technical and financial assistance from the World Bank and the Government of Japan. However, it requires huge amount of capital input for thorough renovation of deteriorated sewer network. In this respect, the Government of Bangladesh requested the “Emergency Project” as a grant aid project, which was recommended in the foregoing “Study on Sewerage System in North Dhaka” (1997-98, JICA), to the Government of Japan.

Particularly, the proposed project aims at rehabilitation/renovation of main sewer running from the Gulshan area up to the Pagla STP via Saydabad L.S. and provision of sewer cleaning equipment, for increasing sewage inflow to the Pagla STP. Thus, the proposed project consists of two sub-projects, namely, “the Emergency Sewer Construction Project in North Dhaka” and “the South Dhaka Urgent Sewer Cleaning Project”.

This project pertains to “the South Dhaka Sewer Cleaning Project”, which is mainly composed of provision of sewer cleaning equipment and priority cleaning of main and sub-main sewers, and is ultimately to increase sewage inflow to the Pagla STP and to improve living environment in Dhaka City.

Major contents of the request are as follows:

(1) Vacuum cleaner equipped with dehydration mechanism	6 units
(2) Submergible sand pump	6 units
(3) Blower	6 units
(4) Toxic/hazardous gas detector	6 units
(5) High pressure cleaning equipment	3 units
(6) Sludge hauling dump truck	3 units
(7) Service truck	3 units
(8) Generator	3 units
(9) High tensile drain hose	3 sets

Chapter 2

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Project Objectives

In Dhaka City, the national capital of the Peoples Republic of Bangladesh, there is the existing sewerage system mainly in the south Dhaka area. However, this existing system has been encountering problems, i.e. breakage and clogging of sewer pipelines owing to deterioration since its first installation in more than 80 years ago and frequent flood damages as well as disposal of garbage into manholes by residents.

The Japanese government extended its grant aid assistance in 1989 to 1992, namely “the Sewerage Construction and Rehabilitation Project for Dhaka WASA” focusing on construction of the Pagla Sewage Treatment Plant (hereinafter referred to as “Pagla STP”) and rehabilitation of relevant sewage pump stations. Although the project was completed, deterioration of main sewer and clogging of sewer network has caused insufficient collection of sewage and approximately half of its capacity (planned daily average sewage flow at 96,000 cu.m/day) is being utilized.

Under these circumstances, the government of Bangladesh requested the government of Japan to provide a grant aid assistance for rehabilitation of trunk sewer and for procurement of sewer cleaning equipment in order to improve deteriorating urban environment and increase swage inflow to the Pagla STP. They are “the Emergency Sewer Consruction Project in North Dhaka” and “the South Dhaka Urgent Sewer Cleaning Project”.

The project is the latter, and the project objective is to contribute to the upgrading of sanitary environment of Dhaka City through the procurement of sewer pipe cleaning equipment to resolve sewer clogging. Consequently, the incoming sewage flow to the Pagla STP will increase. Besides, “the Emergency Sewer Construction Project in North Dhaka” shall also be implemented to achieve the said project objective, since this project is regarded as one of the project components of said project.

2-1-2 Outline of the Project

To achive said project objectives, sewer pipe cleaning equipment shall be supplied and trunk and sub-trunk sewers in Dhaka City shall be cleaned. Resolve the cloggings in these sewers will result in the increse sewage volume to the Pagla STP. The following equipment will be procured and supplied under this project:

- High Pressure Cleaning Equipment 3 units
- Vacuum Cleaner with Dehydration System 3 units
- Sludge Hauling Dump Truck 3 units
- Cleaning Equipment for Deep Manholes 1 set
- Spare Parts 1 set

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

The folowing are the details through establishment of scope of work.

At first, in order to achieve the above-mentioned objectives, contents and scope of requested made by the Bangladesh Government was scrutinized. The Preparatory Study Team dispatched by JICA had confirmed the contents of request shown below.

Table 2-1 Contents of the Request Confirmed by the JICA Preparatory Study Team

Item No.	Requested Item	Requested Quantity	Item No.	Requested Item	Requested Quantity
1.	Vacuum Cleaner with Dehydration System	6 units	6.	Submersible Pump	6 units
2.	High Pressure Cleaning Equipment	3 units	7.	Generator	3 units
3.	Water Tanker	9 units	8.	Blower	6 units
4.	Sludge Hauling Truck	3 units	9.	Gas Detector	6 units
5.	Service Truck	3 units	10.	High Tensile Drain Hose	3 sets

Based on this confirmation, the Basic Design Study Team conducted a series of discussions and further reviewed the contents of request with the Bangladesh Government.

Currently, 6 MODS Zone Offices are undertaking sewer cleaning in its respective jurisdiction. In view of this situation, number of High Pressure Cleaning Equipment and Vacuum Clear was increased from 3 units each to 6 units each, while Water Tanker was decreased from 9 units to 6 units, to correspond the number of MODS Zone Offices. Priority for provision of these equipment were given to 3 MODS Zone Offices, namely Zone I, V and VI as they are located along the main sewer and sub-main sewer running from North Dhaka (Gulshan area) down to the Pagla STP, while other Zones Offices, such as Zone II, III and IV were given second priority. This prioritization was confirmed between the Basic Design Study Team and the Bangladesh Government & DWASA, as shown below.

Table 2-2 Contents of Request Confirmed in the Basic Design Study

Item No.	Requested Item	Requested Quantity	Priority	
			1st (MODS Zone I, V & VI)	2nd (MODS Zone II, III & IV)
1.	Vacuum Cleaner with Dehydration System	6	3	3
2.	High Pressure Cleaning Equipment	6	3	3
3.	Water Tanker	6	3	3
4.	Sludge Hauling Truck	6	3	3
5.	High Tensile Drain Hose	6	3	3
6.	Appurtenances	6	3	3
7.	Spare Parts	6	3	3

Thereafter, field investigation of the Basic Design Study was carried out to scrutinize the present condition of sewer cleaning equipment, cleaning method of sewer pipelines, present condition of existing sewer network, organizational set-up of DWASA, etc. Resultanting from this survey, a sewer cleaning plan with the use of requested equipment was prepared and the most appropriate cleaning method as well as necessary scope and number of equipment was verified to determine appropriateness of the request. Basic concept of the project is then developed as described below.

(1) Sewer Cleaning Plan

A sewer network loses its principal function, such as smooth sewage flow if clogging of sewer pipes occurs by accumulation of sludge and appropriate condition if offensive odor and/or toxic gases are emitted by accumulated sludge. In this regard, periodical cleaning is indispensable to maintain smooth sewage flow.

In Dhaka City, water level in manhole reaches nearby opening of manholes due to stagnant sewage in sewer being caused by accumulation of sludge even above the crown level of sewer. Thus, principal function of sewer network is almost lost by clogging.

At present, DWASA is conducting sewer cleaning by its own staffs and by sub-letting to contractors, but is mainly corresponding to complaints raised by residents. In other words, main sewer is not cleaned properly and systematic cleaning has not been taken up. Sewage collection and disposal function of sewer network is therefore not recovered even after the current cleaning work, and clogging in other section of sewer network occurs soon or later.

It is an urgent requisite for staffs of DWASA to clearly understand that the sewer network is a running water system and an establishment of sewer cleaning plan is indispensable to recover an overall function of sewer network.

An objective of sewer cleaning is sub-divided into two items:

1) Recovery of sewage flow function

   When the main sewer is clogged, the principal function of sewer network to drain sewage is deemed to be lost. In this respect, sewer cleaning shall be started from the downstream side of main sewer toward the upstream.

2) Improvement of sewerage service to customers and recovery of flow capacity in lateral sewer

   Cleaning of lateral sewer is directly concerned to customers and aims at maintaining hydraulic capacity for smooth sewage flow and thereby preventing overflow from manholes, etc. Likewise, this category of cleaning work is classified as routine work of sewer network maintenance. DWASA's current undertaking falls into this type of work.

At present, the above-mentioned 1) is considered as the most urgent work of sewer network maintenance and therefore sewer cleaning plan with the use of requested equipment is developed and necessary number and scope of equipment are delineated as follows:

1) Selection of preferential cleaning section of sewer network

   The existing sewer network has a total length of about 530 km and that of lateral sewer having diameters of 250 mm or smaller occupies some 413 km. Breakdown of main and sub-main sewers with diameters of 300 mm or larger by MODS Zone are summarized in Table 2-3.

   It is deemed that major clogging of sewer network is occurred at these main and sub-main sewers and is targeted for preferential cleaning. It shall be noted however that the total length of this main and sub-main sewer is 117 km and further prioritization is important to come up with more practical cleaning plan.

Table 2-3 Breakdown of Main and Sub-Main Sewer by MODS Zone

Type of Pipe	Dia. (mm)	Length (m)	MODS Zone (Length: m)					Remarks
			I	II	III	V	VI	
Brick Arch	1,372	6,025	6,025					Difficult access
	1,219	2,743					2,743	
	914	3,720					3,720	
	Sub-Total	12,488	6,025				6,463	
Reinforced Concrete	975	1,040	1,040					
	900	6,680	3,400				3,280	
	600	14,700	1,270	4,890	5,980	1,580	980	Zone V is Submerged.
	450	14,030	2,880	1,100	6,570	2,750	730	
	400	15,800	1,230	3,800	3,030	840	6,900	
	350	2,460	220	2,240				
	300	50,130	13,040	12,900	6,350	3,630	14,210	
	Sub-Total	104,840	23,080	24,930	21,930	8,800	26,100	
Total (m)		117,328	29,105	24,930	21,930	8,800	32,563	

Main sewer system consists of Asad Gate Trunk Main, Hazaribag Trunk Main and Nawabganj Trunk Main. These trunk mains have a total of 19 lift stations. Collected sewage is conveyed to the Pagla STP through Narinda PS and Saydabad PS. Relationship among 15 major pump stations with main sewer network is shown in Figure 2-1.

These major sewerage facilities form a key frame of the existing sewerage system. When any part of this frame encounters functional disorder, an overall sewage flow will seriously jeopardized. Sub-main sewers having large service area have also similar function as main sewer.

