Water and Sanitation Agency (WASA)
Lahore Development Authority, Lahore

THE PREPARATORY STUDY ON LAHORE WATER SUPPLY, SEWERAGE AND DRAINAGE IMPROVEMENT PROJECT IN ISLAMIC REPUBLIC OF PAKISTAN

FINAL REPORT
(VOLUME 1: MAIN)

JULY 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

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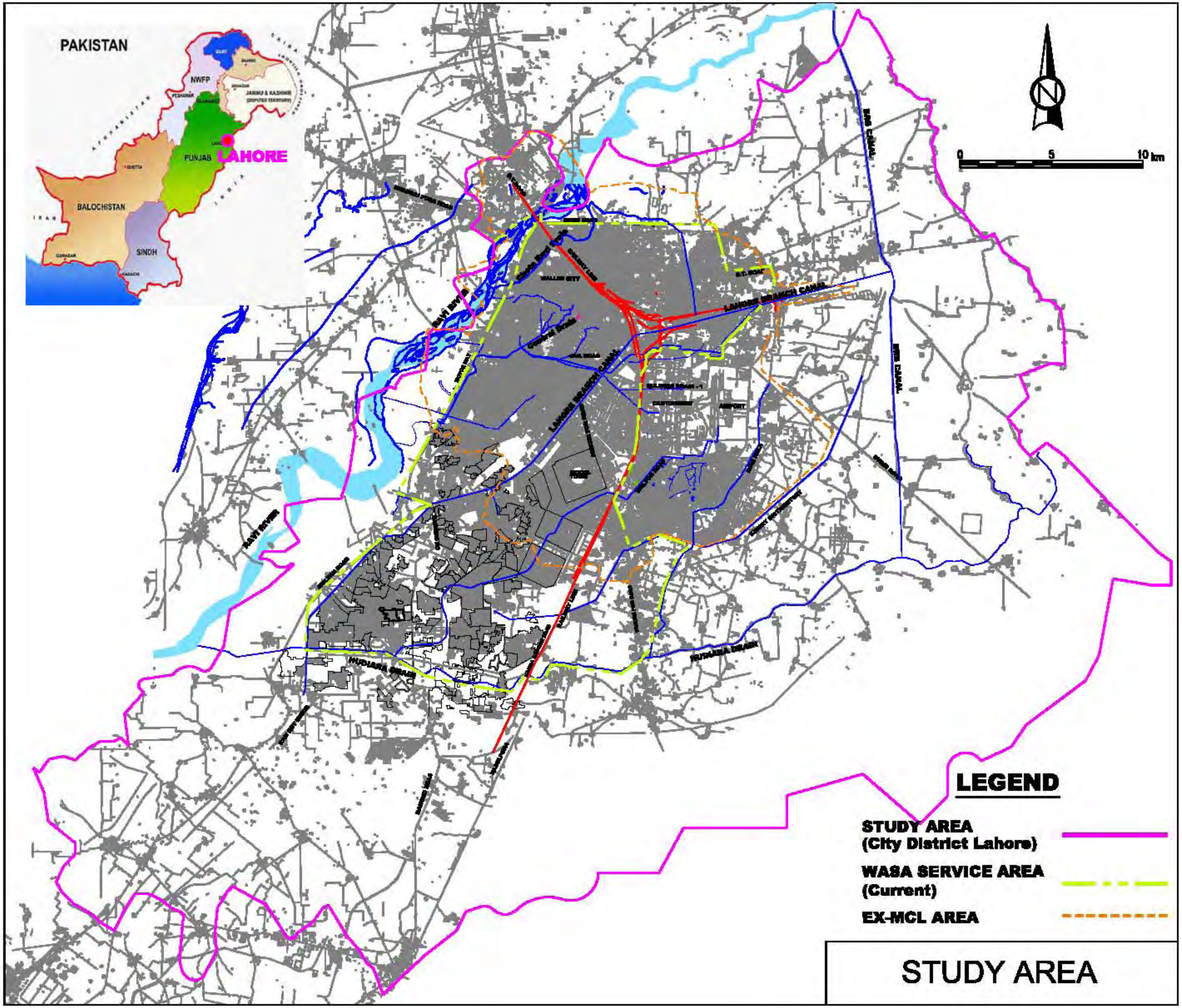
PAKISTAN
NWFP
PUNJAB
LAHORE
BALOCHISTAN
SINDH
JAMMU & KASHMIR
(DISPUTED TERRITORY)
0 5 10 km
RAVI RIVER
LAHORE BRANCH CANAL
HUDIARA DRAIN
BRB CANAL
LEGEND
STUDY AREA
(City District Lahore)
WASA SERVICE AREA
(Current)
EX-MCL AREA
STUDY AREA

