NO

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR THE RETRIEVAL OF SEWAGE AND DRAINAGE SYSTEM IN LAHORE CITY

IN

THE ISLAMIC REPUBLIC OF PAKISTAN

DECEMBER 2004

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.

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PREFACE

In response to a request from the Government of the Islamic Republic of Pakistan, the Government of Japan decided to conduct a basic design study on the Project for the Retrieval of Sewage and Drainage System in Lahore City and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Pakistan a study team from August 3rd to September 11th, 2004.

The team held discussions with the officials concerned of the Government of Pakistan, 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 Pakistan in order to discuss a draft basic design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Islamic Republic of Pakistan for their close cooperation extended to the team.

December 2004

Seiji Kojima
Vice-President
Japan International Cooperation Agency

December 2004

Letter of Transmittal

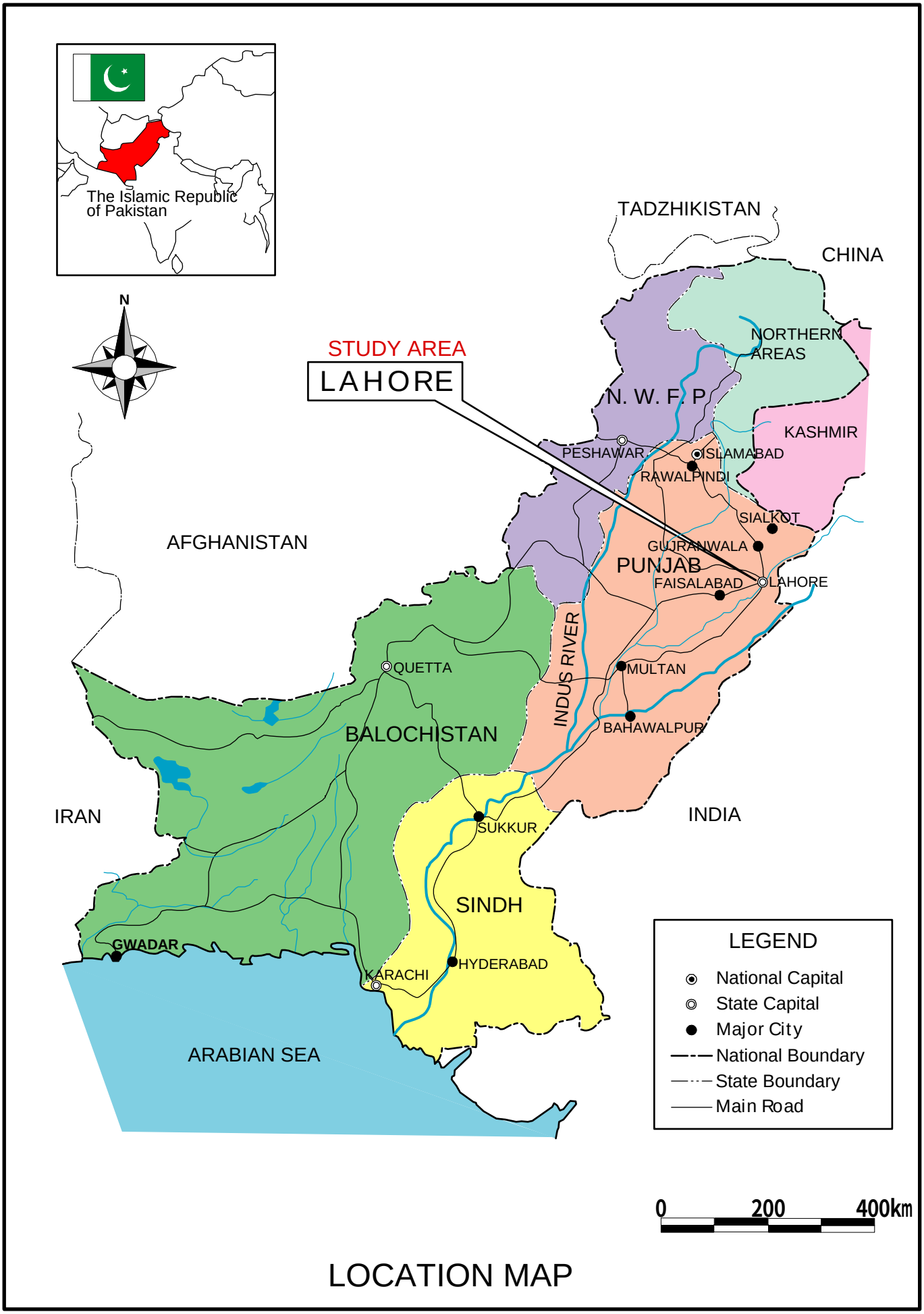
We are pleased to submit to you the basic design study report on the Project for the Retrieval of Sewage and Drainage System in Lahore City in the Islamic Republic of Pakistan.

This study was conducted by CTI Engineering International Co., Ltd, under a contract to JICA, during the period from July to December 2004. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Pakistan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

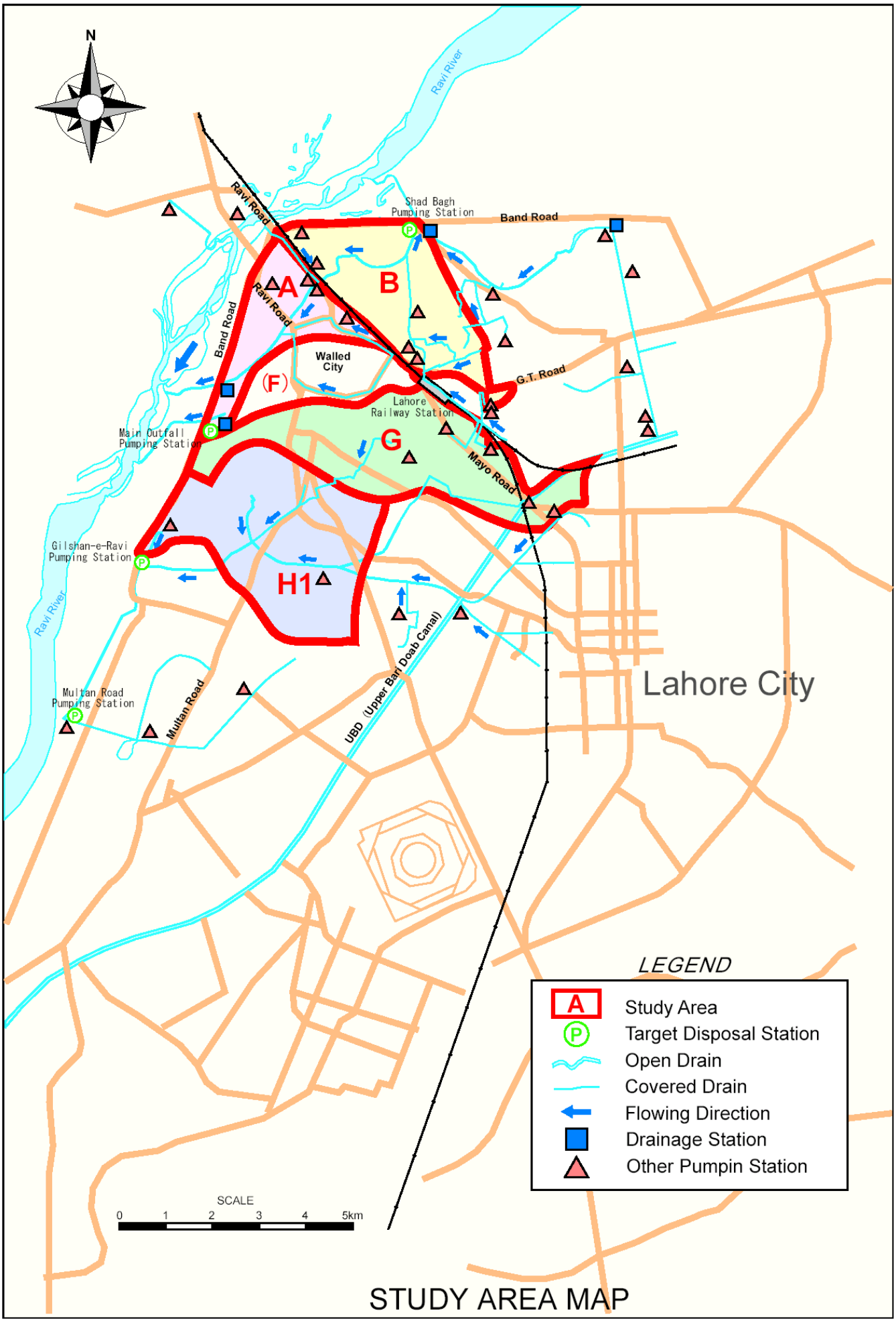
Finally, we hope that this report will contribute to the further promotion of the project.

Very truly yours,

Kazuyoshi Kageyama
Project manager,
Basic design study team on
The Project for the Retrieval of Sewage
and Drainage System in Lahore City
CTI Engineering International Co., Ltd.



LOCATION MAP



STUDY AREA MAP

ABBREVIATIONS

A/P	Authorization to Pay
AAGR	Annual Average Growth Rate, %
B/A	Banking Arrangement
CIF	Cost, insurance and Freight
DFID	Department for International Development
DMD of WASA	Deputy Managing Director of WASA
E/N	Exchange of Notes
EAD	Economic Affairs Division
EIA	Environmental Impact Assessment
EOJ	Embassy of Japan in Pakistan
FOB	Free on Board
GOP	Government of Pakistan
HUD&PHED	Housing, Urban Development and Public Health Engineering Department
IBRD	International Bank for Reconstruction and Development
IEE	Initial Environmental Examination
L/A	Loan Agreement
LDA	Lahore Development Authority
M/M	Man Months
MD of WASA	Managing Director of WASA
N/V	Note Verbal
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
ODA	Official Development Assistance
PDD	Planning and Development Department
PEPA	Pakistan Environmental Protection Agency
PEPD	Punjab Environmental Protection Division
PMU	Project Management Unit
PQ	Pre-Qualification
R/D	Record of Discussions
SDO	Sub-divisional Office, Sub-divisional Officer
SWMD	Solid Waste Management Department
TOR	Terms of Reference
UNDP	United Nations Development Program
WASA	Water and Sanitation Agency in Lahore
XEN	Executive Engineer

SUMMARY

Lahore, the capital city of Punjab, is the second largest city of Pakistan. The city has a population of about 7.2 million and plays an important role in country's economy. However, urban infrastructures such as roads, water service, sewage and drainage systems have not been improved to cope with the development and expansion of the city. Particularly, the silted or choked sewage lines and drainage channels are big hazard and threat to the urban environment. The situation aggravates in Monsoon season causing flooding in many places resulting in not only impediment to the traffic and business but also degradation of sanitary environment.

Water and Sanitation Agency (WASA), one of the constituent agencies of Lahore Development Authority (LDA), is in charge of operation and maintenance of sewage and drainage systems in downtown of Lahore city. At present, desilting operations are carried out mostly by manual labor in order to correspond to the emergency need, and practically no action is taken to improve system and facility according to medium or long-term plan. In Lahore city, there are about 223 km of sewers and 41 km of drainage channels. These are originally designed as separate systems. However, sewer pipes are connected to drains at various points and a large amount of sewage constantly enters storm water drains at various points and is ultimately disposed into the Ravi river. People are complaining about the stench generated from wastewater in open channels, which are full of sludge and garbage. Flood is attributed to the reduction of flow capacity of sanitary sewers and storm water drainage channels, which are silted up and clogged with solid waste. In addition, pumping stations have not sufficient drainage capacity to cope with heavy rains.

Under the above circumstances, LDA has prepared "Integrated Master Plan for Lahore-2021" setting the year 2021 as a target year, and it has proposed various projects with the aim of improving urban environment to cope with city development. This master plan consists of the following three phases: phase 1 for the first five years as short-term plan, phase 2 for the next five years as medium-term plan, and phase 3 for the last ten years as long-term plan. In this regard, urgent projects are enlisted in the short-term plan. As for sewage and drainage sector, it includes the increase in existing pumping capacity, procurement of desilting/cleaning equipment and retrieval of sanitary sewers and drains.

Based on the master plan, WASA has prepared an Action Plan with a view to improving drainage capacity at northern part of Lahore City, which includes zones A, B, G and H1, known as part of administrative and commercial cores and the most serious flood-prone area. It is proposed in the Action Plan that additional pumps at existing pumping stations should be installed and cleaning/desilting operations for 79 km of sewer pipes and 28 km of drainage channels be completed in three years. WASA intends to set up Project Management Unit-II (PMU-II) for undertaking the project and will place about 220 staff members therein.

In June 2002, the Government of Pakistan made a request to the Government of Japan for the provision of pumps and necessary equipment for cleaning/desilting works under the Grant Aid. In response to the above request, JICA dispatched a Preparatory Study Team to Lahore in February 2004 to confirm the necessity of the project and recommended further detailed

study as a result. And then, the Government of Japan has decided to conduct a Basic Design Study for the project and entrusted the study to JICA. JICA sent the Basic Design Study Team to Pakistan from August 3 to September 11, 2004 for the field survey and data collection. After the technical examination in Japan, the team was dispatched again to Pakistan from November 5 to November 14, 2004 for the explanation of the draft report, and as a result of discussions, the Pakistan side basically agreed to the contents of the report.

The project aims to improve the existing sewage and drainage system and alleviate flood damage at the northern part of Lahore City. Within the framework of this project, the requested Grant Aid is to focus on the supply of additional pumps to existing pumping stations and cleaning/desilting equipment for sewer pipes, drainage channels.

The equipment has been selected with due care and attention. Particularly, the following should be taken into account: 1) the capacity of WASA/PMU-II in terms of management and operation/maintenance and work experience of the existing equipment; 2) good work efficiency and favorable working environment; 3) environmentally acceptable; and 4) natural conditions in Lahore City such as raining pattern, type of sediment and quality of wastewater. The outline of the selected equipment for the project is listed in the following table.

Outline of the Selected Equipment

Category	Name of Equipment	Quantity	Use
Cleaning Equipment for a Sewer Pipe	Jetting machine (Truck mounted type)	4	Smashing solid sludge and removing blocked material in pipes.
	Sludge sucker (Truck mounted type)	4	Sucking and removing sludge from sewage pipes, dewatering from the tank and loading sludge to damp truck.
	Water tanker	2	Supplying water to jetting machine.
	4t class dump truck	4	Transporting removed sludge to the final disposal site and discharging thereto
	Submersible sludge pump	4	Drainage of sewage pipes to facilitate desilting work.
	Generator	4	Power supply for the operation of submersible sludge pump
Cleaning Equipment for a Drainage Channel	Clam shell excavator	2	Desilting of large drainage channels and removing garbage/trash in water inflow section at pumping stations.
	Hydraulic excavator ($0.28m^3$)	2	Cleaning and desilting in small drainage channels, and loading the removed sludge to the dump trucks.
	Hydraulic excavator ($0.8m^3$)	1	Cleaning and desilting in large drainage channels, and loading the removed sludge to the dump trucks.
	8t class dump truck	20	Transporting removed sludge and garbage to the final disposal site and discharging thereto
Monitoring Equipment	Pickup truck	4	Patrolling flooded areas and observing flood situation (flood coverage area, water depth and draining time) at 20 monitoring sites.
Cleaning Equipment for a Pumping Station	Wheel loader	2	Loading raked trash and garbage of pumping station to the dump truck.

Pump and the Related Equipment	Shad Bagh Pumping Station		
	Pump	2	Draining sewer, which collected in the pumping station, to the Ravi River.
	Motor	2	
	Suction valve	2	
	Check valve	2	
	Delivery valve	2	
	Piping material	2	
	Low voltage control panel	2	
	Multan Road Pumping Station		
	Pump	2	Draining sewer, which collected in the pumping station, to the Ravi River.
	Motor	2	
	Suction valve	2	
	Check valve	2	
	Delivery valve	2	
	Piping material	2	
	High voltage control panel	2	
	Gulshan-e-Ravi Pumping Station		
	Pump	2	Draining sewer, which collected in the pumping station, to the Ravi River.
	Motor	2	
	Suction valve	2	
	Check valve	2	
	Delivery valve	2	
	Piping material	2	
	Main Outfall Pumping Station (automatic trash rake system)		
	Raking machine	1	Removing trash/garbage to protect pumps and their function from being damaged.
	Level conveyor	1	

In response to WASA's request, the project will include not only the procurement and installation of equipment but also providing technical guidance service, so called "Soft Component". In this regard, two components are considered in the Soft Component; one is technical assistance for PMU-II to establish operation and management system for cleaning/desilting works, and the other one is a technical support for model implementation. The technical guidance service is expected to be a tool for overcoming difficulties that lie ahead in the operation and will contribute to the project with sustainable effects. The action and the expected output of each component are listed in the following table.

The Outline of Technical Guidance Service (Soft Component)

Category	Period	Person in charge	Action	Expected Output
Operational Planning / Management Planning	From the middle of October 2005 (For 2 months)	One Engineer	▪ The review of existing sewer pipe and drainage channel drawings which WASA produces. ▪ The review of the Action Plan and the establishment of the first year cleaning plan ▪ Monitoring and analyzing of the effect of the project. ▪ Production and editorial supervision of check / maintenance manual for cleaning equipment.	▪ Updated drawings of existing sewer pipes and drainage channels. ▪ Cleaning plan (cleaning schedule, output control and distribution planning of equipment) ▪ Monitoring results on rainy days (inundating condition and complaints by residents) ▪ Inspection / maintenance manual for cleaning equipment
Model Implementation	From the middle of December 2005 (For 3 months)	One Engineer	▪ Supervision of cleaning works through a model implementation (management of cleaning schedule, ▪ Sludge removal of a total volume 34,000m3 from sewage pipes (7.1km at a western part of Zone A), a small-scale drainage channel (1.1km) and a large-scale drainage channel (1.9km).	▪ Cleaning/desilting schedule. ▪ Actual output (removed sludge volume and distance of sewage pipes and drainage channels cleaned). ▪ Operation manual. ▪ Safety manual.