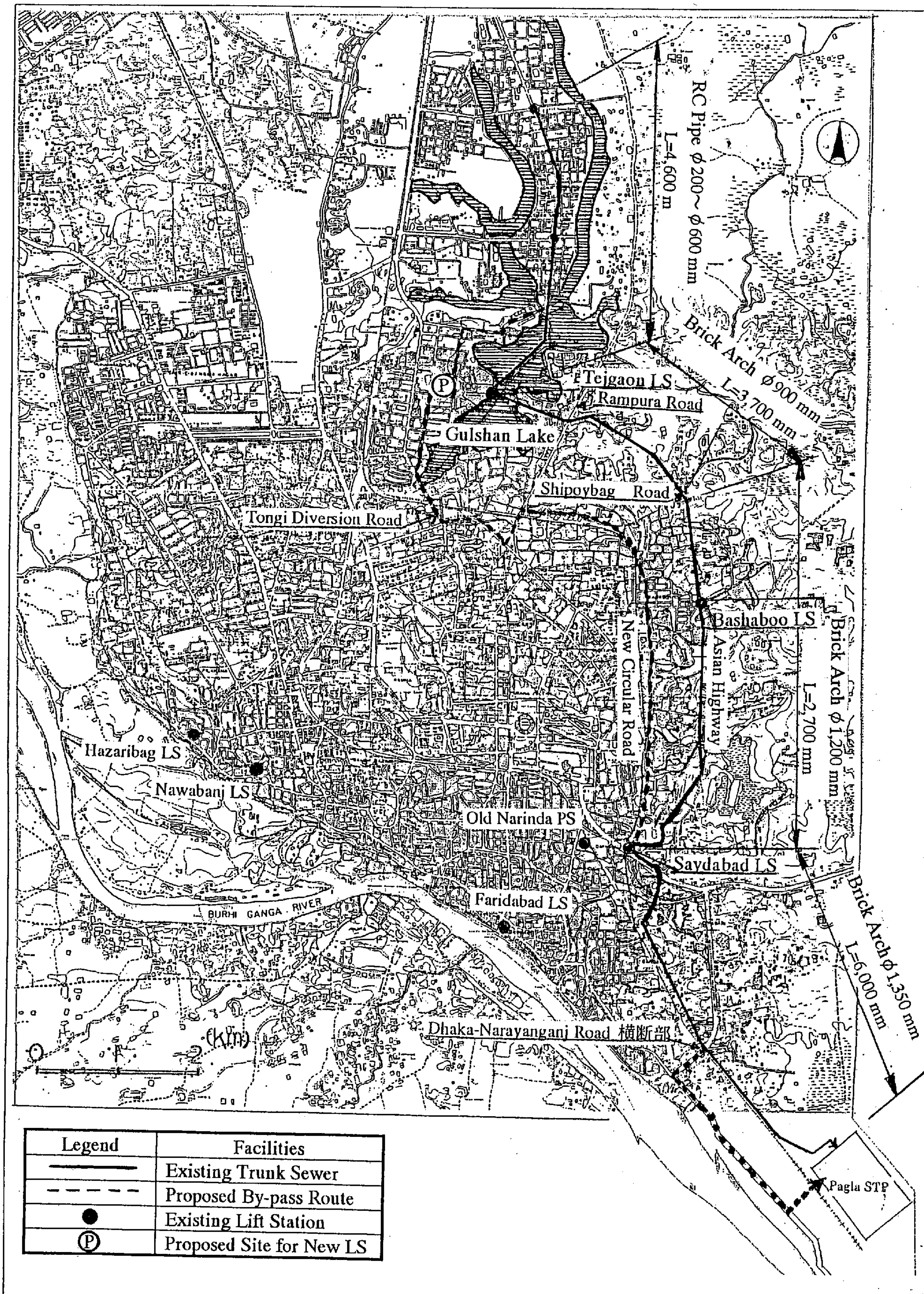
Considering the above-mentioned key points, the preferential cleaning sections are determined as follows:

① **Main sewers connecting 15 major pump stations and flowing to the Pagla STP, as shown in Figure 2-2.**

② **Sub-main sewers having diameters of 400 mm or larger being connected to the above main sewer or 15 major pump stations.**

Any section where access is difficult, such as submerged section, is excluded.

Zone-wise breakdown of preferential sewer cleaning section is summarized in Table 2-4.



Legend	Facilities
————	Existing Trunk Sewer
– – – –	Proposed By-pass Route
●	Existing Lift Station
Ⓟ	Proposed Site for New LS

Figure 2-1 Major Pump Stations and Main Sewre Network in Dhaka City

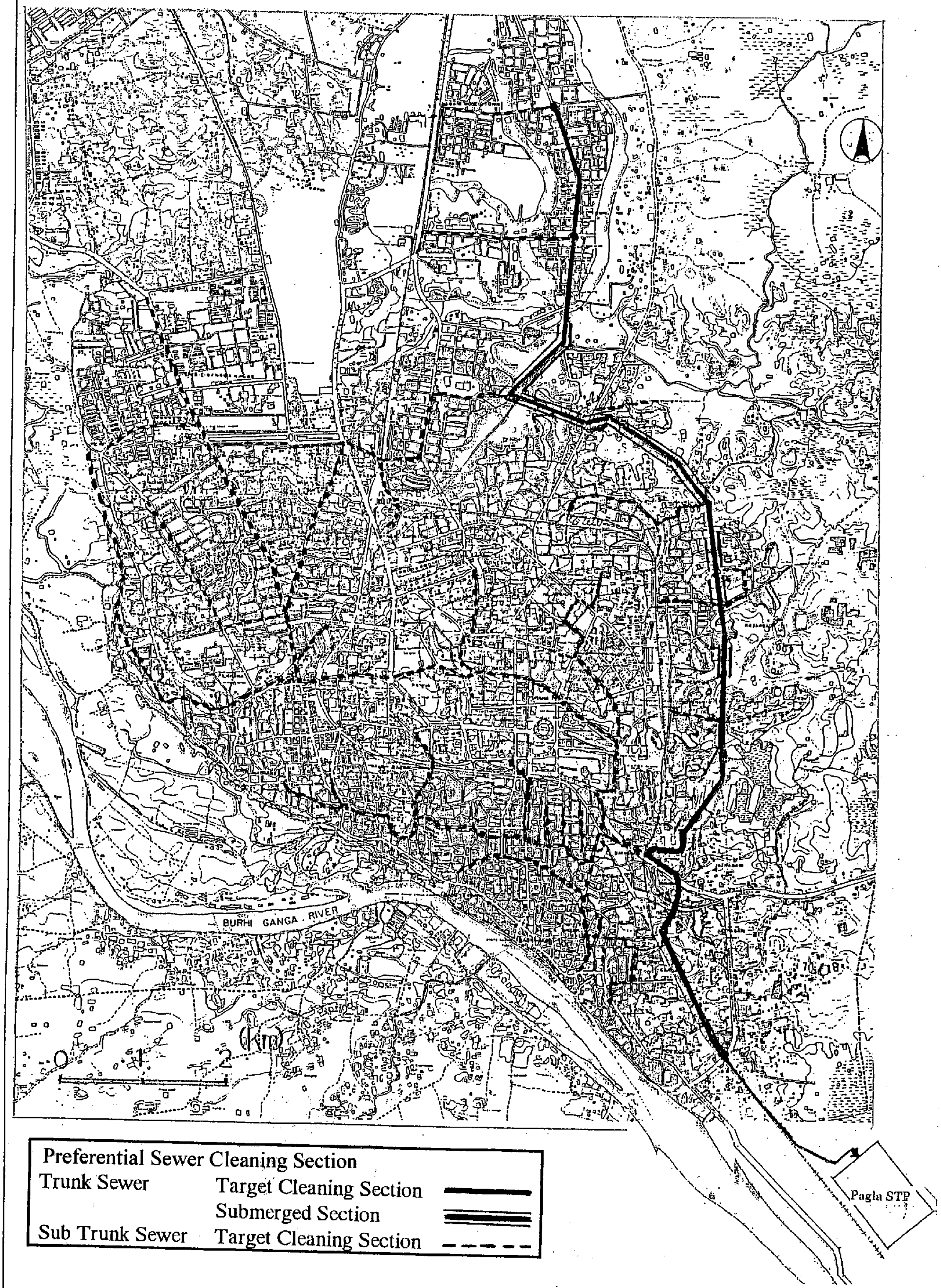


Figure 2-2 Preferential Sewer Cleaning Section in Dhaka City

Table 2-4 Preferential Cleaning Section by Zone

Type of Pipe	Dia. (mm)	Length (m)	MODS Zone （Length: m）					Remarks
			I	**II**	**III**	**V**	**VI**	
Brick Arch	1,372	2,500	2,500					Excluding proposed reconstruction section
	1,219	0						
	914	1,200					1,200	
	Sub-Total	3,700	2,500				1,200	
Reinforced Concrete	975	1,040	1,040					
	900	6,680	3,400				3,280	
	600	13,120	1,270	4,890	5,980		980	Zone V is submerged
	450	14,030	2,880	1,100	6,570	2,750	730	
	400	15,800	1,230	3,800	3,030	840	6,900	
	350	820		820				
	300	1,910	410	1,110			390	
	Sub-Total	53,400	10,230	11,720	15,580	3,590	12,280	
Total（m）		57,100	12,730	11,720	15,580	3,590	13,480	

2) Sewer cleaning method

Sewer cleaning is planned to be carried out by combination of high pressure cleaning equipment, a vacuum cleaner and a water tanker as follows:

- Accumulated sludge is washed out to manhole in downstream by pressurized jetting water supplied from high pressure cleaning equipment.
- Drained sludge in manhole is sucked by a vacuum cleaner.

In this case, working pressure and jetting water volume of the high pressure cleaning equipment shall be controlled considering pipe diameter and settling conditions of sludge in sewer pipe. Generally, working pressure at 7 to 10 Mpa and jetting water volume of 110 to 130 L/min are applied for sewer pipe (diameter of 250 mm).

In large diameter sewer pipes, worker/s comes into a manhole and handles the suction hose of vacuum cleaning equipment. In this case, the vacuum cleaning equipment and the high pressure cleaning equipment are simultaneously operated. The high pressure cleaning equipment is mainly used to clean up manholes and softening the hardly adhered sludge in sewer.

A bucket machine is also applied for the places where introducion of a truck mounted cleaning equipment due to narrow road width, where temporary diversion of sewage flow are difficult due to strong sewage flow, and where sludge is accumulated in large quantity. However, when manhole interval is so large like in Dhaka City, setting up and operation of the bucket machine encounters serious difficulty. In this regard, application of the bucket machine is considered not appropriate in Dhaka City.

Presently, DWASA possesses high pressure cleaning equipment and vacuum cleaning equipment. In combination with manual cleaning equipment, DWASA is conducting sewer cleaning by these equipment. In view of DWASA's past experiences in handling high pressure cleaning equipment and vacuum cleaning equipment, it is deemed appropriate to introduce the same type of equipment. In addition, utilization of sludge hauling dump truck to carry sludge from the site to the Pagla STP will greatly empower the cleaning performance.

It shall be noted that deep manholes with depths of more than 6 m shall be paid special attention as follows:

- Commonly used vacuum cleaning equipment has theoretical vacuum capacity at the maximum 1 atmospheric pressure (-101 Kpa), but actual performance is known at about 0.9 atmospheric pressure (-90 Kpa), which is equivalent to actual suction depth of about 6 m.
- "Fourth Dhaka Water Supply and Sanitation Project Report" (1998, World Bank) shows survey data of existing manholes that more than 20 manholes have depths of 6 to 9 m.

These deep manholes and pump pits at pump stations shall be cleaned by following method and equipment:

<u>Cleaning method of deep manholes and pump pits</u>

- Accumulated sludge shall be removed by means of sand pump powered by generator and sent to vacuum cleaning equipment.
- Vacuum cleaning equipment will dehydrate water and transfer sludge to hauling truck.
- Workers may come into deep manholes for sewer cleaning upon after temporary stop sewage flow, checking presence of toxic/hazardous gases by detector and supplying fresh air into manhole from blower powered by generator.

<u>Cleaning equipment for deep manholes and pump pits</u>

- Sand pump
- Generator
- Lighting equipment
- Drain hose (150 m)
- Gas detector
- Blower

3) Cleaning plan of preferential cleaning section

It is desired to develop annual cleaning plan including target section and frequency, based on the survey results on accumulated volume of sludge in sewer pipes. However, such systematic cleaning plan has not been developed in by DWASA and large size main sewer has not been cleaned for long time owing to its locational condition in swampy area.

The selected preferential cleaning section is therefore assumed to have seriously accumulated sludge worse than lateral sewers. In this respect, the selected preferential cleaning section shall be cleaned "within two years upon delivery of necessary equipment to DWASA". This two year cleaning period is determined considering implementation timing of rehabilitation/reconstruction of Asad Gate Truck Main.

① Type of sewer cleaning work

a. High pressure cleaning work: To be applied for sewers with diameters of 600 mm or less.
b. Vacuum cleaning work: To be applied for sewers with diameters of 900 mm or larger and siphon section.

② Cleaning frequency

Actual working days are determined as follows:

a. Total working days in a year are considered to be 47 weeks after deducting 5 weeks of national holidays, Eid holidays and Ramadan. During 1 month of Ramadan period, annual overhauling of sewer cleaning equipment will be undertaken.
b. Four days are considered as working days in a week; 2 days a week are considered for rest, and 1 day is allocated for cleaning and maintenance of equipment, preparation for next cleaning work and other internal work such as record keeping. During rainy season (24 weeks a year), actual working days are considered to be 50 % of dry season or equivalent to 2 days a week.

Based on the above assumption, annual working days are calculated as follows:

Annual Working Days = 4 days/week x 23 weeks (dry season)
+ 2 days/week x 24 weeks (rainy season)
= 140 days/year

③ Standard work load

Standard daily work load (length of sewer pipe to be cleaned in a day) depends on type of cleaning equipment, size of sewer pipe, and volume of accumulated sludge. Commonly applied standard work load in Japan is summarized in Table 2-5.

Table 2-5 Standard Work Load in Japan (Unit: m/day)

Cleaning Method	Pipe Dia. (mm)	Degree of Sludge Accumulation (Percentage of pipe area)				
		10 %	20 %	30 %	40 %	50 %
High Pressure Cleaning	300	590	340	245	195	160
	350	505	285	205	160	135
	400	440	240	165	130	105
	450	380	205	140	110	90
	500	325	170	115	85	70
	600	220	130	95	75	65
Vacuum Cleaning	900	302	110	62		
	1,000	245	89	50		
	1,200	170	62	35		
	1,350	134	49	28		

Since the daily length of sewer cleaning also depends on skill of workers, the above Japanese standard work load cannot be applied to Bangladesh as it is. Hearing from DWASA staff revealed that usual working days of sewer cleaning using high pressure cleaning equipment and vacuum cleaning equipment are one to two days a week. Considering this current practice and average span of manholes at about 100 m, the daily progress of sewer cleaning will be about 50 to 100 m/day.

As a result, the most critical condition of standard work load in Japan was applied for the project as follows:

Table 2-6 Standard Work Load in Dhaka City

Cleaning Method	Pipe Diameter (mm)	Daily Length of Cleaning (m/day)	Remarks
High Pressure Cleaning	Less than 400	105	Diameter of less than 900 mm
	450	90	
	500	70	
	600	65	
Vacuum Cleaning	Less than 1,000	50	Diameter of more than 900 mm
	1,200	35	
	1,350	28	

④ Staffing schedule and task assignment

Staffing schedule and task assignment for high pressure cleaning and vacuum cleaning are summarized in Table 2-7.

Table 2-7 Staffing and Task Assignment of High Pressure Cleaning Work

Position	High Pressure Cleaning Equipment	Vacuum Cleaning Equipment	Water Tanker	Sludge Hauling Dump Truck	Major Task
Site Engineer	1	-	-		Site Management
Operator	1	1			Equipment Operation
Driver	-	-	1	1	-ditto-
Asst. Driver	1	1	-	-	Safety Guide, etc.
Worker	1	2			Field work

Note: Standard work time is 8 hours/day

Table 2-8 Staffing and Task Assignment of Vacuum Cleaning Work

Position	Vacuum Cleaning Equipment	High Pressure Cleaning Equipment	Water Tanker	Sludge Hauling Dump Truck	Major Task
Site Engineer	1	-	-	-	Site Management
Operator	1	1	-	-	Equipment Operation
Driver	-	-	1	1	-ditto-
Asst. Driver	1	1	-	-	Safety Guide, etc.
Worker	2	1	-	-	Field work

Note: Standard work time is 8 hours/day

4) Number of working days required for 1 set of cleaning equipment

The required number of working days in each of the selected preferential cleaning section can be estimated as (Length of target sewer section) / (Daily cleaning length). The estimated number of working days is summarized in Table 2-9.

5) Required number of cleaning equipment

Based on the annual working days (140 days/year) and required number of working days for sewer cleaning, the number of required cleaning equipment is estimated as follows:

(Required working days for sewer cleaning)/(2 year cleaning period)

= (Required number of sewer cleaning equipment set)

Zone I : 245.2/(140*2) = 0.88 set

Zone II : 142.0/(140*2) = 0.51 set

Zone III : 193.9/(140*2) = 0.69 set

Zone V : 38.6/(140*2) = 0.14 set

Zone VI : 182.2/(140*2) = 0.65 set

Total: 2.87 sets, say 3 sets

Table 2-9 Required Number of Working Days for Sewer Cleaning by MODS Zone

Type of Pipe	Diameter (mm)	Item	MODS Zone I	II	III	V	VI	Total
Brick Arch	1,372	Length (m)	2,500					2,500
		Daily Length (m)	28	28	28	28	28	28
		Required Working Days (day)	89.3	0.0	0.0	0.0	0.0	89.3
	914	Length (m)					1,200	1,200
		Daily Length (m)	50	50	50	50	50	50
		Required Working Days (day)	0.0	0.0	0.0	0.0	24.0	24.0
RC Pipe	975	Length (m)	1,040					1,040
		Daily Length (m)	50	50	50	50	50	50
		Required Working Days (day)	20.8	0.0	0.0	0.0	0.0	20.8
	900	Length (m)	3,400				3,280	6,680
		Daily Length (m)	50	50	50	50	50	50
		Required Working Days (day)	68.0	0.0	0.0	0.0	65.6	133.6
	600	Length (m)	1,270	4,890	5,980		980	13,120
		Daily Length (m)	65	65	65	65	65	65
		Required Working Days (day)	19.5	75.2	92.0	0.0	15.1	201.8
	450	Length (m)	2,880	1,100	6,570	2,750	730	14,030
		Daily Length (m)	90	90	90	90	90	90
		Required Working Days (day)	32.0	12.2	73.0	30.6	8.1	155.9
	400	Length (m)	1,230	3,800	3,030	840	6,900	15,800
		Daily Length (m)	105	105	105	105	105	105
		Required Working Days (day)	11.7	36.2	28.9	8.0	65.7	150.5
	350	Length (m)		820				820
		Daily Length (m)	105	105	105	105	105	105
		Required Working Days (day)	0.0	7.8	0.0	0.0	0.0	7.8
	300	Length (m)	410	1,110			390	1,910
		Daily Length (m)	105	105	105	105	105	105
		Required Working Days (day)	3.9	10.6	0.0	0.0	3.7	18.2
Total		Length (m)	12,730	11,720	15,580	3,590	13,480	57,100
		Daily Length (m)	—	—	—	—	—	—
		Required Working Days (day)	245.2	142.0	193.9	38.6	182.2	801.9

(2) Basic Concept of the Project

Basic concept of the project aims at cleaning of main and sub-main sewers in Dhaka City within 2-year period and provides 3 sets of sewer cleaning equipment consisting of each one unit of high pressure cleaning equipment, vacuum cleaning equipment, water tanker and sludge hauling dump truck, together with one set each of sand pump and its appurtenances as well as spare parts.

2-2-1-2 Pocicy on Equipment Procurement Plan

(1) Exclusion of MODS Zone IV

In MODS Zone IV, there is a small-bore sewer network implemented under the ADB finance. It covers approximately 50 to 100 households and collected sewage is once stored at cesspool and further transferred to three pump stations for disposal due to absence of treatment facility. In this respect, this small-bore sewer network is not connected to the existing sewerage system.

MODS Zone IV has only one unit of sewer cleaning team and systematical cleaning work is not undertaken. Considering these circumstances, MODS Zone IV is excluded from the provision of sewer cleaning equipment.

(2) Introduction of sewer cleaning equipment to preferential area

Observation on DWASA's sewer cleaning work at 5 different locations was carried out during the field investigation period and revealed that all of observed sewer were completely clogged. Through this observation, it is assumed that most of sewer is badly clogged by accumulated sludge, and manholes seem to be like cesspool.

Under these circumstances, cleaning of the existing sewer network seems to be difficult and prioritized cleaning work shall be taken up. Thus, preferential cleaning plan is prepared focusing on main and sub-main sewers with diameters of 400 mm or larger. Sub-main sewer with diameter of 300 mm being connected to pump stations and main sewer is also included in this plan.

(3) Utilization of existing sewer cleaning equipment

a. Truck-mounted high pressure cleaning equipment

Among the existing cleaning equipment, most of truck-mounted high pressure cleaning equipment has insufficient water pressure and is not able to perform required function. Even "operable equipment" recognized by MODS Zone Offices have leakage from pressurized water piping.

b. Truck-mounted vacuum cleaner

Truck-mounted vacuum cleaners are usually functioning, but all of them are not equipped with dehydration mechanism. Thus, vacuum tank is filled up with sucked sludge in 4 to 5 minutes of operation and is forced to dispose removed sludge frequently.

c. Trailer-mounted sludge pump

This type of equipment has engine-driven centrifugal pump, which is commonly used for irrigation and stormwater disposal, and is not capable to pump up sludge from manholes. Its usage is limited to remove stagnant sewage in manhole.

d. Water tanker and pick-up truck

These equipment are generally used for water supply works and their number is not sufficient. It is deemed difficult to share its usage with sewer cleaning activity.

Taking into account the above-mentioned present situation, the existing cleaning equipment are considered to be used for sewer cleaning other than main and sub-main sewers, with combination of manual cleaning.

(4) Type of new sewer cleaning equipment

As described in basic concept of the project, new sewer cleaning equipment shall be composed of truck-mounted high pressure cleaning equipment, truck-mounted vacuum cleaners, truck-mounted water tankers, and sludge hauling dump trucks.