The implementation period of the project will comprise 3.5 months for detailed design and preparation of tender documents, 10 months for procurement and installation of equipment and 5 months for Soft Component. The total project cost is estimated at 1,224 million Japanese Yen, of which 1,222 million Japanese Yen will be the Grant amount and 2 million Japanese Yen will be the local amount.

The project area covers approximately 40 km^2 of land including zones A, B, G and H1, and there will be about 2 million people living therein as project beneficiaries. The project is expected to have the following direct effects:

(a) By desilting/cleaning of sewers and drains, it is expected to remove sludge amounting to 26,000 m^3 and 400,00 m^3 respectively, by which flow capacity as well as storm water storage capacity will increase by nearly 50%.

(b) Drainage capacity at the pumping station will increase from 36.8 m^3/s to 46.6 m^3/s accounting for 30% up.

(c) From the effects mentioned in (a) and (b), the flood situation (flood duration, depth and covering area) will be improved.

In addition, some indirect effects are expected such as the reduction in the number of cases for water-borne infectious diseases due to the improvement of sanitary environment and ensuring the safety in work operations through mechanization.

The project effect will come out in the target year 2009, that is to say, after the three years project operation. It can be indicated by the volume of sludge to be removed and increased pumping capacity. With regard to flood damage, monitoring will be conducted at 22 selected points, and depth of inundation, flooded area and length of time for draining should be carefully observed and recorded at the time of each heavy rain.

The retrieval of sewage and drainage system in Lahore City is considered as one of urgent projects enlisted in the Integrated Master Plan for Lahore-2021 and will certainly give a great impact on the medium and long-term projects. The optimum project scale as well as the specifications of the equipment have been determined after due consideration on the operation and maintenance capability of WASA. The equipment selected as such may be manageable to PMU-II if technical training is provided for a certain period of time. With regard to the local budget, the Government of Punjab has approved Rs.100 million as a necessary cost for the project operation during three years. The amount is deemed reasonable and appropriate.

Judging from the above considerations, the project will contribute to the mitigation of flood damage in Lahore City, and therefore it carries validity to be implemented under the Japan's Grant Aid. However, for the smooth implementation of the project, the following need to be undertaken by the Pakistan side:

(a) Proposed number of staff members shall be assigned for PMU-II and it should be noted that key personnel be competent enough to deal with project management and operation.

(b) Sewage/drainage drawing shall be properly prepared based on the existing 1/2,400 map by September 2005, that is to say, before the commencement of technical guidance service.

(c) Preparatory works for the installation of pumps and automatic trash rake (preparation of additional transformers, arrangement and procurement of electric source, and wiring from a transformer to a control panel, etc.) shall be completed by November 2005, namely before the commencement of work to be undertaken by Japanese side.

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CHAPTER 1. BACKGROUND OF THE PROJECT

Lahore, the capital city of Punjab, is the second largest city of Pakistan. The city has a population of about 7.2 million and plays an important role in country's economy. However, urban infrastructures such as roads, water service, sewage and drainage systems have not been improved to cope with the development and expansion of the city. Particularly, the silted or choked sewage lines and drainage channels are big hazard and threat to the urban environment. The situation aggravates in Monsoon season causing flooding in many places resulting in not only impediment to the traffic and business but also degradation of sanitary environment.

Water and Sanitation Agency (WASA) is a responsible agency for operation and maintenance of sewage and drainage systems in downtown of Lahore city. At present, desilting operations are carried out mostly by manual labor in order to correspond to the emergency need, and practically no action is taken to improve system and facility according to medium or long-term plan. Flood is attributed to the reduction of flow capacity of sanitary sewers and storm water channels, which are silted up and clogged with solid waste. In addition, pumping stations have not sufficient drainage capacity to cope with heavy rains. In some area, for instance, with 30-40 mm of rainfall/hour, the road is inundated at 40 to 60 mm deep and time required for draining is 8 to 12 hours.

Under these circumstances, Lahore Development Authority (LDA) has prepared "Integrated Master Plan for Lahore-2021", which focuses on upgrading sewage and drainage system as one of the issues of immediate concern. In line with the Master Plan, WASA prepared Action Plan regarding the Project for the Retrieval of Sewage and Drainage System in Lahore City. The project is envisaged to implement desilting and cleaning sewers and drains in three (3) years for zones A, B, G and H1, most problematic areas in northern part of the city. The ultimate aim of this project is to recover drainage function and also to upgrade pumping capacity. In view of the above background, the Government of Pakistan made a request to the Government of Japan in June 2002 to procure necessary equipment for the project under the Grant Aid. In response to the above request, Japan International Cooperation Agency (JICA) sent the preparatory study team in February 2004, and from a clear view of the project effects, it was followed by the basic design study team in August of the same year.

CHAPTER 2. BASIC CONCEPT OF THE PROJECT

2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Objective

Although water supply and sewage/drainage systems have been constructed in some part of Lahore city in the1930s, the necessity for the improvement of these systems rose due to the increase in population and city development, and the first master plan "Master Plan for Water Supply and Sewerage and Drainage in Lahore" was prepared in 1969. Then, this master plan was reviewed and reexamined in 1975 with financial support of UNDP and IBRD. Based on results of such a study and plan, the installation of drainage pumps and other relative works have been gradually performed with the support of the World Bank. However, it could not respond at the time of the flood in 1996, but suffered serious flood damage. Under such circumstances, from 1996 to 1998 the Department for International Development (DFID) of UK provided sewage and drainage cleaning equipment for WASA and technical guidance services as well. Despite these efforts, the problems still remain unsolved because the number of available equipment is insufficient for a large amount of sludge removal work.

Under the above-mentioned background, LDA has prepared "Integrated Master Plan for Lahore-2021" setting the year 2021 as a target year, and it has proposed various projects with the aim of improving urban environment to cope with city development. This master plan consists of the following three phases:

Phase 1: Short Term Plan (first five years)

Phase 2: Medium Term Plan (subsequent five years)

Phase 3: Long Term Plan (last ten years)

The short term plan covers 11 sectors, such as transportation, education, parks and recreation, sewage and drainage and so on, and a package of Rs.54,692 million has been allocated. With regard to sewage and drainage, it is estimated at Rs.6,780 million accounting for 12.4% of the total amount.

Urgent projects are enlisted in the short-term plan. As for sewage and drainage, WASA, one of the constituent agencies of LDA, is in charge of managing, operating storm-water drainage system as well as sewage system. With the financial assistance of Punjab Government for the purchase of pumps, WASA is making every effort to improve drainage capacity of existing pumping stations and remove sludge and garbage from open channels running through the city. As the sewage cleaning depends on manpower due to the shortage of proper equipment, the work cannot be performed efficiently. Furthermore, working conditions is undesirable in terms of health and safety for workers who work in a sewage pipe.

From the above considerations, LDA/WASA has prepared an Action Plan for the project of the retrieval of sewage and drainage system. This project is intended to improve the present drainage capacity in three years in northern part of the city (A, B, G, H1 zones) where urgent implementation is required. To achieve this objective, cleaning of sewage pipes/drainage

channels and raising of pumping capacity need to be carried out in appropriate manner. After the three years, the equipment will be repeatedly used in the project area or if the pipes/channels are not clogged with silt or garbage, it may be used in other areas of the city.

2.1.2 Basic Concept of the Project

The project period is estimated to be three years, and it focuses on the procurement of proper equipment to attain the above-mentioned objective. The project also includes public awareness campaign to protect waterway environment from being contaminated by garbage. It is expected that sludge and garbage be removed from the sewage and drainage channels in the northern Lahore area, which has a population of 4 million, recovering the drain function to its original design, and flood situation of the project area can be improved as a result.

In the framework of this project, Japan's Grant Aid is to focus on the supply of the following cleaning machinery as well as equipment for pumping stations. Technical guidance services will also be provided for the capacity development of WASA/PMU personnel to make the project effective and sustainable.

Sludge removal equipment (4 jetting machines, 4 sludge suckers, 2 water tankers, 2 clam shell excavators, 3 hydraulic excavators, 4 submersible sludge pumps, and 4 attached generators)

Sludge transportation equipment (20 units of 8 ton-class dump truck, 4 units of 4 ton-class dump truck, 4 pickup trucks, and 2 wheel loaders)

Equipment for pumping station (6 pumps and accessories, 1 set of automatic trash rake system, and 6 units of control panel)

Technical guidance service (work planning and operation planning: 2 months, supervision for model implementation: 3 months)

2.2 Basic Design of Requested Japanese Assistance

2.2.1 Design Policy

Issues to be clarified and taken into consideration for the basic design of the project are described as follows:

2.2.1.1 Criteria for Selection of Equipment

(1) The Kind of Equipment

The procuring equipment in this project can be classified into the following four kinds.

A. Cleaning equipment
   A-1. Cleaning equipment for sewer pipes
   A-2. Cleaning equipment for drainage channels
   A-3. Cleaning equipment for pumping stations
B. Monitoring equipment
C. Pump and its related equipment
D. Automatic trash rake system

(2) The Selection of Equipment

The following four points are taken into consideration for the selection of equipment.

(a) The Experience and Technical Level of WASA

WASA has an experience of utilizing cleaning equipment supplied from UK DFID and the World Bank, and has accumulated the know-how of sewer cleaning methods. WASA has also utilized these limited equipment over several decades, which proves their capacity of technical maintenance. WASA's requests for the cleaning equipment are based on their experience, and the evaluation of them shall be based on their experience as well as the type of existing equipment and the technical level of WASA so that they can manage and maintain procured equipment easily.

Regarding the request of a pump and its related equipment, it is referred to the specification of existing equipment because all of the requests are simply the additions to other pumps in the same existing building of the pumping station. WASA currently holds and operates more than 100 sets of pumps and it can be inferred by that WASA has a good capacity to control and maintain them and their related equipment.

Regarding the automatic trash rake system, since the existing one has to be removed and be replaced by a new one, it is essential to select an automated system that can be accommodated in the existing building and can be easily maintained.

(b) Improvement in Working Efficiency and Labor-saving

It is expected to improve working efficiency, working condition and reduce labor by mechanization of cleaning equipment. Regarding the sewer cleaning works, it is possible to reduce the number of sewerman who works inside the sewer pipes by mechanizing the work. Actually, WASA is facing a problem in convening necessary number of sewerman year by year due to other job opportunities for the sewerman and their abhorrence to the dirty and dangerous job, and thus facing a certain pressure to mechanize the work.

Regarding a sewer-cleaning machine, a sludge sucker that can dehydrate compulsory and can dump collected sludge directly to a dump truck is adopted for its better working efficiency. In contrast, existing type of sludge sucker with only a vacuum pump and a sludge tank mounted on a vehicle is not efficient because it has to leave the cleaning site for dumping at a drainage channel nearby whenever the tank is filled.

Regarding the cleaning works for drainage channels, the working efficiency of each excavator will improve by providing sufficient number of dump trucks for transportation for removed sediment, which runs short currently.

(c) Consideration of an Environmental Impact

Not only working efficiency but also an environmental impact by introducing these cleaning equipment is also taken into consideration. For example, by introducing a sludge sucker with a dumping function directly to a dump truck, the removed sludge from a sewer pipe which is currently dumped to a drainage channel nearby can be transported to the certified dumping site, thus improving the surrounding environment. Similarly, by supplying enough number of dump trucks for transportation, the removed sludge from a sewer pipe and a drainage channel which is currently exposed to the surface of road until a dump truck reaches the site can be transported to the proper dumping site promptly as well, thus improving the environment at the working site.

(d) Natural Conditions

Natural conditions in Lahore City are also taken into consideration for developing the cleaning plan with selected cleaning equipment. Regarding the rainfall amount, Lahore City receives about 600mm of annual rainfall in average and it varies from 300 to 1,200mm year by year. The number of rainy days is about 40 to 50 days a year, and the number of rainy days for more than 10mm rainfall is about 15 to 20 days a year. Considering the number of public holidays and rainy days that has more than 10mm rainfall amount, the operable days in a year is set at 290 days.

For the determination of a pumping capacity, generally, the target is set by a design storm, however, WASA does not have the data and instead determines the pumping capacity by calculating the inflow of sewer pipes and drainage channels to a pumping station and inundation condition in its catchment area. In other words, if there is a severely inundated area, WASA improves the sewage and drainage system and install a lift-up pump at the site, and if the discharge increases due to these works, WASA improves the pumping capacity at the downstream pumping station. Thus, WASA improves the sewage and drainage system gradually responding to the necessity. Due to these unplanned measures, sewage and drainage system in Lahore City is complicated and intertwined and it makes difficult to divide the drainage districts. For that reason, the pumping capacity is determined by the flow capacity of inflow sewer pipes and drainage channels, which restrict the inflow to the pumping station, following the methodology adopted by WASA.

Meanwhile, the total sludge volume to be removed by the Project is determined based on the amount assumed in the UK DFID report in 1995, which is then compared to actual survey data collected by local re-commission in 2004 and be modified.

2.2.1.2 Concept for the Determination of Grade of Equipment

The grade and the size of equipment are categorized for each purpose of work and are summarized as follows.

(1) Sewer Pipe Cleaning Equipment

Selection of cleaning equipment for sewer pipes is determined by the following order: a) determine the design area and the target sewer pipe, b) estimate the total volume of sludge, c) design a cleaning plan for 3 year period as described in WASA's Action Plan, and d) determine the necessary number and grade of equipment.

(a) Selection of the Target Sewer Pipe

The design area consists of four Zones, including Zone A, B, G and H1, based on WASA's Action Plan and the size of target sewer pipe is diameter between 500 and 1,500mm. The smaller sewer pipes like secondary and tertiary ones, which diameter are less than 500mm, are out of the scope of works. Similarly, the larger sewer pipes which diameters are more than 1,500mm are also out of the scope of works because they are relatively new and sedimentation is not progressing much based on actual observation on site and also they are too large to be effectively cleaned by the equipment introduced by the Project.

(b) Presumption of the Amount of Deposited Sludge

The amount of deposited sludge in the sewer pipe is presumed based on UK DFID survey conducted in 1995 and another survey conducted by a local consultant as a re-commission in 2004. The comparison of each survey results is shown in Table 2.1.

Table 2.1 Comparison of Assumed Sludge Volume at Main Sewer Lines

Main Sewer Lines	UK DFIF Survey (1995)[1)]		Re-commission Survey (2004)		Difference [%]
	Distance [m]	Sludge Volume [m^3]	Distance [m]	Sludge Volume [m^3]	
Zone A					
Ravi Rd.	1,900	454	1,930	614	135
Karim Park Rd.	4,800	1,852	3,560	3,143	170
Zone B					
Umer Din Rd.	2,500	786	2,760	547	70
Zone G					
Davies Rd.	2,900	871	3,070	570	65
Abbot Rd.	3,600	1,080	3,600	906	84
Mecleod Rd.	5,050	2,308	4,250	2,176	94
Railway Rd.	1,550	777	1,500	831	107
Zone H1					
Sham Nagar Rd.	3,700	2,441	3,300	2,400	98
Lytton Rd.	1,200	290	630	94	32

1) WASA has a set of data of sludge volume classified by the diameter of sewer pipe surveyed by UK DFID but does not have its contents which shows where the sewer pipe locates. In other words, there are data such as total sludge volume for sewer pipe with diameter 600mm, but there are no data for each sewer line of diameter 600mm. For that reason, the sludge volume for each sewer pipe is calculated by the distance of each sewer line, which was scaled on a general plan, multiplied by the average depth of sludge.

As shown in the table above, the presumed sludge volume has not increased much or has even decreased a little compared to the data in 1995 except in Zone A, where the volume increased by about 35 to 70% in 2004. Accordingly, it has been confirmed that the sludge volume in sewer pipes has not been changed that much since the survey in 1995 except in Zone A. Therefore, the presumed sludge volume in Zone B, G and H1 shall be the same volume to the data in 1995 for a safety reason for designing a cleaning plan, and the one in Zone A shall be about 60% larger in average than the data in 1995 for the same reason. As a result, the presumed sludge volume in each Zone becomes as tabulated in Table 2.2, and thus the total volume is presumed at about 26,000m^3.

Table 2.2 Presumed Sludge Volume of Sewage System

Zone	Less than Dia.900mm			More than Dia.900mm			Sub-total		
	Distance [m]	Volume in DFID Survey [m^3]	Presumed Volume [m^3]	Distance [m]	Volume in DFID Survey [m^3]	Presumed Volume [m^3]	Distance [m]	Volume in DFID Survey [m^3]	Presumed Volume [m^3]
Zone A[1)]	8,100	1,060	1,700	7,200	2,560	4,100	15,300	3,620	5,800
Zone B	10,200	2,230	2,200	4,800	2,880	2,900	15,000	5,110	5,100
Zone G	22,100	6,470	6,500	5,400	2,770	2,800	27,500	9,240	9,300
Zone H1	14,650	2,700	2,700	6,350	2,860	2,900	21,000	5,560	5,600
Total	55,050	12,460	13,100	23,750	11,070	12,700	78,800	23,530	25,800

1) The sludge volume in Zone A shall be 60% larger than the data of DFID survey in 1995. The other three Zones adopt the same data.