(5) Staffing arrangement for operation of new sewer cleaning equipment

The present sewer cleaning staffs being assigned at each MODS Zone Office are considered to be kept for continuing cleaning works of lateral sewers other than main and sub-main sewer. For new equipment, DWASA shall appoint necessary number of staffs.

(6) Supply of spare parts

A long-term operation of sewer cleaning equipment largely depends on continuous procurement of spare parts as well as their well-organized store keeping and performance of DWASA's workshop.

Since cleaning activity in the preferential area of main and sub-main sewer will take two years and DWASA will further extend its activity to smaller diameter of sewer network, the project will procure a set of spare parts equivalent to 3-year operation.

2-2-2 Basic Plan

2-2-2-1 Study on Composition of Equipment

Sewer cleaning work shall be carried out with the use of afore-mentioned high pressure cleaning equipment and vacuum cleaning equipment, assisted by water tankers and other supporting equipment.

In this sub-section, required performance/function and composition of sewer cleaning equipment for effective and efficient implementation of cleaning activities are studied taking into account the sewer network profile and installation conditions in Dhaka City, clogging condition, traffic condition, etc.

a. Truck-mounted vacuum cleaning equipment

The existing truck-mounted vacuum cleaning equipment in DWASA are not equipped with dehydration mechanism. The absence of this dehydration system necessitates frequent disposal of sucked sludge with large amount of sewage, since the storage tank will be filled up in less than 10 minutes' operation. In this regard, sucked sewage and sludge are disposed off at street gutter nearby manholes, while it shall be carried to designated disposal site. Likewise, the vacuum cleaning equipment without dehydration mechanism jeopardizes smooth and efficient cleaning work.

Sludge volume accumulated in sewer pipes (diameter of 600 mm or smaller) in one section between two manholes is estimated as shown in Table 2-10. Length of one section is assumed at 100 m based on the common length of existing sewers between 80 m to 100 m.

Table 2-10 Volume of Sewage and Sludge in Sewer Pipe

Sewer Pipe			Manhole	Sludge & Sewage Volume to be Removed	
Inner Dia. (mm)	Area (sq.m)	Accumulated Volume of Sludge and Sewage (cu.m)	Standard Volume of Manhole (cu.m)	(1) Total Volume of Sludge and Sewage (Manhole Volume in Upstream/Downstream + Sludge & Sewage Volume in Sewer) (cu.m)	(2) Total Volume of Sewage (Manhole Volume in Downstream + Sludge & Sewage Volume in Sewer) (cu.m)
600	0.306	30.6	6.6	43.8	37.2
500	0.196	19.6	6.6	32.8	26.2
450	0.159	15.9	6.6	29.1	22.5
400	0.126	12.6	6.6	25.8	19.2
350	0.096	9.6	6.6	22.8	16.2
300	0.071	7.1	6.6	20.3	13.7

Note: Manhole size is referred to the standard specifications (4' x 4' x 16') for ϕ450mm pipe. Most of manholes are square shape.

As a typical example, sludge and sewage volume in sewer pipe of 400 mm diameter, which has the longest length among different diameters of sewer pipes, is taken up for estimation of accumulated sludge and sewage volume:

- 25.8 cu.m shall be removed, when manhole in upper stream is included,
- 19.2 cu.m shall be removed, when manhole in upper stream is excluded,
- Storage capacities of existing vacuum cleaning equipment are 6 cu.m, 8 cu.m and 9 cu.m, and
- About 3 to 5 trips between cleaning site and sludge disposal site will be required for

hauling sludge and sewage.

The above estimation clearly reveals that an efficient and effective implementation of sewer cleaning necessitates introduction of vacuum cleaner equipped with dehydration mechanism. This dehydration mechanism separates sludge and sewage in storage tank and sewage is returned to manholes. Assuming water contents of sucked sludge and at 95 % and dehydrated sludge at 75 % as the worst conditions, the dehydrated sludge volume decrease to only 1/5 of raw sludge. This enables that hauling of sludge from cleaning site to disposal site will be only once for one section of sewer to be cleaned.

In addition to the above, introduction of sludge hauling dump truck will further prolong actual work time in the field, especially for cleaning of large diameter sewer, which contains larger volume of accumulated sludge.

Sewer Cleaning Equipment:

Combination of vacuum cleaner equipped with dehydration system and sludge hauling dump truck.

Note: Load-carrying platform of sludge hauling dump truck shall be watertight design to prevent dropping of leachate from sludge, although dehydrated sludge has less water content.

b. Truck-mounted high pressure cleaning equipment

The standard design of truck-mounted high pressure cleaning equipment is equipped with 100 m long cleaning hose. When this standard design is introduced and applied for manholes at upstream and downstream, the maximum of about 180 m of sewer section can be cleaned (10 m of cleaning hose is considered to be used between equipment on ground and underground opening of sewer).

With regard to water volume for high pressure cleaning, the standard requirement specified in "the Guideline for Estimating Operation and Maintenance Cost of Sewerage System" (Japan Sewage Works Association) as follows:

- Average discharge volume: 150 L/min
- Actual operating hour: 2.5 hours/day
- Required water volume: 22.5 cu.m/day (150 L/min x 2.5 hours/day)

Based on the above calculation, the standard size (4 ton-chassis) of high pressure cleaner has a water storage capacity of 2.5 cu.m, which means supplemental water supply is indispensable for continuous operation of the high pressure cleaner.

When the standard size water taker (4 ton-chassis) having a water storage capacity of 4.5 cu.m is accompanied to the high pressure cleaner, 3 to 4 trips of water tanker between cleaning site and water supply point, such as MODS Zone Office or deep well pump stations, can fulfill the above mentioned requirement.

Sewer Cleaning Equipment:

Combination of truck-mounted high pressure cleaning equipment and water tanker.

Based on the foregoing studies a. and b., it is concluded that a combination of following equipment is deemed indispensable for efficient and effective implementation of sewer cleaning:

- Truck-mounted vacuum cleaner equipped with dehydration system,
- Sludge hauling dump truck,
- Truck-mounted high pressure cleaner, and
- Water tanker

c. Study on the most appropriate size of sewer cleaning equipment

There are three different sizes of sewer cleaning equipment, such as large size (8 ton-chassis), medium size (4 ton-chassis) and small size (2 ton-chassis). Standard specifications of these cleaning equipment are compared in 2-11.

Road width in preferential cleaning area of main and sub-main sewers surveyed during the field investigation are summarized as shown in Table 2-12.

The survey results revealed that larger sewer pipes are commonly laid under wide roads. However, sewer pipes with 450 mm diameters or smaller are usually laid under roads with width of less than 8 m.

Table 2-11 Comparison of Cleaning Equipment in Different Sizes

Description	Large (8 ton)	Medium (4 ton)	Small (2 ton)
Truck-Mounted Vacuum Cleaner			
Tank Capacity (cu.m)	4.5	2.3	1.7
Total Width (mm)	2,490	2,170	1,960
Total Length (mm)	7,620	6,200	5,550
Wheel Base (mm)	4,100	3,310	2,750
Total Height (mm)	3,300	2,700	2,500
Min. Rotating Radius (m)	6.9	5.5	5.3
Truck-Mounted High Pressure Cleaner			
Tank Capacity (cu.m)	4.5	2.5	2.0
Discharge Pressure (Mpa)	19.6	17.2	13.7
Total Width (mm)	2,490	2,170	1,960
Total Length (mm)	8,420	6,180	5.500
Wheel Base (mm)	4,100	3,310	2,570
Total Height (mm)	3,090	2,600	2,400
Min. Rotating Radius (m)	6.9	5.5	5.3
Water Tanker			
Tank Capacity (m^3)	8.0	4.5	2.5
Total Width (mm)	2,480	2,170	1,960
Total Length (mm)	7,365	5,765	5,090
Wheel Base (mm)	4,100	3,310	2,750
Total Height (mm)	3,000	2,600	2,180
Min. Rotating Radius (m)	6.9	5.5	5.3
Sludge Hauling Dump Truck			
Payload Capacity (m^3)	5.3	2.6	1.7
Total Width (mm)	2,490	2,225	1,995
Total Length (mm)	2,930	5,800	4,895
Wheel Base (mm)	3,700	3,310	2,750
Total Height (mm)	2,930	2,510	2,180
Min. Rotating Radius (m)	6.3	5.5	5.3

Table 2-12 Road Width in Preferential Cleaning Area of Main and Sub-Main Sewer

Sewer Diameter (mm)	Length (m)	Sewer Length by Road Width (m)		
		>20 m-8 m	8 m-6 m	6 m-4 m
900-975	6,780	5,680	720	380
600	8,700	7,620	250	830
450	11,310	8,570	710	2,030
400	15,030	9,510	1,740	3,780
350	820	0	0	820
300	1,910	400	800	710
Total	44,550	31,792	4,222	8,552
Percentage Composition by Road Width	100	71	10	19
Workability by Size of Equipment		Accessible by All Sizes	Accessible by Medium/Small Size	Difficult Even by Small Size in Daytime

Note: Road width is based on field survey results conducted in Oct. 2000.

Large size equipment (8 ton-chassis) has difficulty to access roads with width of 6 to 8 m, but medium to small size equipment are accessible. Roads with width of 6 m or less have more difficulty even for small size equipment, especially during daytime because of heavy traffic. In this respect, sewer cleaning shall be carried out on holidays and during nighttime. Wherever there are accessible roads nearby the cleaning site, cleaning equipment shall be temporary parked in such roads and suction/pressure hoses shall be extended to compensate access difficulty.

Considering the above mentioned road condition and functions and sizes of cleaning equipment, medium size equipment is the most suitable for Dhaka City in this Project.

d. Spare parts

Cleaning of preferential main and sub-main sewers are planned to be completed within two years. DWASA will continue cleaning activities toward smaller diameter of sewer in succeeding years, aside from periodical cleaning of preferential sewers. In this respect, necessary quantity of spare parts is considered to cover a total of 3-year period consisting of 2-year cleaning for preferential area and succeeding 1-year continuous cleaning.

It shall be noted that standard service life of cleaning equipment is normally 5 to 6 years as shown in Table 2-13, and actual service life is deemed to be further longer for about 10 years, if appropriate maintenance and supply of spare parts are taken up. Therefore, DWASA shall prepare necessary fund to ensure continuous procurement of spare parts.

Table 2-13 Standard Service Life of Sewer Cleaning Equipment

Type of Equipment	Standard Service Life (Year)	Remarks
Vacuum Cleaner	6.0	O&M Cost Estimate Guideline for Sewer System, Ministry of Land and Transportation, Japan
High Pressure Cleaner	5.0	
Water Tanker	6.0	
Dump Truck	8.1	Standard Depreciation Cost Estimation Guideline for Construction Equipment, Ministry of Land and Transportation, Japan

Note: Reference are issued for Fiscal Year 2000.

Currently, DWASA's existing cleaning equipment are encountering difficulty in repair works due to unavailability of spare parts for high pressure pump and vacuum pump, which are imported and assembled in India. Reasons for this difficulty are caused by either lack of fund and lack of supplier's support service. Another difficulty seems to be originated from lack of skills among technicians in DWASA's workshop. In this respect, appropriate OJT to transfer necessary skills is indispensable.

With regard to spare parts of truck chassis and its prime mover, there are many suppliers and procurement of necessary parts is generally easy. Thus, spare parts in this origin are excluded from the planned equipment.

Spare parts: Necessary quantity to meet with 3-year operating period shall be procured.

Contents and quantity of necessary spare parts are listed in Tables 2-14 to 2-17.

Table 2-14 Required Spare Parts for Truck-Mounted Vacuum Cleaner with Dehydration System (4 ton)

No.	Name of Spare Parts	Service Life	Required Quantity per 1 Set of Equipment	Required Quantity for 3-Year Operation
	Vacuum Pump			
1.	Sealing Compound	2	1	1
2.	Washer (1)	3	1	1
3.	Washer (2)	3	1	1
4.	Shaft Sleeve	3	2	2
5.	Ball Bearing	3	2	2
6.	Oil Seal (1)	1.5	2	4
7.	Oil Seal (2)	1.5	2	4
8.	Gland Packing	2	1	1
9.	Ball	3	1	1
10.	Setting Plate	5	2	4
	Hydraulic Parts			
11.	Suction Strainer	2	1	1
12.	Line Filter	2	1	1
13.	Cylinder Packing (1)	2	2	2
14.	Cylinder Packing (2)	2	2	2
15.	Cylinder Packing (3)	2	1	1
16.	Cylinder Packing (4)	2	2	2
	Electric Parts			
17.	Fuse	2	1	1
18.	Working Light	2	1	1
19.	Light	2	1	1
	Driving Unit			
20.	Oil Seal (1)	2	2	2
21.	Oil Seal (2)	2	1	1
22.	Universal Joint	2	1	1
23.	V-Belt	2	6	6
24.	PTO Assembly	2.5	1	1
	Overflow Check System			
25.	O-ring (P50)	2	2	2
26.	O-ring (P16)	2	2	2
27.	Scraper	2	1	1
	Sludge Tank			
28.	Hatch Packing	2	1	1
29.	Stay Plate	2	1	1
30.	Manhole Packing	2	1	1
31.	Connection Hose	2	1	1
	Others			
32.	Tachometer Cable	2	1	1
33.	Throttle Cable	2	1	1
34.	Valve Closure, Packing Holder	2	2	1
35.	4-way Valve Closure, Packing Holder	2	1	2
36.	Suction Hose (1)	0.24	1	13
37.	Suction Hose (2)	0.24	1	13

Note:Necessary quantity per a unit for 3 year operation.
Alternative parts are accepted, but their quantity shall be necessary parts for 3 year operation.

Table 2-15 Required Spare Parts for Truck-Mounted High Pressure Cleaning Equipment (4 ton) (1/2)

No.	Name of Spare Parts	Service Life	Required Quantity per 1 Set of Equipment	Required Quantity for 3-Year Operation
	Plunger Pump			
1.	Suction Valve Assembly	2	3	3
2.	Delivery Valve	2	3	3
3.	Seal Packing	1	12	36
4.	O-Ring (G60)	1	4	12
5.	O-Ring (G70)	1	3	9
6.	O-Ring (G75)	1	6	18
7.	O-Ring (G80)	1	3	9
8.	O-Ring (G85)	1	6	18
9.	Spacer (t3)	1	6	18
10.	Spacer (t5)	1	3	9
11.	Packing Guide	2	6	6
12.	Distant Coller	3	6	6
13.	Suction Valve Spring	3	3	3
14.	Delivery Valve Spring	3	3	3
15.	Valve Guide	3	6	6
16.	Guide Spindle	3	6	6
17.	Crank Pin Metal	3	3	3
18.	Gudgeon Pin Metal	3	3	3
19.	Oil Seal	1	1	3
20.	Rod Packing	1	3	9
21.	Scraper	1	3	9
22.	Retaining Ring	1	3	9
23.	Tongued Washer	1	6	18
24.	Gudgeon Pin Shaft	2.5	6	6
25.	Valve Assembly	2	1	1
26.	O-Ring (P14)	1	2	6
27.	O-Ring (P50)	1	1	3
28.	O-Ring (G35)	1	1	3
29.	O-Ring (G50)	1	1	3
30.	Collar	3	1	1
31.	Oiler	3	3	3
	Hydraulic Parts			
32.	Suction Strainer	2	1	1
33.	Line Filter	2	1	1
	Electric Parts			
34.	Fuse	2	1	1
35.	Cambric Fuse	2	1	1
36.	Water Level Warning Lamp	3	2	2
37.	Working Light	3	2	2
38.	Control Panel Light	3	1	1

Note:Necessary quantity per a unit for 3 year operation.
Alternative parts are accepted, but their quantity shall be necessary parts for 3 year operation.

Table 2-15 Required Spare Parts for Truck-Mounted High Pressure Cleaning Equipment (4 ton) (2/2)

No.	Name of Spare Parts	Service Life	Required Quantity per 1 Set of Equipment	Required Quantity for 3-Year Operation
	Driving Unit			
39.	Oil Seal (2)	2	1	1
40.	Universal Joint	2	1	1
41.	V-Belt	2	5	5
42.	PTO Assembly	2.5	1	1
	Water Tank			
43.	Inspection Batch Packing	1	1	3
	Pipe Parts			
44.	Strainer	2	1	1
45.	Ball Valve	2	1	1
46.	Swivel Joint	2	1	1
	Unloader Valve			
47.	Ball for Bypass Valve	2	1	1
48.	Bypass Valve Body	2	1	1
	Others			
49.	Tachometer Cable	2	1	1
50.	Throttle Cable	2	1	1
51.	High Pressure Hose (Main)	1	5	15
52.	High Pressure Hose (Sub)	2	1	1
53.	Nozzle	2	1	1
54.	Hose Guide Roller	2	1	1

Note:Necessary quantity per a unit for 3 year operation.
Alternative parts are accepted, but their quantity shall be necessary parts for 3 year operation.

Table 2-16 Required Spare Parts for Water Tanker (4 ton)

No.	Name of Spare Parts	Service Life	Required Quantity per 1 Set of Equipment	Required Quantity for 3-Year Operation
	Electric Parts			
1.	Fuse	2	1	1
2.	Working Light	2	1	1
3.	Light	2	1	1
	Driving Unit			
4.	Universal Joint Breaking	2	1	1
5.	PTO Assembly	2.5	1	1
	Overflow Check System			
6.	O-Ring (P50)	2	2	2
7.	O-Ring (P16)	2	2	2
8.	Scraper	2	1	1
	Water Tank			
9.	Manhole Packing	2	1	1
	Others			
10.	Tachometer Cable	2	1	1
11.	Throttle Cable	2	1	1
12.	Valve	2	2	2
13.	Suction Hose (1)	2	1	1
14.	Suction Hose (2)	2	1	1

Note:Necessary quantity per a unit for 3 year operation.
Alternative parts are accepted, but their quantity shall be necessary parts for 3 year operation.

Table 2-17 Required Spare Parts for Dump Truck (4 ton)

No.	Name of Spare Parts	Service Life	Required Quantity per 1 Set of Equipment	Required Quantity for 3-Year Operation
	Driving Unit			
1.	PTO Assembly	2.5	1	1
	Others			
2.	Dump Body Packing	2.5	1	1

Note:Necessary quantity per a unit for 3 year operation.
Alternative parts are accepted, but their quantity shall be necessary parts for 3 year operation.

2-2-2-2 Specifications of Required Equipment

Standardized common specifications of required equipment are determined as the minimum requirements based on comparative evaluation of three different suppliers.

Among others, those which considered to be basic common specifications are as follows:

a. Truck

Principal traffic rules in Bangladesh, such as keep-left and right-handle, are the same as those in Japan. Transmission shall be of 4x2 considering the road condition in Dhaka City. Power transfer to cleaning equipment shall be of PTO (Power-Take-Out) in view of mobility and cost effectiveness.

b. Cleaning equipment for deep manholes

Required performance of sand pump is determined taking into account the maximum depth of deep manholes and sludge volume. Generator for sand pump and blower shall have rated output at 30 KVA based on the start-up load and power consumption. Water-stop plug is excluded from the planned equipment in consideration of sizes of sewer and manholes. Trucks equipped with a crane are considered to be included for transportation of the cleaning equipment.

The required specifications of the above-mentioned equipment are summarized in Table 2-18.

Table 2-18 Required Quantity and Specifications of Sewer Cleaning Equipment

Name of Equipment	Specifications	Q'ty
1) Truck-Mounted Vacuum Cleaner with Dehydration System	Type: Medium size (4 ton class), equipped with dehydration system, out-rigger and hydraulic lift & dump mechanism for sludge tank, right-handle, 4x2, Engine: Water-cooled, 4-cycle, diesel engine Power transfer: PTO Max. Vacuum Pressure: more than -67 Kpa Max. Air Flow: more than 18 m^3/min Sludge Tank Volume: more than 2.2 m^3 Size of Suction/Drain Hose: more than 100 mm	3 units
2) Truck-Mounted High Pressure Cleaner	Type: Medium size (4 ton class), right-handle, 4x2 Engine: Water-cooled, 4-cycle, diesel engine Power transfer: PTO Max. Discharge Pressure: more than 17 Mpa Max. Discharge Volume: more than 200 liter/min Water Tank Volume: more than 2,500 liter High Pressure Hose: Hydraulic winding system, dia. of more than 3/4" and length of more than 100 m	3 units
3) Water Tanker	Type: Medium size (4 ton class), right-handle, 4x2 Engine: Water-cooled, 4-cycle, diesel engine Water Tank Volume: more than 4.4m^3 Delivery Pump Capacity: more than 400 liter/min Suction Pump Capacity: more than 3 m	3 units
4) Sludge Hauling Dump Truck	Type: Medium size (4 ton class), right-handle, 4x2 Load-Carrying Platform: shall be of watertight. Engine: Water-cooled, 4-cycle, diesel engine Engine Displacement: more than 6,000 cc	3 units
5) Other Equipment (Cleaning Equipment for Deep Manholes)	Sand Pump (0.4m^3/min x 15.5mH x 3.7kw, 1 unit), Control Panel of Sand Pump (1 unit), Generator (30 KVA, 50 Hz, 24 Kw, 1 unit), Lighting Equipment (2 lamps with 30 m cable in cord reel, 2 units), Drain Hose (150 m), Gas Detector (Methane, Butane, Hydrogen Sulfide, Oxygen, 1 unit), Blower (0.55 Kw, 50 Hz, AC 100V, single phase, 1 unit), Spiral Duct (5 m length, 2 units), Service Truck with Crane (4 ton, Crane boom with retracted length of more than 3 m, with extended length of more than 5 m, Hoisting capacity of more than 29 KN at 2.7m of working radius, 1 unit)	1 set
6) Spare Parts	Required spare parts excluding truck unit are shown in attached table.	3-year operation