(c) Cleaning Plan

There are four cleaning teams and each of them has a set of equipment including a jetting machine, a sludge sucker, a water tanker, a 4-ton class dump truck for sludge disposal, a submersible sludge pump and a generator for it. The number of each type of equipment is 4 sets except the water tanker, which is 2 sets, because it can supply water to 2 teams, and if necessary, existing water tankers shall be deployed.

The existing jetting machine and sludge sucker are excluded from the cleaning plan because their total number is limited – below the number of SDOs (Sub-Divisional Offices) – and they are occupied by daily works for trouble-shooting raised by the residents and thus cannot be counted on for the plan.

The target area is divided into three areas, namely Zone A and B combined, Zone G and Zone H1, managed by three SDOs (Sub-Divisional Officers). Here, Zone A and B are combined because they have relatively smaller area compared to others and they belong to same Ravi Town. Among them, the cleaning works in Zone G is expected to be the toughest because it has the largest presumed sludge volume and more than 80% of its sewer pipe consists of egg-shape pipe, which were mostly constructed in 1930s to 40s and that implies that hard sediment deposited inside. For that reason, 2 teams are assigned to Zone G.

Following Table 2.3 and Fig 2.1 show the distribution plan of sewer cleanings equipment, each parking area and corresponding SDOs (Sub-Divisional Officers).

Table 2.3 Distribution Plan of Sewer Cleaning Equipment

Sewer Cleaning Equipment	Number	SDO(A&B) Sewerage	SDO(G) Sewerage	SDO(H1) Sewerage
		Shad Bagh Pumping Station	Main Outfall Pumping Station	Kharak (Sabzazar) Office
Jetting Machine	4	1	2	1
Sludge Sucker	4	1	2	1
Water Tanker	2[1)]	0	1	1
Submersible Sludge Pump	4	1	2	1
Generator	4	1	2	1
Dump Truck 4ton class	4	1	2	1

One water tanker supplies water to two jetting machines. If necessary, existing ones shall be deployed for supplement.

Next, the working efficiency by the combination of the above-mentioned cleaning equipment is summarized below. According to the interview with WASA staff, the working efficiency in terms of its covering distance of a sludge sucker is about 20 - 30m per day for a sewer pipe less than diameter 900mm, while it is 12 - 15m per day for a sewer pipe more than diameter 900mm. These figures correspond to about $8m^3$ per day for the former sewer pipes and about $10m^3$ per day for the latter (In Zone G, however, these figures shall be reduced to $9m^3$ and $7m^3$ per day, respectively, for the dominancy of egg-shape sewer pipes as mentioned before). These figures match well with the standardized guidance provided by the "Japan Sewage Works Association".

Then, the number of days (years) required for the removal of sludge in each Zone is obtained as 4.1 years in Zone A & B, 2.1 years in Zone G, and 2.2 years in Zone H1 as shown in Table 2.4. The average period is about 2.8 years as a whole area. It can be inferred from that it is possible to complete the whole cleaning works of sewer pipes in 2.8 years if the equipment assigned in Zone G takes part of some areas in Zone A & B.

Table 2.4 Cleaning Plan for Sewage System

Zone	Diameter of Sewer Pipe	Sludge Volume [m^3]	Nos. of Cleaning Teams	Sludge Volume Removed per Day [m^3/day]	Total Nos. of Days Required [Days]	Total Nos. of Years Required [Years]	
Zone A&B	Less than dia. 900mm	3,900	1	8	488	1.7	4.1
	More than dia. 900mm	7,000		10	700	2.4	
ZoneG	Less than dia. 900mm	6,500	2	14[1)]	464	1.6	2.1
	More than dia. 900mm	2,800		18[1)]	156	0.5	
Zone H1	Less than dia. 900mm	2,700	1	8	338	1.2	2.2
	More than dia. 900mm	2,900		10	290	1.0	
Total (Average*)		25,800	4		2,436	2.8*	

1) The sludge volume removed in one day in Zone G is calculated at $7m^3$/day for sewer pipe less than dia. 900mm and $9m^3$/day for sewer pipe more than 900mm.

(d) Cleaning Equipment for Sewer Cleaning

Consequently, the number of teams required for cleaning the sewer pipes in the target area, Zone A, B, G and H1, is four. One team consists of a jetting machine, a sludge sucker, a water tanker, a 4-ton class dump truck, a submersible sludge pump and a generator, whereas a water tanker belongs to two teams. The specifications and necessity of each type of equipment are tabulated in Table 2.5. In addition, a comparison of a sludge sucker between existing type and a selected one that can dispose sludge directly to a dump truck is given in Table 2.6.

Table 2.5 Specification and Necessity of Each Type of Sewer Cleaning Equipment (1/2)

Type of Equipment (Nos.)	Specification	Necessity
Jetting Machine (#4)	Loading Capacity: 8-ton class, Tank Volume: not less than 4,500 liters, Discharging Capacity: not less than 200 liter/min, Maximum Pressure: not less than 19.6MPa (200kgf/cm^2)	Since there are four cleaning teams, jetting machines are allocated one set for each team, thus making total number four sets. The loading capacity of a dump truck is set at 8-ton class that is same to the existing ones. While, the tank volume is set at not less than 4,500 liters, the discharging capacity at not less than 200 liters/min, and the maximum pressure at not less than 19.6 MPa, as they are equivalent or exceeds the existing ones' specifications. There are 11 jetting machines under WASA' s control, and in addition to that, WASA is going to procure another five by assistance from the Government of Punjab. However, there are 21 SDOs (Sub-Divisional Offices) under WASA and the total number of jetting machines is not sufficient to cover the whole area. For that reason, existing jetting machines cannot be spared for the regular cleaning works and the cleaning plan shall include only the ones that will be supplied by the Japan's Grand Aid.
Sludge Sucker (#4)	Loading Capacity: 8-ton class, Hydraulic Tank, Tank Volume: not less than 4,000 liters, with Compulsory Dehydration System	As well as a jetting machine, one set of sludge sucker is allocated to each cleaning team that makes the total number four sets. The type of sludge sucker shall be the one that can lift the tank and directly dispose collected sludge to a dump truck, which is different from the existing ones, for a better working efficiency. The Existing type has to leave the site for disposing the wastewater and sludge whenever the tank is filled, thus reducing the working capacity. Moreover, there are other disadvantages such as many mechanical troubles for the vehicle of sludge sucker caused by fully loaded tank during transporting and an environmental problem caused by disposed sludge from a sewer pipe to an open channel. A comparison of existing and selected types of sludge sucker is given in Table 2.6. The loading capacity of a sludge sucker shall be 8-ton class that is the same to the existing ones, while the tank volume shall be not less than 4,000 liters to suit the lifting propose. There are presently 16 sludge suckers under WASA and two more are expected in 2004 by the assistant of the Government of Punjab, which makes total number 18. However, as well as a jetting machine, it is not recommended to include existing ones for the regular cleaning works for the same reason. Thus, the cleaning plans shall include only new machines that will be procured by the Japan's Grand Aid.
Water Tanker (#2)	Loading Capacity: 8-ton class, Tank Volume: not less than 8,000 liters	A water tanker is assigned for feeding water to a jetting machine on site. There are four existing water tanks under WASA, and from their experience, it is concluded that one water tanker can supply water to two jetting machines. This is why there are only two requests for water tanker compared to four for jetting machine. Beside that, there are more than 10 hydrants in the target area so that a jetting machine can travel by itself for feeding water. Thus, the number of sets of water tanker, two, for four teams is deemed appropriate. The loading capacity of a water tanker shall be 8-ton class that is the same to the existing ones, while the tank volume shall be not less than 8,000 liters.

Table 2.5 Specification and Necessity of Each Type of Sewer Cleaning Equipment (2/2)

Type of Equipment (Nos.)	Specification	Necessity
Dump Truck 4-ton class (#4)	Loading Capacity: 4-ton class	There is a requirement for a dump truck to carry away the removed sludge since the sludge sucker disposes the sludge directly to the dump truck and stays on site. The volume of sludge from a sludge sucker is about 1-2m^3 per disposal so that the loading capacity of a dump truck is sufficient with 4-ton class. A working cycle for a jetting machine and a sludge sucker combined is about 1 hour that is almost same period to the return trip to the dumping site by a dump truck, which implies that one 4-ton class dump truck is sufficient for one sludge sucker. Initially, the requested number of 4-ton class dump trucks was three and WASA was supposed to provide one by its own existing stocks, however, it turned out that the existing ones are utilized for other areas in Lahore and cannot be spared for the regular cleaning works, Japan's Grand Aid shall provide the whole four dump trucks.
Submersible Sludge Pump (#4)	Non-clogging Type, Discharging Capacity: not less than 3.4m^3/min, Total Head: not less than 13.2m	A submersible sludge pump is utilized to drain sewage from a sewer pipe before and during the cleaning works. A generator supplies electricity to the submersible sludge pump. The initial requested number of submersible sludge pump was four for four cleaning teams and generator was two, because there are existing generators available. However, it was found during the Basic Design Study that these existing generators are frequently used for emergencies and it is not appropriate to count on them for the regular cleaning works. Thus, it is recommended to provide the all four generators as well as submersible sludge pumps by Japan's Grand Aid. The specifications of a submersible sludge pump shall be non-clogging type, discharging capacity not less than 3.4m^3/min and total head not less than 13.2m, which are the same to the existing ones. The capacity of a generator shall be sufficient for the submersible sludge pump. Besides these existing submersible sludge pumps, which are donated by UK DFID and there are two sets, WASA possesses a number of engine pumps for alleviating inundation in many corners in Lahore City during monsoon season. However, these engine pumps are not applicable for draining from a sewer pipe since they may burn out when the water level recedes under the minimum operable level. Thus, it leads to the request of submersible sludge pumps.
Generator (#4)	For Submersible Sludge Pump	

Table 2.6 Comparison of the Type of Sludge Sucker

	Existing Type (with a Water Tank and a Vacuum Pump)	Selected Type (with a Hydraulic Tank and a Compulsory Dehydration System)
Type		
Mechanism	The vacuum pump sucks sewage and fills the tank, and when the tank is filled, it travels by itself and drains to an open channel.	The vacuum pump sucks sewage and fills the tank, and when the tank is filled, the pump is shifted and the liquid in the tank is drained compulsory through a filter by the air pressures. By this process, the sludge, which composes about 10% of the total sewage, remains in the tank. These sucking and draining process can be repeated for several times and then, the sludge sucker lifts up the tank and disposes the sludge to a dump truck.
Work Efficiency (1 cycle-time)	Sucking Sewage: 30-40min Transporting and Disposing: 60-70min Total 90-110min	Sucking Sewage: 20-30min x 2-3times Draining: 0.5-1min x 2-3times Disposing: 10min Total 30-40min
Tank Volume	6,000 liters	4,000-4,500 liters
General Specification	The working efficiency is bad because it has to leave the site for draining to an open channel nearby whenever the tank is filled. The burden on the vehicle is large because it travels with full load that can consequently cause frequent mechanical troubles. There is an environmental disadvantage because it disposes the sludge removed from a sewer pipe at an open channel instead of at a certified disposal site. Bad	The working efficiency is good because it drains liquid on site and continues sucking. The environmental impact is minimal because it disposes the removed sludge form a sewer pipe at a certified disposal site utilizing a dump truck. Good
Maintenance	It requires regular washing of the interior of tank after operation. The burden on the vehicle is large because it travels with full load. Bad	It requires regular washing of the interior of tank after operation. The filter, which separates liquid and solid in the tank, is made of a stainless steel plate with many holes with a size approximately 5mm diameter, and can be washed together with the interior of tank. It is not necessary to replace the filter regularly. The hydraulic system for lifting the tank requires only normal maintenance. Good
Evaluation	The working efficiency is bad because it has to leave the site for draining. There is an environmental disadvantage because it disposes removed sludge to an open channel. The vehicle has heavy burden, which leads to mechanical troubles. Bad	The working efficiency is good because it can dehydrate and dispose sludge directly to a dump truck on site. The environmental impact is minimal because it disposes sludge to a certified dumping site utilizing a dump truck. Good

(2) Cleaning Equipment for Drainage Channels

Selection of cleaning equipment for drainage channels is determined by the following order: a) determine the design area and target drainage channel, b) estimate the total volume of sediment, c) design a cleaning plan for 3 year period as described in WASA's Action Plan, and d) determine the necessary number and grade of equipment.

(a) Selection of the Target Drainage Channel

The target drainage channels are about 28km stretch in total based on the request by WASA as shown in Table 2.7 and Fig 2.2. The catchment area of drainage channels, unlike the one for sewage system, does not much with the boundary of each Zone. The target drainage channels are all open channels and the conduits are out of scope. This is because most conduits are relatively new structure and the sedimentation is not progressing much, and they are exceeding the applicable size of the jetting machine.

(b) Presumption of the Amount of Sediment

The design bed slopes of drainage channels are not fixed or not known because WASA does not have the design documents and drawings that show their values. Furthermore, the channel bed is not covered by structural material except Chota Ravi Drain. For those reasons, the amount of sediment is calculated by presuming the design bed slope and the bed level referring surveyed cross sections and profiles of the drainage channels. By this methodology, the amount of sediment for each drainage channel is calculated as shown in Table 2.7 and the total amount is about 400,000m^3.

Table 2.7 Target Drainage Channels and their Presumed Volume of Sediment

Name of Drainage Channel	Distance [km]	Width of Channel [m]	Depth of Channel [m]	Average Depth of Sediment [m]	Presumed Volume of Sediment [m]	Excavator
Chota Ravi Drain	3.3	2 – 5	1.5 – 2.5	1.0 – 2.0	13,300	Hydraulic Excavator (0.28m^3)
Central Drain	2.8	2 – 8	1.5 – 3.5	0.8 – 1.5	39,600	Cram shell & Hydraulic Excavator (0.8m^3)
Lower Mall Drain	1.1	5 – 10	1.5 – 2.0	0.7 – 0.8	6,200	Hydraulic Excavator (0.28m^3)
Edward Road Drain	1.8	1 – 3	1.5 – 2.0	0.3 – 0.8	1,400	
Alfalah Drain	1.1	2 – 4	1.5 – 2.0	0.5 – 0.8	2,200	
Gulberg Drain-1	2.2	5 – 14	2.5 – 3.5	1.0 – 1.5	25,000	Cram shell & Hydraulic Excavator (0.8m^3)
Gulberg Drain-2	0.7	5 – 8	2.0 – 3.0	1.5 – 1.8	8,400	Hydraulic Excavator (0.28m^3)
Gulshan-e-Ravi Drain	0.7	11 – 15	2.3 – 4.3	1.5 – 2.0	14,700	Cram shell & Hydraulic Excavator (0.8m^3)
Mian Mir Drain	14.0	10 – 20	2.4 – 4.4	1.0 – 2.0	283,900	
Total	27.7				394,700	

(c) Cleaning Plan

The cleaning plan is designed to remove the presumed volume of sediment by utilizing the requested equipment, namely 2 sets of cram shells, 3 sets of excavators and 20 sets of dump trucks. The target period is about 3 years as described in the Action Plan presented by WASA. The smaller type of excavators are in charge of narrow drainage channels which have about 4 –5 m width, while the larger excavator and cram shells take other larger drainage channels as shown in Table 2.7. Based on assumed working efficiency of cram shells, excavators and dump trucks, the cleaning plan is summarized in Table 2.8. As one can see here, it takes about 1.7 years to remove sediment from smaller drainage channels and 3.4 years for larger ones.

Table 2.8 Cleaning Plan for Drainage Channels

Drainage Channel	Volume of Sediment [m^3]	Work Efficiency of Excavator	Transport -ation	Loading and Transportation Period for 1 Dump Truck (1 Cycle) 1)	Volume of Sediment Transported in one day	Nos. of Days Required 2) (Years)
Smaller Ones Chota Ravi Drain Lower Mall Drain Edward Road Drain Alfalah Drain Gulberg Drain-2	31,500	Hydraulic Excavator ($0.28m^3$) x 2, 3min/loading (20loading/hr =$5.6m^3$/hr)	Dump Truck (8-ton) 2sets x 2	Loading: $5.3m^3/0.28m^3$=19times 19 x 3min/time=57min Transportation and Unloading: 80min Total: 137min/cycle 3 cycles/day	$5.3m^3$ x 2 x 2 x 3 trips = $63.6m^3$/day	495 (1.7)
Larger Ones Central Drain Gulberg Drain-1 Gulshan-e-Ravi Drain Mian Mir – Babu Sabu Drain	363,200	Hydraulic Excavator ($0.8m^3$) x 1, 2min/loading (30loading/hr =$24m^3$/hr)	Dump Truck (8-ton) 6sets	Loading: $5.3m^3/0.28m^3$=7times 7 x 2min/time=14min Transportation and Unloading: 80min Total: 94min/cycle 5 cylces/day	$5.3m^3$ x 6 x 5 trips = $159m^3$/day	979 (3.4)
		Cram Shell (0.7-$0.8m^3$) x 2 3min/loading (20loading/hr, =$15m^3$/hr)	Dump Truck (8-ton) 5sets x 2	Loading: $5.3m^3/0.75m^3$=7times 7 x 3min/time=21min Transportation and Unloading: 80min Total: 101min/cycle 4 cycles/day	$5.3m^3$ x 5 x 2 x 4 trips = $212m^3$/day	
Total	394,700	5 Excavoators	20 Dump Trucks		$435m^3$/day	

One retrun trip by a dump truck is 80 minutes (10km/20km/hr x 2 = 60min, unloading 10min).
Working days in a year is set at 290 days.

(d) Cleaning Equipment for Drainge Channels

By the cleanig plan mentioned above, the cleaning equipment required are 2 sets of cram shells, 3 sets of excavators and 20 sets of dump trucks. The specifications and necessity of each of them are summarized in Table 2.9.