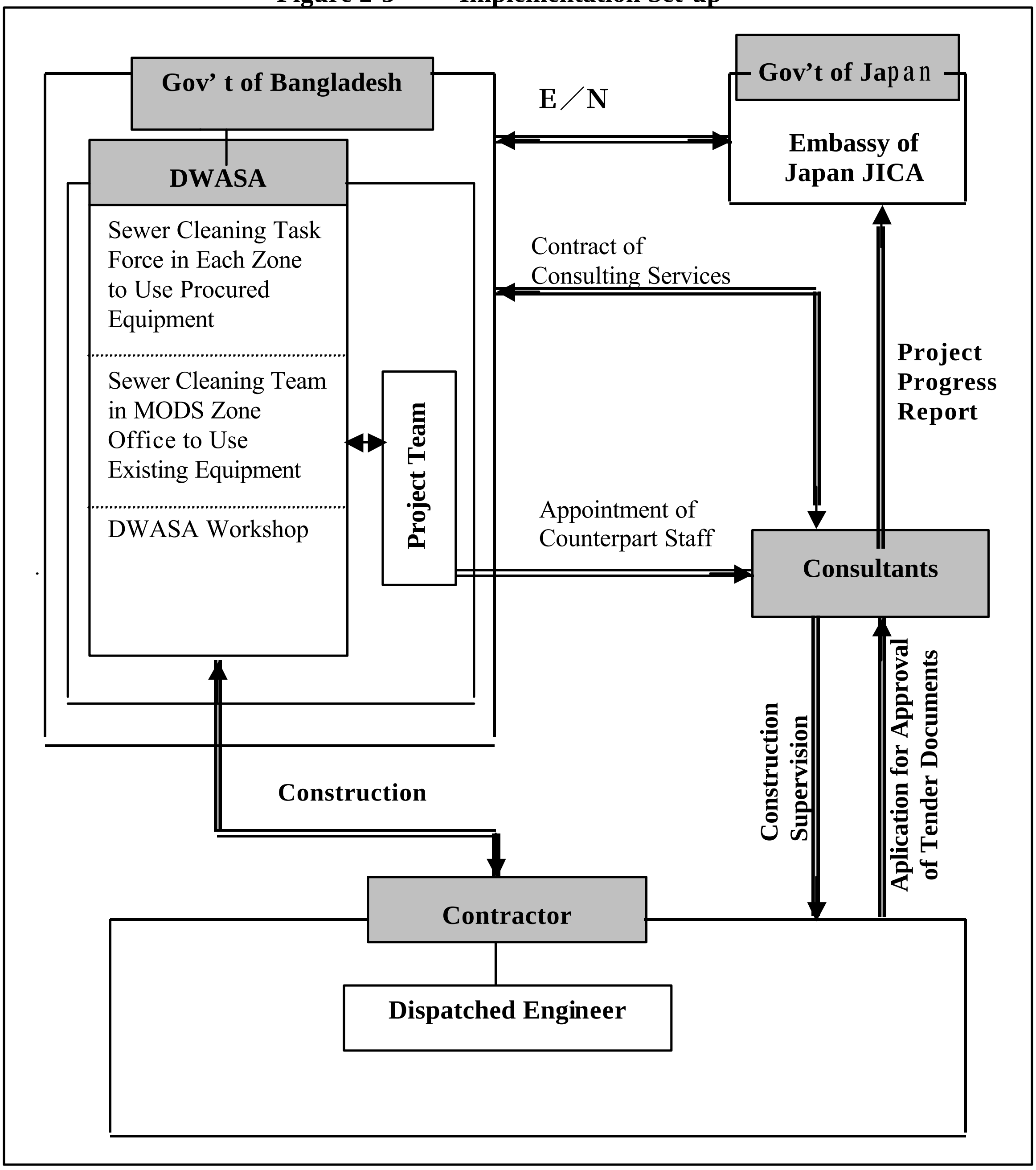
Note: Any figures (as dimension of chassis) shown in the above table are to have the permissible range ±10 %.

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Executing Agency of the project in Bangladesh is DWASA under the jurisdiction of MILGRDC, as shown below.

Figure 2-3 Implementation Set-up



For implemention of the project, close coordination and cooperation among the above-mentioned organizations/agencies are required. In this respect, DWASA shall appoint fulltime counterpart staff exclusively for the project to form a project team and close cooperation with the consultants in the project implementation. At present, a Project Director has been appointed, but no other particular staff members are not assigned yet. Prior to delivery of equipment, DWASA shall form a project team consisting of executive engineers, equipment operators, assistant operators, and workers to undertake the following assignments:

(1) Coordination and implementing arm of DWASA for the Project
(2) Liaison and Coordination within DWASA and with relevant agencies
(3) Cooperative enforcement of design, bidding and project supervision
(4) Planning, coordination and implementation of sewer cleaning plan with the sewer cleaning team in respective MODS Zone Offices, upon participating OJT to be rendered by Japanese Experts

The Japanese consultants shall undertake preparation of tender documents, assistance in bidding, supervision of procurement and delivery for smooth implementation and completion within the designated period of the project.

The Japanese contractor shall enter into procurement contract through bidding and negotiation with the Government of Bangladesh, and commence manufacturing and assembling of sewer cleaning equipmnent upon verification of the contract by the Government of Japan. At the delivery and turn-over of equipment, the Japanese contractor shall provide DWASA with trial operation and technical guidance on maintenance and repair work, as described hereafter.

2-2-4-2 Implementation Conditions

(1) Equipment Placement Plan

Currently, sewer cleaning work is undertaken by respective MODS Zone Offices. In this connection, the procured equipment under the Project is planned to be allocated to concerned Zone Offices for their operation and day-to-day maintenance. The equipment placement plan was prepared taking into account the number of equipment to be procured and locational conditions of concerned Zone Offices, as shown in Table 2-19.

Table 2-19 Equipment Placement Plan

MODS Zone No.	Sewer Cleaning Zone	Remarks
Zone I	Zone I	Zone I is one of the most important area, wherein Asad Gate Trunk Main is running through. Due attention is paid to this zone for allocating 1 set of equipment, since it requires 0.88 set of cleaning equipment to undertake its cleaning assignment.
Zone VI	Zones VI & II	Zone VI has also Asad Gate Trunk Main. This zone is considered to join with Zone II as adjacent to each other. A total equipment requirement by two zones at 1.16 set led to allocate 1 set to these zones.
Zone V	Zones V & III	In Zone V, there is also Asad Gate Trunk Main. Zones V and III, which are adjacenet to each other, shall receive 1 set of cleaning equipment, since a total equipment requirement in these zones show 0.83 set.
Workshop	All Concerned Zones	Cleaning equipment for deep manholes shall be common use by zones concerned and be therefore stationed in this workshop together with all spare parts.

(2) Equipment Operation and Maintenance Plan

Five units of the existing high pressure cleaning equipment in DWASA do not posses sufficient performance to discharge pressurized water, due to leakage and mulfunction of equipment.

On the other hand, the cleaning equipment to be provided under this project has quite high discharge pressure, even to dismember arms and fingers of workers, if he is hit directly by pressurized water. To avoide such potential danger and maintain safe operation of cleaning activities, appropriate training is deemed necessary, not only for supervising personnel, but also for field workers.

In addition, the planned cleaning operation shall be carried out as a team consisting of a vacuum cleaner equipped with a dehydration system, a high pressure cleaner, a water tanker and a sludge hauling dump truck. Likewise, pertinent team play shall also be adhered by DWASA personnels.

Due to long negliged maintenance of sewer network and inappropriate equipment and cleaning practices, the existing sewer network has been clogged in many locations resulting deterioration of urban environment. Periodical cleaning has not been taken up systematically associated with insufficient funding.

In view of the above situation, not only introduction of cleaning equipment, but also skills training for equipment operation, safety control and cleaning procedure is indeed necessary to be included in the project activities.

workshop by Japanese supplier for the period of one month, as shown in Table 2-20.

Table 2-20 Skills Training Plan

Type of Expert	Training Activity	Timing and Duration
Equipment Maintenance Specialist	Skills training to personnel of workshop and MDOS Zone Offices for maintenance and repair works.	One month period upon delivery of equipment to DWASA.

(3) Technical Assistance by Means of Soft Component

Training on sewer cleaning requires both class-room lecture and OJT to cover planning of sewer network cleaning, cleaning technology and procedure, safety and hygiene control, and it cannot be accomplished in short-term. To cope with this requirement, it is recommended to dispatch Japanese experts in this field under soft component of Japan's technical cooperation.

This soft component shall be started right after completion of the skills training on maintenance and repair works by Japanese expert and be undertaken by each one expert on sewer cleaning management and mechanical engineering expert for the period of about 5 months. Table 2-21 shows training activities and duration of soft component.

Table 2-21 Training Activities and Duration of Soft Component

Training Period / Training Activity	Months from Begining of Training					
		1st	2nd	3rd	4th	5th
	▲ End of Training on Maintenance and Repair					
(1) Preparatory Work (Discussion with DWASA, Preparation of Training Program and Handouts)						
(2) Lecture on Planning of Sewer Cleaning Work (To be implemented in 2 groups for lecture, field inspection of manholes for cleaning and planning of sewer cleaning work)						
(3) On the Job Training (To be implemented in 3 groups)						
(4) Cleaning Work by DWASA Staff (Experts will render field advices)						
(5) Summation of Training Activities						

(4) Site to Turnover the Delivered Equipment

Inspection of delivered equipment and spare parts will require considerable space. In this regard, delivery and turnover shall be made at the Pagla STP of DWASA. Upon inspection and turnover, DWASA shall allocate them to respective Zone Offices and workshop at its own expense.

2-2-4-3 Scope of Work

In accordance with the Minutes of Discussions and the outcome of this Basic Design Study, implementation conditions required for both Government of Bangladesh and the Government of Japan are determined as described below.

Table 2-22 Implementation Conditions to be Undertaken by Each Government

Required Undertaking	Responsible Government	
	Bangladesh	Japan
1. Payment of administration fee to the foreign exchange bank (Banking Arrangement and Issuance of Authorization to Pay)	○	
2. Transportation of Goods (Japan to Bangladesh)		○
3. Provision of Pertinent Storage Space	○	
4. Tax Exemption	○	
5. Provision of Assistance	○	
6. Technical Assistance on Maintenance and Repair of Sewer Cleaning Equipment		○
7. Establishment of Tast Force for Sewer Cleaning	○	
8. Appropriate Usage and O&M of Sewer Cleaning Equipment	○	
9. Appropriate Stock Keeping and Supplemental Procurement of Spare Parts	○	

Spare parts shall be kept at DWASA's workshop. In this connection, DWASA shall, at his own expense, prepare one set of desk top computer and necessary software to establish database of spare parts and control its inventory for proper stock keeping and supplemental procurement of consumed spare parts.