Table 2.9 Specification and Necessity of Each Type of Drainage Channel Cleaning Equipment

Type of Equipment (Nos.)	Specification	Necessity
Cram Shell (#2)	Wheel Type, Hydraulic Type, Cram Shell (Attachment)	Cram shell is necessary for the dredging work for a drainage channel because the distance of drainage channel where its width exceeds 10m is more than 10km and the depth of sediment is presumed to be 1-2m. The number of cram shell required for the cleaning work for 3 years in the whole area is 2 sets. The initial requested type, a crane and wheel type cram shell, is not manufactured in Japan and other advanced countries any more for safety reasons. Meanwhile, a crane and wheel type is available, though its weight exceeds 30 tons and it requires a trailer truck for transportation on road, thus it is not feasible for the cleaning works. For these reasons, a hydraulic and wheel type cram shell, which is a hydraulic excavator with cram shell attachment, is adopted since it best satisfies the purpose of the cleaning works. There is one cram shell in WASA presently, of which manufactured year is 1966, and it is fully utilized for garbage removal at a drainage channel and sludge removal at a wet well at a pumping station. Thus, it is not available for regular cleaning works and it is excluded from the cleaning plan.
Hydraulic Excavator (1) (#2)	Bucket Size: 0.28m^3 class, Boom Length: 3,700mm	Due to the 3-year cleaning plan, the number of excavators required for the cleaning works is three, which includes two smaller types (bucket size 0.28m^3) and one larger type (bucket size 0.8m^3). Two smaller excavators works for smaller drainage channels and one larger excavator works for larger drainage channels with two excavators. There are four large excavators (one is out of order) and one small one in WASA. However, since the number is limited and they are working for daily trouble-shootings, they are excluded from the cleaning plan.
Hydraulic Excavator (2) (#1)	Bucket Size: 0.8m^3 class, Boom Length: 5,500mm	
Dump Truck (#20)	Loading Capacity: 8-ton class	A dump truck works for transportation and dumping of removed sediment by these cram shells and excavators. Total number of dump trucks required is 20 sets, which includes 5 sets each for cram shells (10 sets), 2 sets each for smaller excavators and 6 sets for a larger excavator. Initially, WASA was supposed to procure 10 sets of them by requesting the Government of Punjab, however, it is likely to be delayed by the commencement of the Project and since they are essential components, Japan's Grand Aid shall prepare the whole 20 sets of dump trucks. The loading capacity of a dump truck shall be 8-ton class that is the same to the existing ones. WASA has 19 sets of dump trucks presently, though they are fully utilized as well, and thus they are not included in the cleaning plan.

(3) Cleaning Equipment for a Pumping Station

WASA requests one wheel loader each at Shad Bagh and Gulshan-e-Ravi Pumping Stations for loading the garbage collected at a screen or in a regulating reservoir to a dump

truck. There is no loading equipment there presently and the garbage collected, which amounts about 7 –10 m^3 per day each and that is relatively larger than other pumping stations, are loaded manually at both pumping stations. It is required to mechanize the process by introducing a loading machine and improve the working efficiency and the working environment.

The number of a wheel loader is two sets and the specification is as follows.

Specification of a Wheel Loader

Specification	Remarks
Backet Size: 1.2 m^3 class	The amount of garbage collected at each pumping station is about 7-10m^3 and a wheel loader with a backet size 1.2m^3 is appropriate for loading them to a dump truck.

(4) Monitoring Equipment

WASA has not monitored inundation situation, such as inundated area, inundated depth and inundated period, during heavy rains so far because of the lack of enough number of vehicles for patrol and monitoring that suits these purposes. WASA requests pickup trucks for monitoring the effect of the Project quantitatively. Pickup trucks are an indispensable item for patrolling the inundated areas during a heavy rain and for monitoring inundated situation at 20 points in the Study Area that was selected during the Based Design Study where frequently inundation take place (see Fig 2.3). The number of pickup trucks requested is four sets and they are planned to park one each at three PMU Offices and at WASA Head Office.

The specifications of the pickup truck shall be 4-wheel drive that can drive on bad roads and has a high body above the ground for the purposes mentioned above. In addition, it is also required to have a double cabin because most likely there will be at least two passengers, one is an XEN (Executive Engineer) and another is a SDO (Sub-Divisional Officer), except the driver during the monitoring.

The number of pickup trucks is four sets and the specification is given below.

Specification of a Pick-up Truck

Specification	Remarks
Double Cabin	More than two passengers excluding a driver are expected during monitoring works.
4 Wheel Drive (4WD)	For driving inudated and unpaved roads.
Displacement : not less than 2,800cc Diesel Engine	The least displacement necessary for 4WD car.

(5) Pump

There are four sewage pumping stations in the Study Area that directly drain to Ravi River, which are, from the north, Shad Bagh, Main Outfall, Gulshan-e-Ravi and Multan Road Pumping Stations. The pumping stations where pumps are requested are all of them except

Main Outfall Pumping Station and the requested number was 2 pumps each with a discharge capacity at 1.1m^3/s each. A comparison of a current discharge capacity and a required discharge capacity calculated from the inlet pipes is given in Table 2.10. As shown here, these pumping stations have only 30 – 60% of required discharge capacity, except Main Outfall Pumping Station which has enough capacity, and that is why they require an urgent improvement. In addition to that, all of these three pumping stations have a building and a space for two pumps each already which means there is no need for civil works but only mechanical installation of a pump and the related equipment and thus smooth implementation is expected. For those reasons, it is considered reasonable to choose these pumping stations as a target for urgent improvement works.

As shown in the same table, the total amout of present discharge capacity of those four pumping stations is 36.8m^3/s, which is about 53% of required amount, 68.9m^3/s. In other words, there is a shortage of about 32.1m^3/s (47%). While, the total of requested discharge capacity at three pumping stations and the one WASA is requesting to the Governemtn of Punjab at one pumping stations is 9.8m^3/s (= 2.2m^3/s x 3 + 3.2m^3/s). The expected discharge capacity after installment of those requested pumps is 46.6m^3/s and that will increase the capacity by 28%. This figure corresponds to 68% of the required discharge capacity, and it is expected to improve the drainage system as a whole.

The direct effect expected by the installment of those requested pumps and the cleaning of sewage pipes and drainage channels is the improvement of drainage condition in many reguraly inundated areas. The rough assumption of the direct effects are : 1) the discahrge capacity of pumping stations increases by about 30%, 2) the drainage and storage capacity of sewer pipes increase by about 50% by removing the clogging sludge which covers roughly about half of the pipe in average, 3) the drainage and storage capacity of drainage channels increase by 30 – 50% by removing the sediment which amount about 400,000m^3 in total, and as the reslut, 4) the inundation damage will reduce to about a half of what it is today by the improvement of these drainage capacity of pumping stations, sewer pipes and drainage channels and due to their synergy effect.

In other words, it is expected that the inundation will not appear by a small amount of rain due to the improvement of storage capacity of sewer pipes and drainage channels, and the number of inundating days will reduce to about a half of today and also the inundated area and period will reduce to about a half of today. For example, at Lakshimi Chowk (see location No.1 in Fig2.3), where frequently inundation takes place, the inundation period that is about 8-12 hours currently caused by a rainfall about 30-40mm is expected to reduce to about 4-6 hours, and the inundation depth will reduce from 40-60cm to 20-30cm as shown in the following table. At another frequently inundated location, Choburgi Chowk (see location No.8 in Fig2.3), the inundation period will reduce from 4-8 hours to 2-4 hours and the inundation depth will reduce from 25-35cm to 10-20cm by a 20-60mm rainfall. Nevertheless, these are just assumptions and the effect can vary depending on the achievment of the cleaning works. For that reason, it is strongly recommended that a regular monitoring of inundation situation is essential to judge the effect of the Project quantitatively.

Expcted Effect by the Implementation of the Project

Frequently Inundated Area (Number in Fig2.3)	Rainfall Amount [mm]	Before the Project		After the Project	
		Inundation Period [hrs]	Inundation Depth [cm]	Inundation Period [hrs]	Inundation Depth [cm]
Lakshimi Chowk (No.1)	30-40	8-12	40-60	4-6	20-30
Chuburgi Chowk (No.8)	20-60	4-8	25-35	2-4	10-20

Meanwhile, the pumping stations, including sewage and drainage pumping stations, that are related to the Project are shown in the Table 2.11. In that table, the required drainage capacity at three drainage stations, namely Babu Sabu, Chota Ravi and Shad Bagh Drainage Stations, appears also facing a shortage as well as above-mentioned three sewage pumping stations, though they are not urgent. Here are the reasons.

First, Babu Sabu Drainage Station does not require urgent improvement or increase in drainage capacity because it has gravity flow and, in fact, the pumps has not been operated since 1997, or in other words, there has not been any serious ocation that requires forced drainage by pumps. Furthermore, the discharge reaching Babu Sabu Drainage Station has been reduced due to the construction of both Multan Road and Gulshan-e-Ravi Drains that discharge directly to Ravi River which used to flow to Babu Sabu Drainage Station. Similarly, Chota Ravi Drainage Station has also gravity flow and it has not been in use since 1988 for the same reason. While, for the Shad Bagh Drainage Station, it does not have gravity flow and the present and planned drainage capacity is smaller than the required one and that implies it needs an increase in the capacity in future. However, there are already plans to increase the drainage capacity by installing two pumps each at Shad Bagh, by the Project, and Khokar Road Sewage Stations which locate in the same vicinity and receive the discharge at the same regulating pond. For that reason, a further increasing plan for Shad Bagh Drainage Station can be reserved for future after observing the effect of these new pumps.

Table2.10 List of Sewage Pumping Stations Related to the Project

No.	Name of Pumping Station	Drainage Capacity Required by the Size of Inlet Pipes [1]		Present					Plan								Remarks
				Drainage Capacity by Pumps		Number of Pumps	Shortage of Drainage Capacity		Request to Japan's Grand Aid	Request to Govt. of Punjab	Sub-total	Number of Pumps	Expected Drainage Capacity after Japan's Grant Aid		Expected Shortage of Drainage Capacity after Japan's Grant Aid		
		[m^3/s]	[%]	[m^3/s]	[%]	[Nos.]	[m^3/s]	[%]	[m^3/s]	[m^3/s]	[m^3/s]	[Nos.]	[m^3/s]	[%]	[m^3/s]	[%]	
1	Shad BaghPumping Station[2]	26.8	100	9.2	34	7	17.6	66	2.2	3.2	5.4	4	14.6	54	12.2	46	
2	Main Outfall Pumping Station[2]	9.7	100	9.7[3] (10.9)	100	20	0.0	0	—	2.2[4]	2.2[4]	2[4]	9.7[4]	100	0	0	
3	Gulshan-e-RaviDisposal Station	21.6	100	13.4	62	12	8.2	38	2.2	—	2.2	2	15.6	72	6.0	28	
4	Multan Road Disposal Station	10.8	100	4.5	42	4	6.3	58	2.2	—	2.2	2	6.7	62	4.1	38	
Total (Average)		**68.9**	**100**	**36.8[3] (38.0)**	**53**	**42**	**32.1**	**47**	**6.6**	**3.2[4] (5.4)**	**9.8[4] (12.0)**	**8[4] (10)**	**46.6**	**68**	**22.3**	**32**	

1) The drainage capacity required by the size of inlet pipes is calculated as follows: (Cross Section of the inlet pipe) x (Velocity: 1.2m/s) x (25% Extra Capacity)

2) Shad Bagh Pumping Station consists of Shad Bagh Disposal Station and Khokar Road Disposal Station. While, Main Outfall Pumping Station consists of Main Outfall No.1 –3 Disposal and Drainage Stations.

3) Main Outfall Pumping Station has a drainage capacity more than the amount required by the size of inlet pipes. For that, the drainage capacity is deemed to be the same to the required drainage capacity.

4) There is a plan to replace two old pumps at Main Outfall Pumping Station No.1 within year 2004. This is a replacement and there is no increase in drainage capacity.

Colored portion is the requested Pumping Stations.

Table 2.11 List of Sewage and Drainage Pumping Stations Related to the Project

No.	Name of Pumping Station	Zone	Estab-lished Year	Gate	Donor	Present Drainage Capacity [m^3/s]	Drainage Capacity of Each Pump [m^3/s]	Number of Pumps	Inlet Pipe /Channel	Required Capacity by the Inlet Pipe/Channel[1] [m^3/s]	Present Shortage of Drainage Capacity [m^3/s]	Request to Japan's Grant Aid [m^3/s]	Request to the Govt. of Punjab [m^3/s]	Expected Shortage of Capacity after Grant Aid [m^3/s]	Type of Trash Rake System	Remarks
1	**Shad Bagh Pumping Station[2]**					**15.1**		**10**		**98.7**	**83.5**	**2.2**	**3.2**	**78.1**		
1-1	Shad Bagh	B	1982	—	World Bank/DFID	4.5	1.1 x 4	4	D1,370 x 3 + D1,680 + B 5.2m x H2.4m	26.8	17.6	1.1 x 2	—	12.2	Elevator Type	Inlets for Shad Bagh and Khokar Road Disposal Station meet at the wet well.
1-2	Khokar Road	B	1997	—	World Bank/DFID	4.7	1.6 x 3	3				—	1.6 x 2		Elevator Type	The requested pumps to the Govt. of Punjab are expected in 2004.
1-3	Shad Bagh Drainge Station	B	1997	with gate	World Bank	6.0	2.0 x 3	3	B(15.3m +9.2m)/2 x H4.6m	71.8	65.9	—	—	65.9	Trash Car Type	Gravity flow is impossible. There are gates but permanently closed.
2	Chota Ravi Drainage Station	A	1967	with gate	World Bank	2.8	0.3x5, 0.7x2	7	B3.0m x H0.8m	3.2	0.4	—	—	0.4	Nil (manually)	Gravity flow is possible. The pumps have not been operated since 1988.
3	**Main Outfall Pumping Station[2]**					**10.9**		**20**		**9.7**	**0.0**	—	**2.2**	**0.0**		
3-1	Main Outfall No.1	A, F, G	1945	—	Pre-Pakistan	5.6	1.1x1, 0.4x4, 0.3x1, 0.2x2, 0.7x3	11	D1,370 + D1,450	4.7	0.0	Automatic Trash Rake System	1.1 x 2	0.0	Catenary Type	The requested pumps to the Govt. of Punjab that replace two old pumps are expected in 2004[3].
3-2	Main Outfall No.2	A	1997	—	World Bank	2.9	0.7x2, 0.73x2	4	D1,520	2.7	0.0	—	—	0.0	Nil (manually)	
3-3	Main Outfall No.3 Drainage Station	G	1985	—	Govt. of Punjab	2.4	0.7x3, 0.2x2	5	D1,370	2.2	0.0	—	—	0.0	Nil (manually)	Gravity flow is impossible.
4	Gulshan-e-Ravi	H1,H2, M	1982	—	World Bank	13.4	1.1 x 12	12	B3.3m x H4.3m	21.6	8.1	1.1 x 2	—	5.9	Elevator Type	
5	Multan Road	J, K	1993	—	World Bank	4.5	1.1 x 4	4	B3.3m x H4.3m	10.8	6.3	1.1 x 2	—	4.1	Nil (manually)	
6	Babu Sabu Drainage Station	H1	1985	with gate	World Bank	5.6	0.7 x 8	8	B9.0m x H1.5m	18.2	12.6	—	—	12.6	Nil (manually)	Gravity flow is possible[4]. The pumps have not been operated since 1997.
Total						**52.4**		**61**		**162.2**	**111.0**	**6.7**	**5.4**	**101.1**		

1) The drainage capacity required by the size of inlet pipes is calculated as follows: (Cross Section of the inlet pipe) x (Velocity: 1.2m/s) x (25% Extra Capacity)

2) Both Shad Bagh P/S and Main Outfall P/S consist of three pumping stations.

3) Replacement of 6 pumps at Main Outfall P/S No.1 was requested In the initial PC-1, but they are no more necessary because 4 pumps have been replaced (one $1.1m^3/s$ pump in 2001, and three $0.4m^3/s$ pumps in 2003) and another 2 pumps are going to be replaced in 2004. After that, there is a plan to remove 5 old pumps there.

4) Since the drainage capacity was increase from $2.8m^3/s$ to $5.6m^3/s$ in 2003, and new drainage channels from Gulshan-e-Ravi and Multan Road P/S directly to Ravi River were constructed, the drainage condition has improved.

Colored portion is the requested Pumping Stations.

(6) Pump Related Equipment

The equipment requested at three pumping stations each is a main pump, a motor, a switchboard, valves including a suction valve, a non-return valve and a discharge valve, and piping material. In addition to that, a water level gauge is requested only at Shad Bagh Pumping Station. The prominent points for these equipment are mentioned here:

(a) A discharge valve at Gulshan-e-Ravi Pumping Station

The existing outlet pipes at Gulshan-e-Ravi Pumping Station do not have a discharge valve because the outlet pipe is located higher than the receiving water and there is no chance of backwater entering the outlet pipe. For that reason, a discharge valve for the requested pump is not necessary and it is out of the scope of works.

(b) A water level gauge at Shad Bagh Pumping Station

The water level gauge requested at Shad Bagh Pumping Station is aimed to control all of the six pumps there, including two requested ones, automatically. An operation system of pumps controlled by an automated water level gauge system is useful and important for a better and efficient management, though, in reality, many other existing pumping stations are operated and controlled manually by inspecting the water level visually and, consequently, there has not been major failure reported so far. For above reasons, it can be concluded that the urgency of an automated water level gauge system is not confirmed and it is out of the scope of works.

(7) Automatic Trash Rake System

(a) The necessity for maintenance

The request for an automatic trash rake system is aimed to replace the existing oldest one, which was constructed in 1945, at Main Outfall Pumping Station No.1. The existing trash rake system is not functioning well because of its old age and is causing troubles to the pumps due to its low efficiency in trapping and collecting garbage and other floating materials. Because of that, the staff has to stop the pumps frequently and solve the problem, such as removing clogging material in a pump, during heavy rains. Main Outfall Pumping Station No.1 has a catchment area mainly in Gunj Bukhsh Town, where most of the political and commercial functions of Lahore City concentrate, and its function is vital for the success of the overall Project. For those reasons, it is concluded that the priority of the replacement of the automatic trash rake system is high.

(b) A loading hopper and an inclined conveyor

The existing trash rake system has a loading hopper and an inclined conveyor for loading collected garbage to a dump truck, though they are old and not functioning anymore. The amount of garbage collected there is relatively small, about 3 – 4m^3 per day, and they are loaded manually on a dump truck or a tractor trolley. Thus, the urgent need for a loading hopper and an inclined conveyor was not confirmed.

(c) Specification of an automatic trash rake system

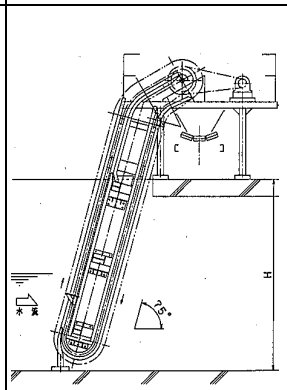
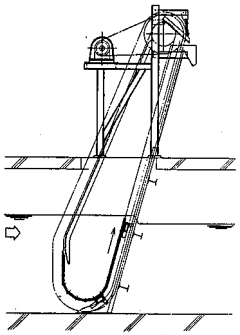
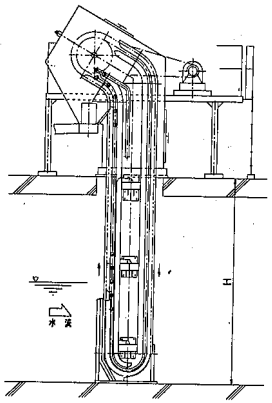
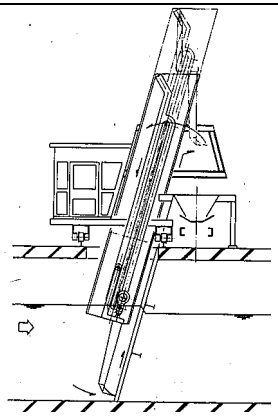
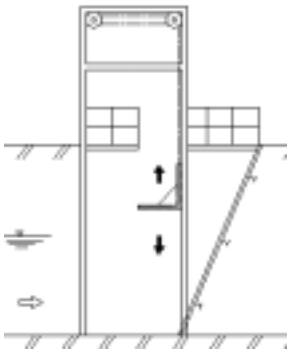
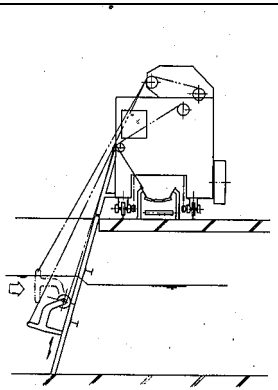
The existing type of trash rake system is a kind of catenary type which has a sprocket wheel on the tope and an endless chain with rakes that press the floating material trapped in front of the screen and collect them and move upward continuously. The structure is simple and the mechanical maintenance does not require special skill, though it does not accommodate large rakes and thus it cannot collect large garbage. In addition, garbage is easily deposited at the bottom of the trash rake system and that requires regular maintenance manually. For those reasons, a bar screen type of trash rake system which is a simple structure, easy to maintain, and effective in collecting large and small garbage is selected as shown in Table 2.12.

(8) Spare parts for equipment

The equipment selected for the Project is mostly the same or similar to existing ones so that the staff in WASA can easily handle them. There are many local agents which provide maintenance services and also which are used to procure and provide spare parts from other countries. Nevertheless, the spare parts from other countries occasionally require certain time for procurement and it is better to have a stock of them for prompt maintenance. For that reason, a provision of a set of essential spare parts at least for one year for emergencies and a guarantee for a kick-start period for cleaning works for all of the provided equipment are confirmed. A list of main spare parts for each type of equipment is given in the following table.

Type of Equipment	Name of Spare Parts
1. Equipment for sewer pipe cleaning	Hose, valve, belt, filter and packing
2. Equipment for drainage cleaning	Nil
3. Equipment for monitoring	Nil
4. Equipment for pumping stations	
a) Pump	Sleeve, bearing and others
b) Automatic trash rake system	Fuse, plug, raking chain, conveyor and others

Table 2.12 Comparative Table of Automatic Trash Rake System

	Fixed Type					Movable Type
	Continues Raking Type			Intermittent Raking Type		
	Bar Screen Type	Catenary Type	Net Type	Telescopic Arm Type	Lifting Table Type	Trash Car Type
Figures						
Existing Pumping Station	—	■ Main Outfall	—	—	■ Shad Bagh ■ Khokhar Road ■ Gulshan-e-Ravi	■Shad Bagh
Mechanism	The trash, which is caught by the front screen is removed continuously by a rake attached at a fixed interval.	A rake is attached in the endless chain made to hung vertically at a fixed interval. The trash of a screen side pushed by the rake is removed continuously.	A net frame is attached in an endless chain. With the injection water from the backside of net flush away the thrash.	A rake held by the telescopic arm rakes the trash repeatedly. A high space on the base is required due to the mechanic structure.	The tray installed in the front of a screen lifts the trash operated by manual. The dust lifted to the ground is removed by manpower.	The rake is attached in the electric vehicle, moves on the rail between several water-way.
Disposal Capacity	- Since it is continuation motion, throughput is large. - A big refuse can be removed.	- It is suitable for thin refuse disposal. - The stake bite power of a rake is weak in the lower part.	- Throughput is large due to continuous motion. - It is suited to fine trash and adhesive trash.	- It cannot operate continuously but throughput is small. - Removal of a bulky trash is impossible.	- Since it cannot operate continuously, throughput is small. - Human power work is required to remove trash from the tray.	- The throughput per time is small. - A rake bites power is small, and the trash bigger than the size of the rake cannot be removed.
Operation & Maintenance	- An underwater part is maintenance-free. - The mechanism of a drive parts are simple - A chain stroke needs to be adjusted periodically.	- The condition of the bottom needs to be checked periodically. - Operation will become impossible if the trash accumulates gradually.	- By the type which has sprocket in underwater part, maintenance takes trouble. - It is tended to get the fine trash.	- Maintenance is complicated. - A bruise is early in order that a power cable may fluctuate along with a motion of a rake.	- It is easy to deposit the trash on the bottom of the tray, and periodical maintenance is required.	- Since the mechanism is complicated, maintenance check takes time. - Compulsive descent of a rake cannot be performed.
Application in the project	- Applicable to the project **most appropriate**	Since this type cannot respond to big trash, it is unsuitable. **applicable**	unsuitable in this project, since big trash flows in. **not applicable**	- Since the waterway is deep, The equipment scale will be large. - It is not applicable for the indoor equipment. **Not applicable**	-Unsuitable to indoor equipment. **applicable**	It is difficult to deal with the quantity of the trash which flows in continuously at the time of rain. **not applicable**

2.2.1.3 Operation and Maintenance

It is scheduled for WASA to set up Project Management Unit (PMU) with approximately 220 full-time staff to be engaged in management and operation of the project. In principle, it will be composed of WASA's staff members and without recruiting new personnel. With regard to the storage of equipment, WASA intends to manage it in intensive way by reducing the number of store yards from existing 15 to 3. WASA is well prepared for taking quick actions in response to emergrncy case when flood occurs. However, it seems that pre-emptive measures are not properly taken at ordinary times in order to alleviate flood damage. This may be attributable to the fact that strategy and planning are missing for cleaning and desilting the whole sewage/drainage network system. Actually the work is carried out to meet immediate needs.

Although WASA owns 20 or more store yards including sub-divisional offices scattered over in each town, there is no mechanical workshop, so when a machine breaks down and needs repairs, except for the minor case, it will be fixed up by the contractor selected by bidding. Many items of equipment were purchased 6 to15 years ago, but these are generally well maintained and practically used. For example, a clamshell has been used since 1966 after being repaired many times.

Spare parts are collectively stored in the storehouse in Main Outfall pumping station, and when required, it should be approved according to the following procedure: SDO - Executive Engineer - Project Director - Deputy Managing Director. Currently, it is managed by store officer using Bin Card (handwriting) and inventory book, which has been prepared by the Department of Procurement and Store. Under present conditions, it is not computerized management system but seems to the most appropriate method.

Regarding spare parts to be supplied under the present project, these will be stocked in the same storehouse as enough space is still available, and shall be delivered according to the same procedure.

2.2.1.4 Procurement Method

Since this is a kind of equipment procurement project, the procurement method is an open bidding by Japanese trading companies or manufacturers. The bidder is required to have an aftercare service system. The list of equipment can be categorized into following two sets: one is a set of equipment such as an excavator and a dump truck that are relatively easily procured and provided, and another is a set of equipment such as a pump, sewer cleaning machines, and an automatic trash rake system, that requires an engineer who supervises the installment, operation and maintenance of them. Thus, it is required to divide the procuring equipment into two sets for smooth implementation.

The origin of procuring equipment includes Japan, Pakistan and other third countries, namely American and European countries, but the manufacture has to have a branch or a service branch for an aftercare service. The selection of the equipment shall take into consideration not only the cost and quality of the equipment but also the usefulness and satisfaction of the recipient. In other words, the equipment that is easily operable and maintained by the staff of WASA shall be selected referring to the existing equipment and its management and maintenance system.

2.2.2 Basic Plan

As a result of basic design study, the basic plan for the requested Japanese assistance can be summarized as follows.

2.2.2.1 Overall Plan

(1) Equipment storage system

Originally, equipment was planned to store in more than 10 parking areas. However, WASA has decided to reduce the number of such areas to 3 in order to provide easy management system for PMU. These are designated at Shad Bagh pumping station, Main Outfall pumping station and old pumping station of Kharak (unused open land now), each having a large space of land with easy access from the trunk road. WASA intends to use them not only as parking areas but as garages providing facilities for car washing, oil change, daily mechanical check and so on.

In Shad Bagh pumping station located in Ravi Town northern part of the city, one SDO will be in charge of drainage areas A and B and undertake storage and maintenance of the cleaning machinery and equipment, while in Main Outfall pumping station, which belongs to Gunj Bukhsh Town and covers area G, equipment will be managed under the responsibility of one SDO. As for Kharak located within jurisdiction of Iqbal Town, two SDOs will be responsible for the storage and management of equipment to be employed in area H1. Although the proposed store yard of Kharak is the property of WASA, care is not taken so it is bare land without fence. WASA plans to put up fence around the site and build PMU office and its necessary facilities by March 2005.

Further details of equipment to be under the control of each storeyard are described in the following section “Basic Design Drawing”.

(2) Situation of equipment installation site

Two pumps are planned to be installed at each of the three existing pumping stations (Shad Bagh, Gulshan-e-Ravi, Multan Road). They are located in flat area having no problems on accessibility and availability of power supply. The pump house is equipped with crane and provides spaces for the two new pumps, so that it seems that problems will not be encountered for the installation of pumps.

Since existing trash rake system of Main Outfall pumping station is superannuated and deteriorating its function so it needs to be replaced by a new one. For the replacement work, special care should be taken to leave existing facility as much as possible, and dismantling of existing trash rake and other minimum reinforcement works will be required for the installation of the new trash rake system. Moreover, the trash rake house is not equipped with crane and its entrance is so small that the material cannot be easily moved out and in for the installation work

2.2.2.2 Equipment Plan

To know the fact that the existing equipment of WASA is always used to respond to 20 to 40 complaints per day from the residents and mobilized in various parts of the city, there

are very few possibilities of using for this project. Therefore, this project is planned to complete only using the requested equipment. Basically, the scale and specification of the equipment shall be equivalent to the existing one, and the required number of units is calculated according to the cleaning/desilting plan.

Although the Government of Pakistan has requested 6 units of 4 ton-class trucks in PC-1 for cleaning narrow streets, this request was changed in preparatory study in March 2004 demanding 12 pickup trucks (double cabin type) instead. However, according to Action Plan prepared by WASA, the number of this pickup trucks is drastically reduced from 12 to 4 units, while the number of 8 ton-class dump trucks is increased from 8 to 10 units.

In this Basic Design Study, it was judged that the above-mentioned pickup trucks are not proper equipment for the transportation of removed sludge or material although they can be used for the transportation of small equipment or workers. However, when the city is hit by heavy rainfall, this type of vehicles will be indispensable to patrol flood areas and to carry out the monitoring of flood situation. A total of 4 units are required, each to be deployed to PMU respective storeyards and WASA headquarters.

In Action Plan it is described that three years are required for the project implementation, and based on this three-year plan, operational schemes and work schedule are described with a list of necessary machinery and equipment. However, the number of dump trucks is short by 20 units for the transportation of sludge and garbage, which are generated by cleaning/desilting work for open channels. WASA once intended that 10 dump trucks could be supplied by the financial assistance from the Punjab Government and the remaining 10 units would be under Japan's Grant Aid. This idea has been changed because of difficulties of local budget allocation for this purpose, and all 20 dump trucks are included in the final request as a result.

Desilting work of sewage is carried out by 4 teams, and each team will provide mobility with one set of the following equipment: jetting machine, sludge sucker, water tanker and 4 ton dump truck. Based on the above, the equipment plan is summarized as follows:

<Equipment for desilting sewage pipes>

(1) Jetting machine

Currently, truck mounted type vehicle of 8 ton-class (loading capacity) is the most frequently used by WASA. In addition, workers are used to handling and operating this type of machine, so the equipment of the same size and specification is designed for the project. A total of four (4) units are needed.

(2) Sludge sucker

Based on the desilting plan, 8 ton-class truck-mounted type will be provided to the 4 respective teams just like jetting machine. In consideration of work efficiency and environmental aspect, the machine will be designed for dewatering from the tank after sucking wastewater from the sewage pipe and then loading the sludge to the dump truck.. A total of four (4) units are needed.

(3) Water tanker

Truck-mounted type with tank capacity of 7,000L to 8,000L will be designed for supplying water to jetting machine. One unit of water tanker is to be shared by two jetting machines, so a total of two (2) units are required for the project.

(4) 4 ton-class dump truck

As it is expected that 1to 2m^3 of sludge be collected by a sludge sucker, this small type of dump truck can be used to carry and discharge it to the final disposal site. One combined operation cycle for jetting machine and sludge sucker will require about 60 minutes, which is equivalent to the time for transportation/discharge by a truck, so that one unit will be required for a team. WASA had an intention of deploying one truck of its own and requesting for three by the Grant Aid of Japan, but as a result of basic design study, it was concluded that all four (4) units would be provided under the Grant noting that WASA's proposed vehicle would need to be used for activity other than the project

(5) Submersible sludge pump and generator

Before and during the operation of jetting machine, submersible sludge pump is used for draining water from the sewage pipe to facilitate desilting work, and generator is definitely used as a power supply source for the submersible sludge pump. In view of the fact that the sludge pump with the capacity of 3.4m^3/min, which was supplied by DFID, is still being used, a similar type of pump will be provided to each team. Regarding generator, there was a possibility of using two existing units owned by WASA, but after due consideration it was decided that all four (4) units would be supplied under the Grant. This is because of the fact that the two existing ones are frequently used for emergency cases

<Equipment for cleaning/desiliting drainage channels>

(1) Clamshell

WASA owns only one unit of crane-typed clamshell excavator, which was manufactured in 1966. Nonetheless, it is operating at full swing to remove solid wastes from the drainage channels as well as sludge from the pumping stations. For this reason, it cannot be used for desilting in drainage channels.

The total length of the 10 m wide channels running through the project area is estimated at 10 km or more, and assuming that the deposition depth of sludge is 1 to 2 m, the equipment with bucket capacity of. 0.7 to 0.8m^3 will be suitable and required for cleaning/desilting. If the crane-typed equipment with wheel is requested, it is hardly available because this type of equipment is no longer manufactured in Japan and other developed countries for safety reason. On the other hand, the same machinery with crawler, instead of wheel, can be found in the market, but this is not considered practicable because the body size becomes as large as 30 ton-class heavy equipment and a trailer will be needed to move it from one place to another.

From the above considerations, it was judged that wheel-typed hydraulic excavator with clamshell attachment would be the best option to meet requirement of the client.

(2) Hydraulic excavator

Although WASA owns four large-sized excavators and one small-sized one, these are not added to the cleaning/desilting plan for the project as they are fully deployed for the work corresponding to the daily emergency cases. In the project, the work will be carried out in such a way that a large-sized excavator is used in combination with a clamshell for desilting work in large drainage channel. Bucket capacity will be $0.8m^3$, which is equivalent to the existing one. On the other hand, a small-sized excavator shall be used for small drainage, and bucket capacity will be $0.28m^3$.

(3) 8 ton-class damp truck

For the transportation of sludge and material removed from the drainage channel to the final disposal site, the reasonable size of dump truck will be the same as existing ones, which is designed for 8 ton-class loading capacity. For the project a total of twenty (20) units are needed. Among them ten (10) units will be deployed for two clamshells, six (6) are for a large-sized excavator, and four (4) for two small-sized excavators.