2-2-4-4 Consultant Supervision

Consultant supervision will enter into contract with DWASA upon execution of Exchange of Notes and will be effective when the contract is verified by the Government of Japan. Supervisory services will include the following activities and duration:

(1)	Final confirmation of content of the project with DWASA	7 days
(2)	Preparation of Tender Documents	15 days
(3)	Approval of Tender Documents by DWASA	14 days
(4)	Project briefing and Tender Document release	7 days
(5)	Bid evaluation	15 days
(6)	Factory inspection of manufactured goods by authorized inspection agency	5 days
(7)	Delivery inspection and issuance of delivery certificate in Dhaka	15 days

Throughout the course of the consulting services, consultants will maintain close coordination with both governments.

2-2-4-5 Procurement Plan

In Bangladesh, only DWASA posses Indian Truck-Mounted Vacuum Cleaners and High Pressure Cleaners. Taking into account this fact, sewer cleaning equipment made in India and Japan are compared as shown in Table 2-23.

(1) Cost

Market prices of Indian sewer cleaning equipment are commonly cheaper than Japanese one.

(2) Procurement Conditions

Among existing sewer cleaning equipment in DWASA, most of high pressure cleaners (5 units) and a part of vacuum cleaners are not functioning properly. This phenomena owes to difficulty in repairing high pressure pumps or vacuum pumps of cleaning equipment, being generally caused not only by repair techniques, but also by difficulty in purchasing necessary spare parts from India. Sewer cleaning equipment supplied from India are only assembled in India using imported units, such as high pressure pumps and vacuum pumps. Likewise, Indian assembler itself encounters difficulties in purchase arrangement of necessary units to supply for customers.

Japanese manufacturers, on the other hand, take full responsibility for manufacturing and assembling of their products and gurantee supply of required spare parts/units.

(3) Sales Representative in Bangladesh

Indian assemblers do not have sales representative in Bangladesh. Thus, customers are forced to

Table 2-23 Comparison between Indian and Japanese Sewer Cleaning Equipment

Item	Indian Products		Japanese Products	
	Contents of Comparison	Evaluation	Contents of Evaluation	Evaluation
Products	① Vacuum Cleaner (8 ton) ② High Pressure Cleaner (8 ton) (Discharge Pressure: 14 Mpa × 270 L/min) ③ Water Tanker (8 ton) ④ Dump Truck (8 ton)	△	① Vacuum Cleaner (4 ton) ② High Pressure Cleaner (4 ton) (Discharge Pressure: 17.2 Mpa × 200 L/min) ③ Water Tanker (4 ton) ④ Dump Truck (4 ton)	○
Quality	• Rough Appearance and Finishing (Roughness is remarkable at welded portion. Tank body is made of patching of steel sheets.)	△	• Manufactured under Quality Control and uniform quality maintenance as well as finishing work of products.	○
Performance	• 8-tons body is standard products and 4-tones body is manufactured at special order, leading to limitation to comply with specifications. ① No lifting mechanism is equipped, resulting labor intensive transfer of sludge from tank to dump truck, and poorer vacuum pump capacity (166 L/min x -90 Kpa). ② High pressure pump has poorer discharge pressure (14 Mpa) and high pressure nozzle is equipped only for sewer cleaning.	△	• Both 8 ton and 4 ton bodies are standard products. ① Sludge tank of vacuum cleaner is lifted for mechanical transfer of sludge to dump truck enabling continuous operation, and vacuum pump has higher capacity (350 L/min ② High pressure pump has higher discharge (more than 17 Mpa), and nozzles are equipped for both sewer cleaning and equipment cleaning.	○
Technical Compliance	• Products are assembled at small scale workshops with the use of units/parts imported mainly from EU, and therefore assemblers can hardly take manufacturers' liability both for products and supply of spare parts.	×	• Each manufacturer shoulders products' liability and gurantees steady supply of spare parts/units based on their customer support service.	○
Manufacturing and Delivery Period	• Delivery period may not be assured owing to special manufacturing at the order.	△	• Manufacturing: 6 months from receipt of purchase order. Delivery: 1.5 months from Japan to Dhaka.	○
Overall Evaluation	△		○	

In case of Japanese products, spare parts for trucks can be easily purchased in Dhaka since major manufacturers of Japanese truck have their sales representatives in Balgladesh. For Sewer cleaning equipment assembled on the truck, sales representatives of each manufacturer will also respond to inquiry and purchase order from customers.

(4) Quality and Performance

In terms of product's quality, Japanese products are generally made of monoblock casting or integral construction, while Indian products are made of patch-work of metal plates and poorfinishing of welding. In this regard, Indian products are deemed to have less strength and service life.

With regard to performance, Indian products have less output of high pressure pumps and vacuum pumps. Indian vacuum cleaner is not equipped with lifting mechanism of sludge tank and requires manpower unloading of sludge from tank to dump truck, resulting unefficient implementation of sewer cleaning work.

(5) Manufacturing and Delivery Period

In case of Indian products, 8 ton-chassis is their standard product and 4 ton-chassis is custom made, which will lead to difficulty in complying with specifications and delivery period.

Based on the aforementioned studies, it is recommended to purchase Japanese products rather than Indian products in terms of quality, performance, technical compliance and procurement conditions, while procurement cost of Indian products are less than that of Japan.

2-2-4-6 Implementation Schedule

The implementation schedule is prepared in due consideration of manufacturing period, ocean shipping and inland transportation as well as delivery inspection and technical assistance to DWASA personnel, as shown in Table 2-24.

Table 2-24 Project Implementation Schedule

Year	1st Year											
Month		1	2	3	4	5	6	7	8	9	10	11
Detailed Design												
Procurement												

The procurement process will include the following activities:

(1) Negotiation and arrangement with contractor for manufacturing: 10 days

(2) Manufacturing period: about 3 to 6 months

(3) Ocean shipping and inland transportation: about 1 month

- Ocean shipping from Japan to Chittagong, Bangladesh: about 20 days
- unloading, costum clearance and inland transportation to Dhaka: about 10 days

(4) Delivery inspection and turnover: about 6 days

(5) Technical guidance to DWASA for maintenance and repair: about 1 month

2-3 Obligations of Recipient Country

Undertaking by the Government of Bangladesh is shown in Table 2-22. Aside from those enlisted undertaking, the Government of Bangladesh shall:

- secure space and shelves for safekeeping of procured spare parts at workshop of DWASA,
- secure desk top computer and encode inventory of procured spare parts for proper stock keeping and management, and
- shoulder expenses on operation of sewer cleaning equipment to be incurred during technical guidance and OJT training of DWASA personnel.

Details of the undertaking by the Government of Bangladesh are broken down as follows:

(1) Garage

Garages at three (3) MODS Zone Offices shall be prepared for sewer cleaning equipment.

- Parking capacity: 4 cars/site (approx. 200 sq.m)
- Cost: 1.5 mil. Taka/site, total 4.5 mil. Taka

(2) Shelves to store spare parts

Provision of shelves for proper safekeeping of spare parts at DWASA Workshop.

- Cost: 0.4 mil. Taka

(3) Personal computer

Preparation of spare parts inventory and stock management as well as planning and monitoring of sewer cleaning program

- Cost: 0.7 mil. Taka/set, total 1.4 mil. Taka

(4) Incidental cost for initial operation

- Salary/wages: 0.177 mil. Taka for 30-persons/3-teams/month
- Fuel and lubricant: 0.259 mil. Taka for 3-sets/25-working days/month
- Total cost: 0.44 mil. Taka

Thus, the total cost requirements to be borne by the Government of Bangladesh was estimated at 6.74 mil. Taka.

2-4 Operation and Maintenance Cost

(1) Staffing Requirement for Operation of Sewer Cleaning Equipment

In accordance with the sewer cleaning plan, required staffs for operating a high pressure cleaner, a water tanker, a vacuum cleaner, and a dump truck are as follows:

1)	Sewer cleaning inspector:	1 person
2)	Operator of high pressure cleaner and vacuum cleaner:	2 persons
3)	Driver for water tanker and dump truck:	2 persons
4)	Assistant drive (hose handling, safety guide, etc.):	2 persons
5)	Field worker for manual cleaning:	3 persons
	Total	10 persons/team

A total of 3 cleaning team will be required corresponding to the number of equipment to be procured (3 sets). Thus, total of 30 persons will be required. In addition, each Zone Office may be required to assign an Executive Engineer and an Assistant Engineer for administrative work.

(2) Expenses to be Borne by DWASA

Upon introduction of the sewer cleaning equipment, salaries/wages of sewer cleaning team shall be secured by DWASA. As shown in Table 2-25, a total of 2,125,200 Taka shall be borned by DWASA.

Table 2-25 Wages/Salaries of Sewer Cleaning Team

Position	Average Salary (Taka/month)	No. of Staff	Total Salary/Year (Taka)
Executive Engineer	14,500	1	174,000
Asst. Engineer	12,000	1	144,000
Inspector	6,000	3	216,000
Operator	6,700	6	482,400
Driver	6,700	6	482,400
Asst. Driver	3,000	6	216,000
Field Worker	3,800	9	410,400
Total			2,125,200

Note: Average salary is referred to DWASA data as of Nov. 2000.

(3) Annual Operation Cost of Equipment

Annual cost on operation and maintenance of the sewer cleaning equipment is estimated as folllows:

1) Regular cleaning activity shall be carried out by a combination of 4 units of equipment (a high pressure cleaner, a water tanker, a vacuum cleaner, and a dump truck). Annual operating days is assumed to be 140 days.
2) Manholes deeper than 6 m shall be cleaned by the aforementioned combination with the use of sand pump to be powered by generator and mobilized by truck. A total of 20 days/year is considered to clean 22 locations of deep manholes.
3) Operating cost consisting of fuel (diesel) and lubricant is estimated, referring to the standard consumption rate specified in "Guideline for Cost Estimate of Operation and Maintenance of Sewerage Facilities - Sewer Network" (Japan Sewage Works Association). An actual unit consumption rate is considered at 120% of the said standard consumption rate in consideration of heavy traffic conditions in Dhaka City. It shall be noted that cost for fresh water for sewer cleaning and sludge treatment are not considered.