<Other equipment>

(1) Equipment for monitoring

The pickup truck is required for patrol in flooded areas as well as monitoring flood conditions when heavy rainfall hits the city. Monitoring will be conducted observing flood coverage area, water depth and draining time at 20 sites determined in the Basic Design Study. A total of four (4) pickup trucks are needed, one for WASA headquarters and three for PMU offices to be located in the proposed three storeyards. The pickup truck shall be durable, resistible and powerful to achieve the above objective, so it is desirable to be 4-wheel drive and will be double cabin-typed vehicle to provide space for two persons other than a driver as the monitoring work will be carried out by two competent staff members per team.

(2) Cleaning equipment for pumping station

One wheel loader will be provided for Shad Bagh pumping station and Gulshan-e-Ravi pumping station respectively for loading garbage to dump trucks. As the amount of garbage collected from the screen in each of these two pumping stations is 7 to 10 m^3 per day, which is an amount hardly removable by manpower. Therefore, mechanical system will be introduced to develop work efficiency. And it will certainly serve to the improvement of working environment.

<Pump and its installation work>

(1) Drainage pump

Two pumps with $1.1m^3/s$ capacity each are required in Shad Bagh, Gulshan-e-Ravi and Multan Road pumping stations respectively. It will help develop drainage capacity at each pumping station. Pumps will be designed to be duplex stainless steel for the impellers taking account of durability and resistance against abrasion and corrosion. Along with the pumps, motors, control panels, valves (suction valve, check valve, delivery valve), piping materials will also be provided under the Grant. Water level gauging equipment will not be included in this regard.

(2) Installation work

In principle, the Japanese side shall be responsible for the work to be carried out in pumphouse, and the Pakistan side shall be responsible for the work outside pumphouse such as cabling for power supply, installation of transformer, etc. The Japanese side will be in charge of pump installation, pipe connection, installation of motor and control panel and its wiring, and adjustment and test run will also be conducted after the installation.by the Japanese side.

<Removal and installation of trash rake system>

(1) Automatic trash rake system

Trash rake system of Main Outfall pumping station is superannuated as it serves for nearly 60 years. This system needs to be updated by replacing by the new one with the aim of raising trash-removing efficiency. With regard to hopper and sloped-belt conveyor, which are now abandoned, the replacement of these items will be ruled out due to the low necessity for the project.

(2) Removal and installation work

The share of work responsibility is just the same as pump installation. The Japanese side shall undertake only in-house works. It is important to note that the removal and installation should be under the same work management system, as they have to be carried out simultaneously. That is to say, one competent Japanese contractor will undertake dismantling of old equipment, assembling of new equipment and its installation according to the work schedule and quality control system.

From the above considerations, all items of equipment and their quantity and specification are summarized in Table 2.13.

Table 2.13 List of Equipment (1/2)

Equipment	Quantity	Specification	Objective
Equipment for desilting sewage pipes			
Jetting machine (Truck mounted type)	4	Loading weight: 8ton class Jetting pump: 250to300 L/min	Smashing solid sludge and removing blocked material in pipes
Sludge sucker (Truck mounted type)	4	Loading weight: 8ton class Tank: capacity 4000 to 4500L with hydraulic lifting system Dewatering system	Sucking and removing sludge from sewage pipes, dewatering from the tank and loading sludge to damp truck.
Water tanker	2	Loading weight: 8ton class Tank capacity: 7000 to 8000L	Supplying water to jetting machine.
Dump truck	4	Loading weigh: 4ton class	Transporting removed sludge to the final disposal site and discharging thereto
Submersible sludge pump	4	No clogging type Discharge: 3.4m ^{3}/min, Total head: 13.2m	Drainage of sewage pipes to facilitate desilting work.
Generator	4	For submersible sludge pump	Power supply for the operation of submersible sludge pump
Equipment for cleaning/desilting drainage channels			
Clamshell excavator	2	Wheel type hydraulic excavator Bucket capacity: 0.7-0.8m3	Desilting of large drainage channels and removing garbage/trash in water inflow section at pumping stations.
Hydraulic excavator I	2	Wheel type Bucket capacity: 0.28m3 Boom length: approx. 3700mm	Cleaning and desilting in small drainage channels, and loading the removed sludge to the dump trucks.
Hydraulic excavator II	1	Wheel type Bucket capacity: 0.8m3 Boom length: approx. 5500mm	Cleaning and desilting in large drainage channels, and loading the removed sludge to the dump trucks.
Dump truck	20	Loading weight: 8ton class	Transporting removed sludge and garbage to the final disposal site and discharging thereto
Equipments for monitoring			
Pickup truck	4	4WD and double-cabin type Diesel engine: 2800 to 2800 cc	Patrolling flooded areas and observing flood situation (flood coverage area, water depth and draining time) at 20 monitoring sites
Cleaning equipment for pumping station			
Wheel loader	2	8 ton class Bucket capacity: 1.2m3	Loading raked trash and garbage of pumping station to the dump truck.

Table 2.13 List of Equipment (2/2)

Equipment	Quantity	Specification	Objective
Equipment for pumping station			
(Shad Bagh) • Pump • Motor • Suction valve • Check valve • Delivery valve • Piping material • Control panel (low voltage)	 2 2 2 2 2 2 2	 68 m3/min, duplex stainless steel for impellers 180 KW, 415V 700mm 600mm 600mm 600mm	Draining sewer, which collected in the pumping station, to the Ravi River.
(Multan Road) • Pump • Motor • Suction valve • Check valve • Delivery valve • Piping material • Control panel (high voltage)	 2 2 2 2 2 2 2	 68 m3/min, duplex stainless steel for impellers 180 KW, 3300V 700mm 600mm 600mm 600mm	Draining sewer, which collected in the pumping station, to the Ravi River.
(Gulshan-e-Ravi) • Pump • Motor • Suction valve • Check valve • Delivery valve • Piping material • Control panel (high voltage)	 2 2 2 2 2 2 2	 68 m3/min, duplex stainless steel for impellers 180 KW, 3300V 700mm 600mm 600mm 600mm	Draining sewer, which collected in the pumping station, to the Ravi River.
Automatic trash rake system (Main Outfall) • Raking machine • Level conveyor	 1 1	 Automatic trash raking system	Removing trash/garbage to protect pumps and their function from being damaged.

2.2.3 Basic Design Drawing

2.2.3.1 Basic Concept of Layout Plan

There are three PMU Offices with parking areas, namely Shad Bagh Pumping Station, Main Outfall Pumping Station and Kharak (Sabzazar) Office, allocated for cleaning equipment for sewage and drainage system. Among them, Kharak (Sabzazar) Office is located at a land of a replaced pumping station and WASA is planning to construct the PMU Head Office there by March 2005.Four pickup trucks for monitoring purpose are allocated one each to these three PMU Offices and WASA Head Office. Pumps and the related equipment are distributed to Shad Bagh, Gulshan-e-Ravi and Multan Road Pumping Stations. And, two wheel loaders are distributed to Shad Bagh and Gulshan-e-Ravi Pumping Stations one each.

The distribution and layout plan are shown in Table 2.14 and Fig 2.3.

Table 2.14 Distribution Plan of Equipment

Name of Equipment	Total	Shad Bagh P/S	Main Outfall P/S	Gulshan-e-Ravi P/S	Multan Road P/S	Kharak PMU Office	WASA Head Office
Cleaning Equipment for a Sewer Pipe							
Jetting Machine	4	1	2			1	
Sludge Sucker	4	1	2			1	
Water Tanker	2		1			1	
Dump truck (2)	4	1	2			1	
Submersible Sludge Pump	4	1	2			1	
Generator	4	1	2			1	
Cleaning Equipment for a Drainage Channel							
Clam Shell	2					2	
Hydraulic Excavator (1)	2					2	
Hydraulic Excavator (2)	1					1	
Dump Truck (1)	20					20	
Cleaning Equipment for a Pumping Station							
Wheel Loader	2	1		1			
Monitoring Equipment							
Pickup truck	4	1	1			1	1
Pumps and Related Equipment							
Pump	6	2		2	2		
Motor	6	2		2	2		
Suction Valve	6	2		2	2		
Reverse Valve	6	2		2	2		
Discharge Valve	4	2			2		
Piping Material	6	2		2	2		
Switchboard	6	2		2	2		
Automatic Trash Rake System	1		1				

2.2.3.2 Layout Plan for Pumps and the Related Equipment

The installation sites for pumps and the related equipment are three pumping stations, namely Shad Bagh, Gulshan-e-Ravi and Multan Road Pumping Stations. Each plan and cross sections are shown in Figs. 2.4-2.12.

2.2.3.3 Layout Plan for Automatic Trash Rake System

The installation site for an automatic trash rake system is Main Outfall Pumping Station No.1. The plan, cross section and the front view are shown in Figs. 2.13-2.15.

2.2.3.4 Layout Plan for Parking Area for Cleaning Equipment

The parking areas for cleaning equipment of a sewer pipe and a drainage channel are three locations, namely Shad Bagh and Main Outfall Pumping Stations, and Kharak (Sabzazar) Office. Each layout and the parking area are shown in Figs. 2.16-2.18.

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

The equipment listed for procurement is mostly manufactured in Japan and they are competent in the world market. Thus, most of the equipment will be procured in Japan except the piping material for a pumping station that is produced in Pakistan and will be procured locally.

It is confirmed that the manufacturer are responsible for the installation and proper operation of the equipment, such as a pump, an automatic trash rake system and cleaning equipment, and they are to send engineers for installation works and initial operational guidance.

The manufacturers are to provide technical guidance service for sewer pipe cleaning as an on-the-job training utilizing the whole set of equipment. It is expected by those series of technical guidance that the procured equipment to be utilized efficiently.

2.2.4.2 Implementation Conditions

The location of handing over of the procured equipment will be each pumping station and parking area, and the transportation cost to there will be beard by the Japanese side for the following reasons.

The inland transportation cost from Karachi Port to Lahore City is beard by Japanese side. There are two options for the inland transportation: by the railway and by the road. There are two dry ports in Lahore City, one is for the railway which locates in the vicinity of Mughalpura Station on the east of the city, and another is for the road transportation which locates in Tokar Naiz Baig on the southwest of the city. Usually, transportation by railway is slightly cheaper than by road, although there is a disadvantage that it can convey only the items which can be loaded in the standard-sized containers. Thus, for the transportation of items which exceeds the standard size of a container, it is better use the road transportation and WASA uses the road transportation by a trailer in many cases. Customs clearance at a dry port is possible for either mode of transportation.

Although there are many contractors who take in charge of inland transportation from Karachi to Lahore, government organization uses a government-affiliated agent called NLC (National Logistic Cell) in many cases. NLC receives support by the army of Pakistan to prevent accident during the transportation and the safety control which uses GPS ant other system is reliable. Since on-load transportation of a vehicle by driving by itself requires to travel 1,200km of distance from Karachi to Lahore, the chances to be involved in a robbery and an accident. For that reason, it is common to transport government-related equipment under the NLC service and even a large vehicle is often loaded on a trailer for a safety purpose.

WASA prefers the use of NLC and the customs clearance in Lahore based on its experiences, and since there are many merits such as the convenience on customs procedure in Lahore, customs clearance will be in Lahore. In that case, the inland transportation will be on the road using trucks and trailers. The location of handing over will be at each designated pumping station and parking area after a test run and initial operation guidance are completed.

2.2.4.3 Scope of Works

There is a space available in the existing building for installment of each pump related equipment and an automatic trash rake system. In principle, the indoor installation works will be beard by Japanese side and outdoor works such as a power supply and an extension of a transformer will be beard by the recipient side. The details of the work for each type of equipment are described below.

(1) Installation of a Pump

Since WASA and local contractors have installed some pumps by themselves, it is inferred that they have a basic technical capability for the installation works. However, local consultants still have problems in the accuracy of installation, such as an alignment work, and the management of quality and schedule control. It is reported that, for example, during an installation work of a pump at Khokar Road Disposal Station in 1997, the motor overheated during a test run and the whole power unit had to be replaced.

The Project had to carry out from the selection of a contractor to the handing over of the equipment within a single fiscal year, and the contractor had to guarantee the quality of the equipment including the installation works and the test run. For that reason, the installation works are borne by Japanese side in order to meet the time restriction. The installation works borne by Japanese side are shown in Fig2.19 and the following table.

Component of Japanese Side	Component of Recipient Side
■ Installation of a pump ■ Piping of an inflow pipe and a discharge pipe (connection with established piping) ■ Installation of a motor and a switchboard, and wiring ■ Adjustment after installation and trial operation	□Procurement and installation of a new transformer □Wiring from a transformer to a switchboard (The work has to be completed by the middle of December, or before the commencement of installation work by Japanese side.)

(2) Installation of an Automatic Trash Rake System

Since the inlet channel of Main Outfall Pumping Station No.1, where an automatic trash rake system will be installed, is a structure made of bricks about 60 years ago, it is required to install that with a safe and reliable construction method. Furthermore, supervision by the manufacturer is indispensable for the assembling and installation of the automatic trash rake system since the assembling parts will be sent separately. In addition to that, in order to ensure the better and consistent quality and schedule management by the manufacturer from manufacturing to installation, the installation works are borne by Japanese side. Meanwhile, the removal of existing trash rake system will also be borne by Japanese side for the following reasons:

a) Since there is a chancel to damage existing structure partially, the contractor will be responsible for the management of the whole installation works.

b) Since the installation works will take place while existing one is operating, the removal and installation works have to be controlled consistently.

c) Since the installation works are the key component for the whole construction schedule, the contractor has to be responsible for the schedule management.

Following works are required for the installation of an automatic trash rake system.

Component of Japanese Side	Component of Recipient Side
■ Removal of the existing equipment (an indoor sprocket, a level conveyor, and a screen in a waterway) ■ Repair of existing building (an opening portion of the floor slab and the wall) ■ Installation of a screen and a guide rail ■ Installation of an indoor sprocket (power unit) ■ Installation of a control panel and indoor wiring ■ Adjustment and a test run	□Wiring from the existing transformer to an indoor switchboard (The work has to be completed by the middle of December, or before the commencement of installation work by Japanese side.) □Disposal of the removed existing equipment

2.2.4.4 Consultant Supervision

(1) Supervision by a Consultant

(a) Contents of work

While a contractor procures equipment, a consultant supervises whether the quality and schedule control and preparation and installation works are in due course. The main contents of supervision are as follows:

a) Deliberations with a contractor,

b) Inspection at a factory before loading and at a port before shipment,

c) Deliberations and arrangements with WASA and other relevant organizations,

d) On-site inspection of a work done by the recipient country,

e) Inspection on procuring progress of equipment,

f) Confirmation and follow-up of the progress regarding customs clearance of equipment,

g) Inspection of equipment and installation works,

h) Issue of a certificate, and

i) Presentation of a report.

(b) Supervising structure

Supervising structure consists of three engineers, which are a locally stationed supervisor, a chief supervisor and an inspection engineer. The role of each engineers are given in the following table.

No.	Consultant staff	Work Contents	Period
(1)	Locally Stationed Supervisor for Procurement Control	The consultant arrives to the site together with the procured equipment and supervises the entire procurement process. The consultant also supervises the installation of a pump and an automatic trash rake system, and arranges meetings with a contractor and the staff of WASA.	4.0 M/M
(2)	Chief Supervisor for Procurement Control	The consultant stays on site during manufacturing period of equipment and arranges meetings with WASA staff prior to the implementation. The consultant also attends at inspection and delivery.	1.4 M/M
(3)	Inspection Engineer	The consultant inspects and checks the design documents and drawings prior to the manufacture. The consultant also inspects the products at the factory and before shipping.	0.95 M/M
(4)	Assistant Engineer	A local Consultant takes charge of quality and scheduling control during the installation work of pump as an assistant engineer.	2.5 M/M

(2) Contractor's Procurement Management Plan

The contractor shall assign following staff, which include a procurement and installation manager and six other engineers, for procurement management and installation works.

No.	Occupation	Contents of work	M/M
(1)	Procurement and Installation Manager	The manager is in charge of the whole procurement and installation process, which include procurement management of equipment, negotiation with the staff of recipient country for kickoff meeting and other meetings, customs clearance, schedule and safety management for installation works, and the handing over of equipment.	4.0 M/M
(2)	Mechanical Engineer A (Cleaning Equipment)	The mechanical engineer A is in charge of arrangement of equipment, test run and initial operation guidance for cleaning equipment, which include a jetting machine, a sludge sucker, a water tanker and others. In addition, the person is responsible for on-the-job training for local engineers and staff utilizing all of the equipment.	1.25 M/M
(3)	Mechanical Engineer B (Shad Bagh P/S)	The mechanical engineers B, C and D are in charge of pump installation and their quality control. They are also responsible for the arrangement of equipment, test run and initial operation guidance to local engineers after the installation.	2.5 M/M
(4)	Mechanical Engineer C (Gulshan-e-Ravi P/S)		2.5 M/M
(5)	Mechanical Engineer D (Multan Road P/S)		2.5 M/M
(6)	Mechanical Engineer E (Automatic Trash Rake System)	The Mechanical Engineer E is in charge of installation of an automatic trash rake system and its quality control. The person in also responsible for the arrangement of equipment, test run and initial operation guidance to local engineers after the installation.	3.4 M/M
(7)	Electric Engineer F	The electric engineer F is in charge of quality control on electric system for all of the pumps procured and an automatic trash rake system. The person is also responsible for the arrangement of equipment, test run and initial operation guidance.	1.0 M/M
(8)	Excavator Mechanic Engineer G	The excavator mechanic engineer G is in charge of test running and operation guidance of Clamshell and Excavators.	0.5 M/M

2.2.4.5 Procurement Plan

The equipment for the Project will be, in principle, procured in Japan except piping material for pumping stations that can be procured in the recipient country. The Equipment for Drainage Channel Cleaning, Pickup Trucks and Motors for Pump will be possible to be purchased in third country in order to keep an impartial procurement. The equipment that can be purchased in the third country other than Japan and Pakistan are given in the following table.

Classification	No.	Name of Equipment	Procured in Japan	Procured in Third Country	Procured in the Recipient Country
A. Equipment for Sewer Cleaning	1	Jetting Machine	O		
	2	Sludge Sucker	O		
	3	Water Tanker	O		
	4	Dump Truck (2)	O		
	5	Submersible Sludge Pump	O		
	6	Generator	O		
B. Equipment for Drainage Channel Cleaning	7	Cram Shell	O	O	
	8	Hydraulic Excavator (1)	O	O	
	9	Hydraulic Excavator (2)	O	O	
	10	Dump Truck (1)	O	O	
C. Equipment for Monitoring	12	Pickup Truck	O	O	
D. Pumps and the Related Equipment	13	Pump	O		
		Motor	O	O	
		Valves	O		
		Piping Material			O
		Switchboard	O		
	14	Automatic Trash Rake System	O		

2.2.4.6 Quality Control Plan

Before manufacturing equipment, supplier and manufacturer(s) shall be called for meeting to discuss details of specifications and quality control method for each item of equipment.

It should be noted that factory inspection be conducted before shipping to ensure the quantity, quality and performance of the equipment, and particular attention needs to be paid to packing method in order that no damage is given to the equipment during transportation. With regard to inland transportation from the port of disembarkation to the final destination, transportation method and schedule shall be submitted in advance from the supplier.

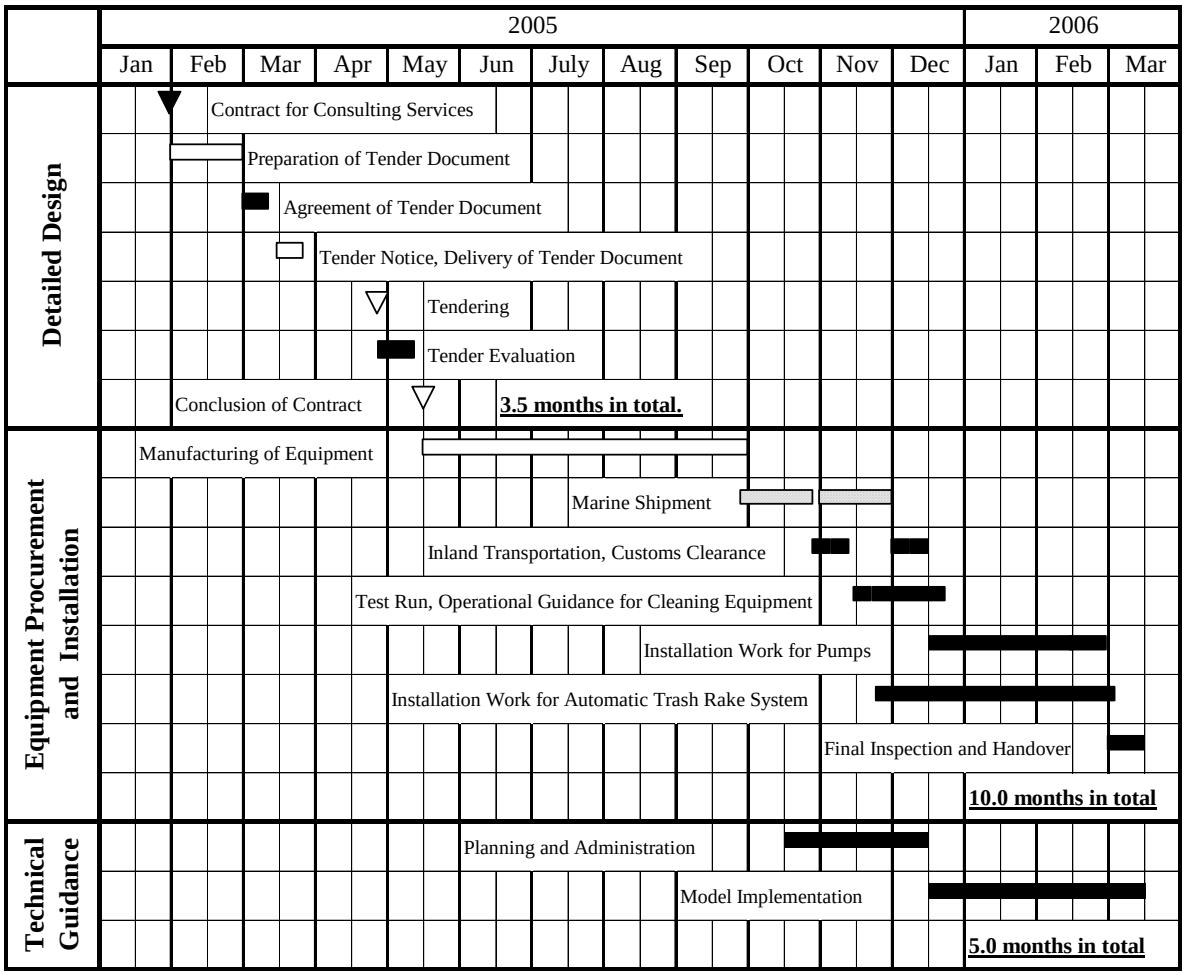
As the equipment is sensitive to dust and high temperature, it shall not be stored under the blazing sun. A responsible person from the supplier shall stay constantly with the equipment to keep careful watch on it.

Necessary arrangements are required to take an immediate action if some defective equipment is found by the inspection and test run, which will be conducted after the installation of equipment.

2.2.4.7 Implementation Schedule

The implementation period of the project will comprise 3.5 months for detailed design and preparation of tender documents, 10 months for procurement and installation of equipment and 5 months for Soft Component. The table below shows further details.

Implementation Schedule



2.3 Obligations of Recipient Country

2.3.1 Undertakings Required to Pakistan

Based upon Minutes of Discussions agreed on August 7, 2004 between JICA study team and Pakistani side, it is confirmed that undertakings required to the Pakistani side for smooth implementation of the project are as follows:

(1) To provide data and information necessary for the Project,

(2) To ensure prompt unloading and customs clearance at the port of disembarkation in Pakistan and internal transportation of the equipment purchased under the Grant Aid,

(3) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Pakistan with respect to the supply of products and services under the project,

(4) To arrange the acquisition of visa and other formalities that may be necessary for the entry of Japanese nationals into Pakistan and stay therein for the performance of the work,

(5) To maintain and use the equipment properly and effectively with suitable number of staff assigned for the operation and maintenance and to bear all expenses other than those covered under the Grant Aid,

(6) To procure required spare parts for maintenance timely and sufficiently,

(7) To use the equipment exclusively for the Project and it shall not be re-exported from Pakistan, and

(8) To bear advising commission of Authorization to Pay (A/P) and payment commission to the Japanese bank for banking services based upon the Banking Arrangement (B/A).

2.3.2 Obligations of Pakistani Side

There are four important obligations for the Pakistani side for a smooth implementation of machinery and equipments. One is the preparation works of the electric source, transformer and their cables for installation of pumps and an automatic trash rake system at relevant pumping stations. The second one is the construction of the PMU Office and an adjacent parking space at Kharak (Sabzazar) where the former Multan Road Pumping Station has been cleared. Third one is the preparation of sewage /drainage drawing based on 1/2,400 map. The fourth one is the final disposal of dismantled trash rake.

(1) Preparatory Works for Installation of Pumps and an Automatic Trash Rake System

For the installation of pumps and an automatic trash rake system at relevant pumping stations, Pakistani side shall bear the cost for preparation works regarding electricity, such as preparation of additional transformers, arrangement and procurement of electric source, and wiring from a transformer to a control panel. There are four pumping stations for installation of pumps and an automatic trash rake system, and one of them, namely Gulshan-e-Ravi Pumping Station, requires a new transformer

with a capacity at 630 kVA, and other three pumping stations do not require a new transformer. The expenses for these works are, as shown in Table 2.15, about Rs. 1.0 million in total. WASA has an annual budget allocated for maintenance of pumping stations, which includes the replacement of a transformer, and it is about Rs. 7.5 million for the fiscal year 2004-05. The expenses for these preparatory works will be paid by this budget. Thus, the budget prepared for running and maintenance expenses for the Project, which is Rs. 100 million, is separated from the expenses for these preparatory works.

In addition to these preparatory works, Pakistani side shall also be responsible for the disposal of removed machinery.

The deadlines for these preparatory works shall be by the middle of December when the installation of pumps and an automatic trash rake system are expected to start, and that shall be agreed by a Minutes of Discussions.

Table 2.15 Preparatory Works by Pakistani Side and Their Expenses

Name of Pumping Station	Number of Existing Pumps	Number of Pumps to be Installed	Number of Automatic Trash Rake System to be Installed	Preparatory Works by Pakistani Side	Necessary Expenses [Rs. million]
Shad Bagh Pumping Station	4	2	-	Installation of wirings from the transformer to the control panel. Existing transformer (1500kVA) has a capacity for all of the pumps including new ones.	0.1
Gulshan-e-Ravi Pumping Station	12	2	-	Installation of wirings from the transformer to the control panel. Installation of a new transformer (630 kVA).	0.7
Multan Road Pumping Station	4	2	-	Installation of wirings from the transformer to the control panel. Existing transformer (1500kVA) has a capacity for all of the pumps including new ones.	0.1
Main Outfall Pumping Station	-	-	1	Installation of wirings from the transformer to the control panel. Existing transformer has a capacity for the new automatic trash rake system. Disposal of removed machinery.	0.1
Total	20	6	1		1.0

(2) Construction of PMU Office at Kharak (Sabzazar)

WASA is planning to construct a new site for the PMU Office and adjacent parking space for procured vehicles and machinery at Kharak (Sabzazar) where the transferred Multan Road Pumping Station used to be. This is also a part of an obligation by Pakistani side. The construction is scheduled from November 2004 to February 2005. The expenses for the construction comes from WASA's own annual budget, thus it is separated from the running and maintenance expenses allocated for the Project. It is expected that the construction of these facilities will be completed by the time of provision of machinery and equipments, though regular confirmation of the progress is desired.

2.4 Project Operation Plan

2.4.1 Project Operation System

WASA is a responsible agency to manage and operate water supply, sewage and drainage systems in 6 Towns in the whole area of Lahore city. At the time of basic design study, a total number of staff is reportedly 4,666. WASA is structurally composed of three Directions under Managing Director (MD) such as Engineering, Finance/Administration/Revenue and Operation/Maintenance, and each controlled by respective Deputy Managing Directors (DMD). Among those three, Direction of Operation/Maintenance is practically more concerned with the project as there are 3,661 persons dedicating themselves to the public service accounting for 78 % of the total number of staff. This Direction consists of WASA head quarters and 6 regional offices or each every Town. DMD and one Executive Engineer (XEN) are permanently stationed in head quarters to prepare for emergency and also assemble information by keeping in touch with regional offices. There is a Director in every regional office taking leadership of the work in its jurisdiction

2.4.1.1 Project management unit (PMU)

WASA intends to set up two project management units (PMU) under the Direction of Operation/Maintenance as shown in Fig. 2.20, and will place full-time staff in an effort to establish proper operation and management system for the project. PMU-I has been already established and will act as counterpart of Japanese study team for a period between Basic Design and Detail Design. In fact, all staff members of PMU-1 was involved in preparing action plan and discussion to select required equipment and its prioritization. With regard to PMU-II, personnel arrangement will be made after signing Exchange of Notes between the two Governments. It will play an important role to implement the project such as supervising overall desilting work, equipment management as well as schedule management, etc.

According to Action Plan, 2 XENs and 4 SDOs are supposed to be placed under the Project Director, the leader of PMU as shown in Fig. 2.21. For PMU-I, apart from the 4 SDOs who are currently engaged in managing pumping stations, public relations officer is expected to promote public awareness campaign. On the other hand, PMU-II is considered as a task force to deal with cleaning and desilting works, and there will be 2 SDOs under each XEN, who will be in charge of their respective assigned areas. WASA has selected 3 storeyards for the equipment in order to make easy operation and maintenance for PMU. However, for Kharak, one of the three proposed storeyards covering approximately one hectare, the land needs to be developed and prepared at the earliest time possible for the construction of project management office and proper parking lot. The operation system of PMU-II is given as follows:

Table 2.16 Operation System of PMU-II

PMU-II	Assigned area	Storeyard
Executive Engineer (XEN-I)	SDO (in charge of areas A and B)	Shad Bagh Pumping Station
	SDO (in charge of area G)	Main Outfall Pumping Station
Executive Engineer (XEN-II)	SDO (in charge of area H1)	Kharak (Sabzazar)
	SDO (in charge of storm water drainage)	

Operation and management capacity of PMU-II is the key point to lead the project to the successful implementation. As for personnel arrangement, WASA proposes to place about 220 persons to PMU-II, who will be staff members of the Direction of Operation/Maintenance, and not to recruit new members.

2.4.1.2 Financial Situation

According to WASA's revenue and expense statement (10 years at a glance), the situation is not promising every year as there is no sign to recover from the red-ink finance. Main sources of revenue are water and sewage service charges accounting for about 80 % of the total income, while major part of expense is for fuel and power, which is corresponding to 53 to 55 % of the whole operating cost. Water rate was increased by 40 % from April 2004, thereby decreasing the deficit from Rs.302 million in 2003/04 to Rs.219 million in 2004/05, which is about 27 % of shrinkage. Despite these facts, the deficit increases again from the following year.

Electricity rate was likely to lower by 10 to 20 % at the time of preparatory study. However, this rate deduction has been applied only to the sector of industry and not to WASA. There are about 5,5 million people living in the service area of WASA, and 485,000 households are receiving water supply services and 90% of such beneficiaries have sewage system. Since service charge is collected from 75% of the total number of beneficiaries, so that it is necessary that WASA should make every effort to increase this collection rate for improving financial situation..

Since water and sewage are considered as the most important infrastructure for human life, the Punjab Government provides financial support to WASA as a loan every year. The annual interest rate for the loan is more or less 11 %, but it varies depending upon the year and is expressed in the statement as financial expenses, which amounts to Rs. 540 million by 2003/04. Reimbursement plan is not shown.

2.4.2 Operation and Maintenance Cost

The Government of Punjab has approved Rs. 100 million as a local budget to complete the project in three years. The amount is judged reasonable and practicable. It should be noted that this budget includes the cost of commission for banking arrangement and public awareness campaign, which is estimated at Rs. 18 million, so the operation and maintenance cost for desilting work will be the remaining portion amounting to Rs. 82 million. The table below shows the detail of local budget allocation.

Table 2.17 Local Budget Allocations

Item	Budget (Rs.Million)
PLO expenses	78.90
Equipment maintenance charges	2.00
Purchase of health &Safety equipment	1.00
Public awareness campaign	1.00
Bank commission for B/A	17.10
Total	100.00

Note: PLO: Petroleum oil and lubricant

PLO expenses cover nearly 80 % of the total budget while equipment maintenance charges are estimated to be Rs. 2 million or 2 % of the total amount. This is explained by the following reasons: (1) no serious mechanical troubles are expected to occur during the first 3 years, (2) WASA/PMU will be able to manage minor repairs with spare parts which will be supplied under the Grant Aid.

With regard to the operation life of equipment, it is commonly estimated at 5 to 6 years for vehicles, 8 to 12 years for heavy machinery, and 10 to 20 years for pumps. But if proper operation and maintenance will take place, it will certainly last longer and the replacement will need to be considered after 10 years, 15 years and 20 years respectively.

2.5 Cost Estimate of the Project

The total project cost will be estimated 1224 million yen, and contents of the cost based on the scope of work for Japan and Pakistan, which stated previous section, could be allocated as follows.

(1) Japanese Side

(Million Yen)

Items		Project Cost		
Equipment Cost	(1) Cleaning equipment for sewer pipes	293	**1,179**	**1,222**
	(2) Cleaning equipment for drainage channels	203		
	(3) Cleaning equipment for pumping stations	18		
	(4) Monitoring Equipment	13		
	(5) Shad Bagh Pumping Station	173		
	(6) Gulshan-e-Ravi Pumping Station	145		
	(7) (Multan Roa Pumping Station	159		
	(8) Main Outfall Pumping Station	175		
Supervision and Technical Guidance Cost		**43**		

Exchange Rate：1 Rs.= 2.07 yen / 1 US$＝110.08 yen (as of September 2004)

This cost estimate is provisional and would be further examined by the Government of Japan for the approval of the Grant.

(2) Pakistan Side

Scope of Work	Locations	Cost	
Purchase of Transformer and Wiring	(1) Shad Bagh Pumping Station	10 (0.21)	100 (2.07)
	(2) Gulshan-e-Ravi Pumping Station	70 (1.45)	
	(3) Multan Road Pumping Station	10 (0.21)	
	(4) Main Outfall Pumping Station	10 (0.21)	

10,000Rp. (Million Yen)

2.6 Technical Guidance Service (Soft Component)

2.6.1 Background

With the view of minimizing flood damage in Lahore city, WASA has been emphasizing the necessity of recovering and even increasing the drainage capacity of existing sewage and drainage facilities. To attain this objective, WASA prepared an Action Plan to implement the project in northern part of the city and requested to the Government of Japan for the supply of proper equipment under the Grant Aid.

It seems that WASA's staff members are trained in order to quickly respond to the emergency case but not well prepared for planning or designing overall work system with strategic approach. Financial constraints may be one of the main reasons. Therefore, at the time of establishing PMU-II, it is desirable to assist them in developing their technical capability for the project management and operation.

From the above considerations, the project will include not only the procurement and installation of equipment but also technical guidance service, which consists of two components, work planning and fieldwork management. It is expected to be a tool for overcoming difficulties that lie ahead and will contribute to the project with sustainable effects.