Daily operation cost for 1 set of equipment is estimated as shown in Table 2-26:

Table 2-26 Daily Operation Cost of Sewer Cleaning Equipment

Name of Equipment	Consumables	Unit	Quantity	Unit Cost (Taka)	Operating Cost (Taka)	Remarks
1. High Pressure Cleaner	Fuel	liter	35.28	15.5	546.84	4.9 L/hr x 1.2 x 6 hr
	Luburicant	set	1		109.37	20% of fuel
	Sub-Total				656.21	
2. Vacuum Cleaner	Fuel	liter	48.96	15.5	758.88	6.8 L/hr x 1.2 x 6 hr
	Luburicant	set	1		151.78	20% of fuel
	Sub-Total				910.66	
3. Water Tanker	Fuel	liter	34.56	15.5	535.68	4.8 L/hr x 1.2 x 6 hr
	Luburicant	set	1		107.14	20% of fuel
	Sub-Total				642.82	
4. Dump Truck	Fuel	liter	17.04	15.5	264.12	7.1 L/hr x 1.2 x 2 hr
	Luburicant	set	1		52.82	20% of fuel
	Sub-Total				314.94	
Total (1. + 2. + 3. + 4.)					2,524.63	
5. Generator	Fuel	liter	33.60	15.5	520.80	5.6 L/hr x 6 hr
	Luburicant	set	1		104.16	20% of fuel
	Sub-Total				624.96	
6. Hauling Truck	Fuel	liter	17.04	15.5	264.12	7.1 L/hr x 1.2 x 2 hr
	Luburicant	set	1		52.82	20% of fuel
	Sub-Total				316.94	
Total (5. + 6.)					941.90	
Grand Total					3,466.53	

Based on the above-estimate, the annual operation cost is calculated as follows:

1) Regular cleaning: 2,524.63 Tk/day x 140 days/year x 3 set = 1,060,345 Taka/year

2) Deep manhole cleaning: 941.9 Tk/day x 20 days/year = 18,838 Taka/year

3) Total = 1,079,183 Taka/year

(4) Cost for Procurement of Spare Parts

Upon completion of preferential cleaning of main and sub-main sewer for 2 years and consequent cleaning work for 1 year, DWASA shall, at his own expense, procure required spare parts. The necessary procurement cost is estimated as follows:

Annual procurement cost:	21,000,000 Yen
Freight and Insurance:	2,700,000 Yen
Total:	23,700,000 Yen (11,650,000 Tk)

(5) Annual Operaion and Maintenance Cost

The annual operation and maintenance cost consisting of salaries/wages of DWASA personnel, operating cost of equipment, and spare parts procurement is estimated at 14,854,000 Taka, with following breakdown:

Operating cost of equipment:	1,079,000 Taka/year
Salaries/wages:	2,125,000 Taka/year
Spare parts procurement:	11,650,000 Taka/year
Total:	14,854,000 Taka/year

This annual O&M cost (14,854,000 Taka/yea) falls within sustainable level when compared with DWASA's annual cash flow (refer to Table 3-1) that it occupies about 26 % of the surplus in 1999 (55,896,000 Taka).

In addition to the above estimation, depreciation cost is also calculated at about 20,103,000 Taka/year, assuming that the equipment will have 10 years of service life based on the standard service life and actual operating conditions. When this depreciation cost is added on the annual operation and maintenance cost, the total cost will reach at about 34,95,000 Taka/year, which is equivalent to about 63 % of annual surplus in 1999.

2-5 Other Relevant Issues

Since the training on sewer cleaning shall be carried out by means of both class-room lecture and on-the-job training covering broad aspects of activities, i,e, preparation of sewer cleaning plan, cleaning method, safety and hygien management, etc., it is difficult to achieve the objectives of training in a short period. In this respect, an introduction of technical assistance, such as dispatch of experts by means of soft component to the grant aid is deemed indispensable.

This technical assistance is planned to be commenced just after completion of the initial guidance and training on equipment operation and maintenance. Contents and schedule of technical assistance are exhibited in Table 2-27 and summarized hereafter.

(1) Necessity of technical assistance by soft component and targets to be achieved

1) Necessity of technical assistance

- Most of existing sewer network in Dhaka City is clogged:
  This problem is originated from absence of appropriate sewer cleaning program and cleaning method at DWASA and is deemed to be solved by an introduction of technical assistance through soft component to the grant aid program.
- DWASA shall adhere systematic cleaning equipment and method:
  Functions of new equipment and their operation require a systematic cleaning plan and team work. DWASA personnel being assigned for sewer cleaning shall thoroughly acquire this know-how and skills.

2) Targets to be achieved

- Advancement/improvement of knowledges on sewer cleaning and sewage works in general.
- Acquisition of know-how and skills in developing a systematic sewer cleaning plan covering target area for annual/montly cleaning, monthly and weekly work schedule, design of daily report, manpower allocation, procurement of fuel and consumable goods, etc.
- Capable to carry out sewer cleaning in accordance with cleaning plan.
- Capable to remove clogging sludge and debris with the use of new equipment.
- Well acquaintance of systematic operations of new equipment.

3) Expected effects by introduction of technical assistance (soft component)

- DWASA personnel assigned to sewer cleaning will acquire knowledges on sewer cleaning tehnology and onverall sewage works.
- DWASA will be capable to develop systematic sewer cleaning program.
- DWASA will be capable to carry out sewer cleaning in accordance with the sewer cleaning program.

- Clogging problem on main and sub-main sewers in Dhaka City will be dissolved and collected sewage will smoothly flow down to the Pagla STP as the sewer network will resume its principal function.

(2) Activities and their magnitude

1) Scope of activities

- Organization of sewer cleaning task force
- Guidance and instructions on developing method of sewer cleaning plan and on scope of cleaning plan.
- Preparation of teaching materials and handouts pertaining to generals on sewage works, sewer cleaning method, safety and hygine management, etc.
- Lectures to DWASA personnel.
- On-the-job training.
- Supervision and advisement of sewer cleaning work to be undertaken by DWASA.
- Summation of technical assistance program.

2) Magnitude

- Short-term experts will consist of one person each for sewer cleaning and mechanical engineering for about 6 month period.

Table 2-27 Contents and Duration of Technical Assistance by Soft Component

Scope of Work	Months					
	0	1st	2nd	3rd	4th	5th
	▲ Completion of Initial O&M Training					
1. Preparation (Discussion with DWASA, preparation of training program and teaching materials/handouts)						
2. Lecture and Development of Sewer Cleaning Plan (2-groups for lectures, inspection of sewer network for OJT, development of sewer cleaning plan)						
3. On-the-Job-Training						
4. Self Operation of Sewer Cleaning by DWASA (Supervision/advicement by Japanese experts)						
5. Summation of Technical Assistance						

Chapter 3

Chapter 3 Project Evaluation and Recommendations

3-1 Project Effect

The sewerage system of Dhaka City is composed of sewer network, covering Gulshan district in north and Old Dhaka City in south, and the Pagla STP located in south end. However, since most of these sewer pipes are clogged, only a part of generated sewage is conveyed to the STP. Further, raw sewage overflowing from manholes due to pipeline clogging is discharged into the public water bodies, namely rivers and lakes, through drainage canals and is aggravating the living environment of Dhaka City.

Capacity of sewer pipeline will be recovered and incoming sewage flow will be increased through the implementation of this project. Consequently, raw sewage volume discharged into public water bodied will be reduced and sanitary environment of Dhaka City will be remarkably improved. The expected project effects are presented in Table 3-1.

3-2 Recommendations

In order to activate and sustain the project effect, Bangladesh side shall tackle the following issues and the following technical cooperation will be necessary:

(1) Formation of Cleaning Project Team

Upon introduction of proposed cleaning equipment, Bangladesh side shall form the Cleaning Project Team under the direct control of the DWASA headquarter. This Project Team shall coordinate with each MODS Zone Office; to secure the necessary staff and budget for the cleaning work with proposed equipment, to acquire the knowledge on sewerage system, to prepare the cleaning plan, and to transfer the technology on pipe cleaning.

(2) Implementation of Soft Component

Current pipe cleaning method is not appropriate. DWASA only removes waste and sludge accumulated in sewer only when complained by residents and such cleaning works have never achieved the original objectives of pipe cleaning work, i.e. recovery of sewer capacity.

Therefore, technical transfer regarding the following items shall be conducted to the relevant staff for the efficient operation of the proposed pipe cleaning equipment:

Table 3-1 Expected Project Effects

Current Status	Countermeasures to be Taken by this Project	Project Effects
1. Pipeline cleaning is not conducted appropriately due to capacity deficiency of the existing cleaning equipment.	- 3 sets of the following equipment will be purchased: a) High Pressure Cleaning Equipment b) Vacuum Cleaner with Dehydration System c) Water Tanker d) Sludge Hauling Truck - 1 set of Cleaning Equipment for Deep Manholes and 1 set of spare parts will be procured.	- Proper sewer pipe cleaning according to their diameter, depth, accumulated sediments will be enabled. - Pipe cleaning work will be more efficiently.
2. Systematic and proper cleaning method is not recognized by supervisor and workers.	- Organize Cleaning Project Team with procured equipment and secure necessary workers, engineers. - Soft Component will also be implemented for the technical transfer of the pipe cleaning.	- Participants' knowledge on pipe cleaning and sewerage system will be enhanced. - Rational and efficient pipe cleaning method will be acquired.
3. Incoming sewage flow is less than half of the design capacity of Pagla STP and STP is not displaying its full performance.	- Priority cleaning sections will be set on trunk and semi-trunk sewers - Cleaning plan will be prepared and target cleaning districts will be cleaned within 2 years.	- Incoming sewage to Pagla STP will be increased up to its design capacity. - To maximize this project effect, "the Emergency Sewer Construction Project in North Dhaka" shall be implemented along with this project.
4. Overflowed raw sewage is discharged to public water bodies through drainage canals and is deteriorating the sanitary condition in Dhaka City.	- Pipe clogging will be solved by systematic cleaning.	- Discharged raw sewage volume will be decreased from 41,200 m^3/day to 96,600 m^3/day and sanitary condition of Dhaka City will also be remarkably improved. - To maximize this project effect, "Emergency Sewer Construction Project in North Dhaka" shall be implemented along with this project.
5. Beneficiaries	- Pipe cleaning equipment procurement and cleaning works in priority cleaning sections.	- Living environment of local population of about 1.12 million inhibiting in sewerage service area will be improved and inundation by sewage gushing out from manholes will be solved.

a) Pipe cleaning methods
b) Systematic sewerage map
c) Sanitary control
d) Capacity and function of proposed equipment
e) Cleaning plan

However, such technical transfer cannot be accomplished by short-term training and training through actual site cleaning work will be efficient. Thus, implementation of the soft component by dispatched experts from Japan is necessary.

(3) Reservation of Storage Yard for Procured Equipment and O&M Budget

Storage yard for procured equipment will be within MODS Zone I, V, VI and workshop site. While, DWASA shall reserve the storage yard and shall prepare the spare parts procurement plan based on the inventory control for the stable and long-term O&M works. Periodical inspection shall be conducted to maintain the performance of the equipment.

(4) Relationship with Emergency Sewer Construction Project in North Dhaka

The trunk sewer passing through Gulshan district, Bashaboo/Saydabad PSs and reaching to the Pagla STP is heavily deteriorated and resulting in remarkable sewage leakage. As described in section 3-1, implementation of “the Emergency Sewer Construction Project in North Dhaka”, which is the rehabilitation project of said trunk sewer, is indispensable to maximize the effect of this project and therefore, its early implementation is desirable.