2.6.2 Objectives

Objectives to be accomplished through the technical guidance service are as follows:

(a) To achieve work plan (cleaning/desilting) as well as operation plan which should be technically viable and acceptable by PMU.

(b) To establish sustainable fieldwork management system through model implementation.

2.6.3 Outputs (Direct Effects)

The technical guidance service will be provided in the fields of work planning/operation planning and fieldwork management through the supervision of model implementation, and the following effects are expected after the completion of such services:

Work planning/operation planning

To develop capacity of PMU personnel as a result of acquiring technical knowledge on planning work.

Supervision of model implementation

(a) To accomplish desilting work in the selected model area within the specified period.

(b) To develop capacity of PMU personnel as a result of acquiring knowledge on fieldwork management system.

2.6.4 Confirmation of Outputs

Prior to the completion of the technical guidance service, the above outputs can be confirmed by the following ways:

Work planning/operation planning

(a) Accuracy of cleaning/desilting plan to be prepared on the map at 1/2,400 (to be checked by calculation sheet and equipment deployment scheme).

(b) Understanding of the manual's description on mechanical check and inspection (to be checked by a test).

Supervision of model implementation

(a) Volume of desilted material (record available from the final disposal site).

(b) Number of accidents occurred under the safety control during the work (setting zero as a target)

2.6.5 Activities (Inputs)

Work planning/operation planning

One Japanese consultant will be assigned to assist XENs and SDOs of PMU in preparing desilting work plan. A map showing existing sewage and drainage systems is extremely important for the subsequent planning work so it will be prepared by WASA by the end of September 2005, and then carefully reviewed by the Japanese expert to complete the map prior to the commencement of the planning. The required work will include the following:

(a) Review of the sewage/drainage map at 1/2,400 prepared by WASA (accuracy check and correction will be carried out together with Project Director and XENs).

(b) Preparation of desilting plan for the first year and the first quarter of the year (work schedule, equipment deployment plan, etc will be prepared together with Project Director and XENs).

(c) Following monitoring works and analysis, which should be conducted together with XENs and SDOs:

    i) To observe flood coverage area, water depth and draining time at 20 designated sites when heavy rainfall hits the city.

    ii) To totalize the number of complaints to WASA by creating systematic way.

    iii) To estimate the volume of silt removed from sewage pipes and drainage channels (information will be available from the records of the final disposal site).

(d) Preparation of manual on routine check/inspection for the equipment (the work will be carried out together with XENs and SDOs).

The consultant to be assigned for the above work will serve his expertise for a period of two (2) months.

Supervision of model implementation

One Japanese consultant will provide technical assistance for the fieldwork management to XENs and SDOs through the model implementation. In this regard, particular attention will be paid to the work schedule and work progress rate, which may be observed on the basis of removed silt volume. It is also extremely important that safety control and quality control be maintained as a priority during the whole project period as the work will be carried out in urban areas. The zone "A" will be selected for the model implementation by the following reasons: (1) area recurrently flooded in monsoon period, and (2) project effects observable even in a short period of implementation. As to drainage channels, there exists only small open channel in zone "A", so that a part of Central Drain in zone "H1" will be selected for the large channel cleaning/desilting. The consultant will be assigned for three months to supervise the work. Further details of the work are given below:

Sewage Pipes（Western part of zone"A"）

Team	Pipe length [m]	Diameter [mm]	Estimated Volume [m3]
1	1,300	φ1,350, φ1,500	600
2	1,000	φ1,200	1,300
3	2,500	φ600, φ900	570
4	2,300	φ600, φ900	560
Total	7,100		3,030

Drainage Channel（Open Channel）

Team	Channel length [m]	Estimated Volume [m3]	Observation
Chota Ravi (Zone A)	1,100	4,500	Small (width: less than 4m)
Central Drain (Zone H1)	1,900	26,300	Large (width: over 4m)
Total	3,000	30,800	

2.6.6 Method of Service to be Provided

i) Japanese consultants will provide the technical guidance service for the following reasons:

ii) Pakistan is short of experts specialized in planning and operation/management for sewage and drainage system.

iii) There is a shortage of qualified engineers to supervise desilting and drainage works in WASA.

iv) As there is no donor in Pakistan in the sector of sewage and drainage except Japan, experts are not available from the third countries.

2.6.7 Implementation Work

Consultant to be assigned for the work planning/operation planning is scheduled to dispatch to Pakistan at the middle of October 2005, and will start preparing desilting plan in PMU office soon after the meeting with authorities of WASA. Sewage and drainage map at a scale of 1/2,400 will need to be prepared by WASA as a precondition by the end of September 2005.

Supervisor of the model implementation work will take up his assignment after the completion of desilting plan. It will be around the middle of December 2005 after OJT is properly provided to the equipment operators of PMU under the responsibility of the Contractor.

Overall implementation schedule is given in the following section.

2.6.8 Output Materials

The output material or products are as follows:

i) Work planning/operation planning

ii) Finalized sewage and drainage map covering the project area

iii) Cleaning/desilting plan (including work schedule, equipment deployment schedule, etc.)

iv) Monitoring record (flood situation, complaints from the residents)

v) Manual for mechanical checkup and inspection

Supervision of model implementation

vi) Work schedule (real) and work achievement record (volume of removed silt and/or length of pipes/channels with the work completed).

CHAPTER 3. PROJECT EVALUATION AND RECOMMENDATIONS

3.1 Project Effect

(1) Direct Effect

The project area covers approximately 40 km^2 of land including zones A, B, G and H1, and there will be about 2 million people living therein as project beneficiaries. The project is expected to have the following direct effects:

(a) By desilting/cleaning of sewers and drains, it is expected to remove sludge amounting to 26,000 m^3 and 400,00 m^3 respectively, by which flow capacity as well as storm water storage capacity will increase by nearly 50%.

(b) Drainage capacity at the pumping station will increase from 36.8 m^3/s to 46.6 m^3/s accounting for 30%.

(c) From the effects mentioned in (a) and (b), the flood situation (flood duration, depth and covering area) will be improved.

(2) Indirect Effect

The project is expected to have the following indirect effects:

(a) Sanitary environment will be improved, and it may result in reduction in the number of cases for water-borne infectious diseases (there reportedly broke out 13,000-15,000 cases of amebic dysentery in the year 2002-2003, 9,000-10,000 cases of bacterial dysentery, 1,300-1,400 cases of typhoid and 700-900 cases of hepatitis).

(b) It will ensure the safety for workers through mechanization and technical guidance services for desilting/cleaning of sewers

The project effect will come out in the target year 2009, that is to say, after the three years project operation. It can be indicated by the volume of sludge to be removed and increased pumping capacity. With regard to flood damage, monitoring will be conducted at 22 selected points as shown in Fig 2.3, and depth of inundation, flooded area and length of time for draining should be carefully observed and recorded at the time of each heavy rain.

From the above considerations, should the project be properly implemented, the present situation will certainly be improved. The project effects are summarized in Table 3.1.

Table 3.1 Summary of Project Effect

Present Conditions	Inputs under Grant Aid	Project Effects
1. Flood occurs in many places in Lahore city due to storm water in monsoon season. Flood is attributed to (1)the reduction of flow capacity of sewers and drains, which are silted up and clogged with solid waste, and (2)pumping stations have not sufficient drainage capacity to cope with heavy rains.	- Procurement of equipment for desilting/cleaning of sewers and drains. - Procurement and installation of equipment for pumping stations.	- Desilting/cleaning of sewers and drains will be properly operated. - Drainage capacity will increase in pumping stations - Flood situation will be improved, thereby mitigating damage
2. PMU-II will be established to complete the project in 3 years. Staff members are trained to quickly respond to the emergency case but not well prepared for planning/designing overall work system with strategic approach.	- Technical guidance service will be rendered to the staff of PMU-II regarding operation and management planning. - Technical training will be provided to the staff of PMU-II through model implementation.	- Operation and management plan for desilting/cleaning of sewers and drains will be prepared by the staff of PMU-II. - Desilting/cleaning works will be operated according to the plan under the guidance of trained personnel of PMU-II.

3.2 Recommendations

With the aim of ensuring project effect and its sustainability, it is important to note that the Pakistan side should secure the budget to cover the cost for operation and maintenance of facilities and equipment, and should promote public awareness campaign for solid waste management.

The project is scheduled to be completed in three years and the Government of Punjab has approved the local budget amounting to Rs.100 million as operation costs. However, after the three years, basically WASA should bear the cost of operation and maintenance. To know the fact that WASA is currently faced with difficult financial situation, the District Government will provide financial support to WASA when the need arises. Nonetheless, the other authorities concerned emphasizes that WASA should make every effort to manage the project without resort to such an assistance. Taking the above into account, WASA is now taking practical measures to increase revenue by upgrading its services. These are (1) to convert un-metered connections into metered water connections, (2) to enhance collection and recovery of outstanding dues or arrears, and (3) to detect and prevent all unauthorized/misused water connections. These efforts will certainly contribute to the improvement of WASA's financial situation, so it is necessary to keep careful watch on it.

As cleaning operation and maintenance of drainage facilities are deeply concerned with solid waste carelessly thrown into open channels, WASA will conduct public awareness campaign to keep the channels clean and free from garbage. The campaign will be implemented through a local NGO having vast experience of interaction with communities. The budget allocated for this purpose is estimated to be Rs.one million. It is extremely important to take campaign activities

during a period of project operation such as dialogue with community, distribution of handbills, videos presentation, information dissemination to the public through web site, etc. These activities will help enhance public awareness of sanitary environment and may call attention to the problem of clogged drains as well. In addition, WASA's role and activities will become better known to the public as a result. Such campaign needs to be continued under the leadership of WASA, and SWMD and other relevant agencies/institutions should be involved in the campaign.

The project includes the technical guidance service, which will be provided to the competent personnel of PMU-II at the beginning of operation. It will certainly satisfy the requirements for producing project effect; so technical assistance from other donors will not be needed.

FIGURES

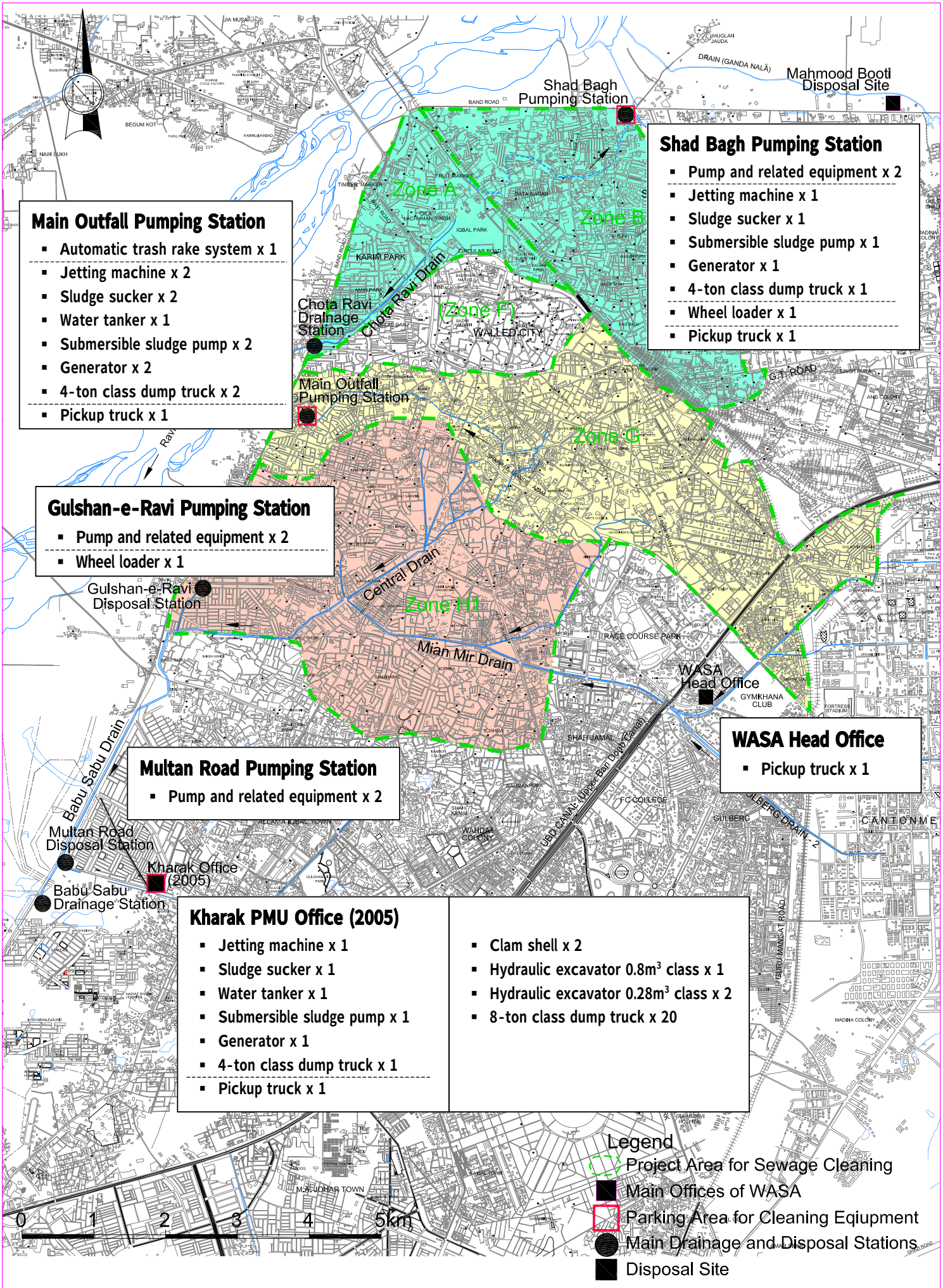


Fig 2.1 Layout Plan of Equipment

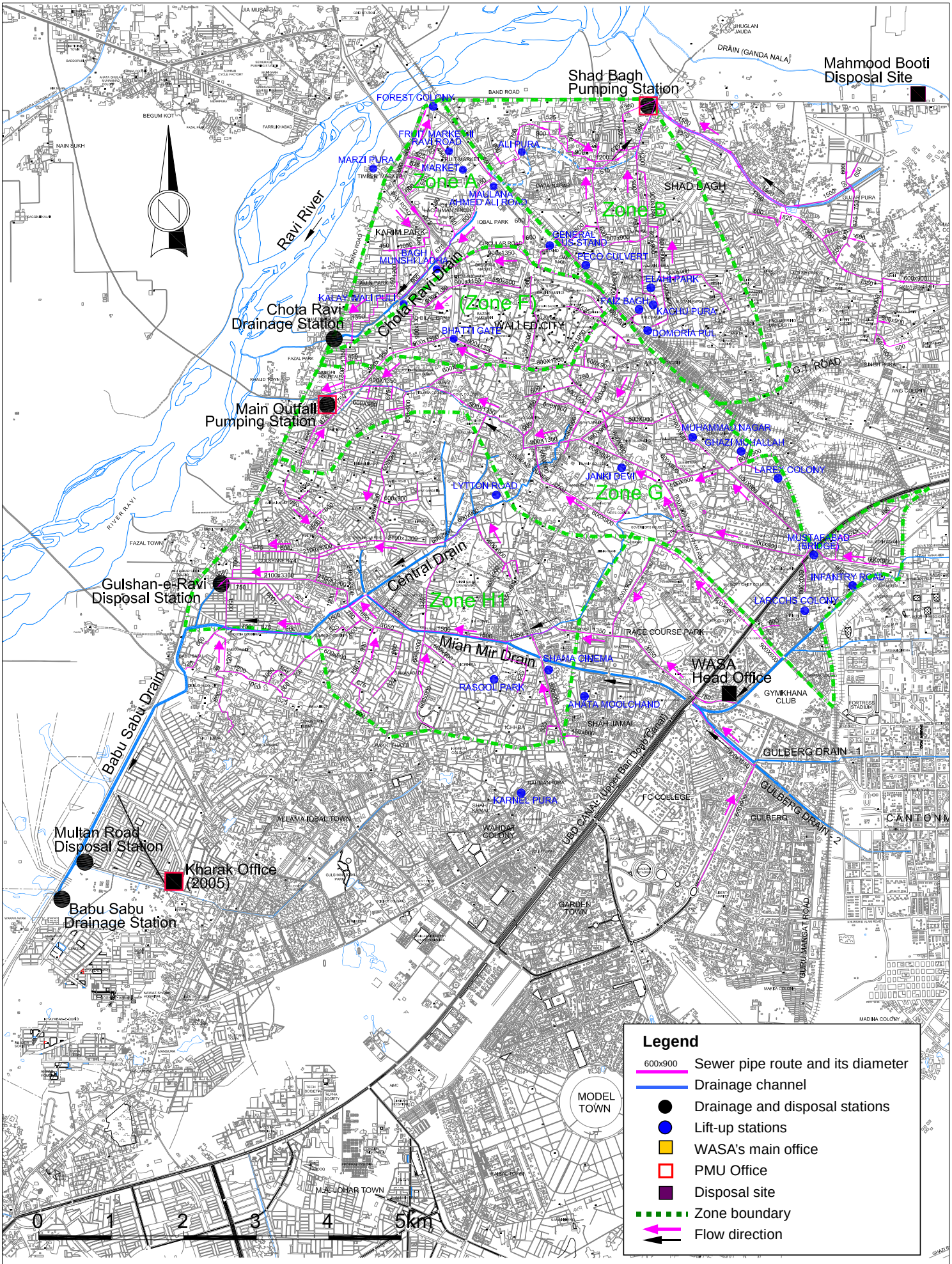


Fig 2.2 Plan of Existing Sewage and Drainage System and Pumping Stations