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ABBREVIATIONS

Abbreviation	Definition
	Institutions / Organizations
ADB	Asian Development Bank
CDG	City District Government
CDM	M/s. Camp Dressers and Mckee
DHA	Defense Housing Authority
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
GOP	Government of Pakistan
HUD&PHED	Housing, Urban Development and Public Health Engineering Department
IDA	International Development Agency
IRSA	Indus River System Authority
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LCB	Lahore Cantonment Board
LCCHS	Lahore Cantonment Cooperative Housing Society
LDA	Lahore Development Authority
MCL	Metropolitan Corporation Lahore
NESPAK	National Engineering Services Pakistan (Pvt.) Limited
ODA	Overseas Development Agency
Pak-EPA	Pakistan Environmental Protection Agency
PCRWR	Pakistan Council for Research in Water Resource
SWM	Solid Waste Management
TMA	Town Municipal Administration
UD	Urban Development Wing, LDA
UNEP	United Nations Environmental Program
WAPDA	Water and Power Development Authority
WASA	Water and Sanitation Agency
WB	World Bank
WHO	World Health Organization
	Technical
AC	Asbestos Cement
ADP	Annual Development Plan
AEE	Assistant Executive Engineer
AP	Anaerobic Pond
B/C	Benefit-Cost Ratio
B/S	Balance Sheet
BOD	Biochemical Oxygen Demand
BOT	Build-Operate-Transfer
CE	Chief Engineer
CIP	Cast Iron Pipe
CIS	Customer Information System
CMS	Complaints Management System
COD	Chemical Oxygen Demand
CRO	Chief Revenue Officer
CSC	Consumers Service Centre
DG	Director General
Dia	Diameter

Abbreviation	Definition
DIP	Ductile Iron Pipe
DMA	District Metering Area
DMD	Deputy Managing Director
DNI	Distribution Network Improvement
DNM	Distribution Network Main
DO	Dissolved Oxygen
DPS	Distribution Pumping Station
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
FIRR	Financial Internal Rate of Return
FP	Facultative Pond
GDP	Gross Domestic Product
GIP	Galvanized Iron Pipe
GIS	Geographic Information System
GPS	Global Positioning System
IEE	Initial Environmental Examination
KPI	Key Performance Indicator
LGO	Local Government Ordinance
LMA	Lahore Metropolitan Area
LPB	Lahore Protection Bund
M/P	Master Plan
MD	Managing Director
MTS	Model Town Society
NA	(Information) Not Available
NEQS	National Environmental Quality Standards (for Municipal and Liquid Industrial Effluent)
NGO	Non-Governmental Organisation
NPV	Net present Value
NRW	Non Revenue Water
O&M	Operation & Maintenance
ODA	Official Development Assistance
P&D	Planning & Development
P&E	Planning & Evaluation
P/L	Profit and Loss Statement
PC-1	Planning Commission-1
PI	Performance Indicator
PIU	Project Implementation Unit
PPP	Public-Private Partnership
PS	Pumping Station
PVC	Polyvinyl Chloride
RCC	Reinforced cement concrete
SCADA	System Control and Data Acquisition
SS	Suspended Solids
TA	Technical Assistance
TDS	Total Dissolved Solids
TF	Trickling Filter
ToR	Terms of Reference
TSS	Total Suspended Solids
TWL	Top Water Level
UASB	Upflow Anaerobic Sludge Blanket (Process)

Abbreviation	Definition
UBD	Upper Bari Doab Canal
UC	Union Council
UFW	Unaccounted for Water
UNDP	United Nations Development Programme
WWTP	Wastewater Treatment Plant
	Units of Measurement
%	percent
am	time between midnight and noon
°C	degree celsius
cm	centimetre
Cfs	Cubic feet per second
cusecs	cubic feet per second
ft	Feet
gpcd	gallon per capita per day
gpm	gallon per minute
gmcd	gram per capita per day
ha	hectare
hp	horsepower
in	inch
Kanal	Kanal (which is unit for area used in Lahore)
km	kilometre
km^2	square kilometre
KV	kilovolt
KVA	kilovolt ampere
kW	kilowatt
kWh	kilowatt hour
l	litre
Ipcd	litre per capita per day
m	metre
m/s	metre per second
m^2	square metre
m^3	cubic metre
m^3/d	cubic metre per day
m^3/h	cubic metre per hour
mg	million gallons
mg/1	milligram per litre
mgd	million gallons per day
ml	millilitre
mm	millimetre
MPN	most probable number
MW	megawatt
pm	time between 12 noon and 12 midnight
ppm	parts per million
Rs	Pakistan Rupee
US$	United States Dollar
yd^2	square yard
	Units Conversion
	1 ft = 12 in = 0.304800m
	1 gallon [imperial(UK)] = 4.546090 letre

Abbreviation	Definition
	1 cubic feet = 0.0283168 cubic meters
	1 cusecs = 2446.6 m^3/d
	1 Kanal = 500 Square yards = 0.103 acre (= 417 m2) Source: "Land Records Manual (Reviced by Malik Mushtaq Ahmad Nonari, Advocate High Court) "

EXECUTIVE SUMMARY

1 Background, Objective and Scope of Work of the Study

Lahore is the second largest city in Pakistan with a population of more than 7 million. Whereas 87% population has access to safe water supply, increase in water supply and efficiency improvements through water conservation and water loss reduction are required to meet the demands of rapidly increasing population. As for sewerage and drainage facilities, underdeveloped sewer network has caused aggravated sanitary environment for the people in Lahore. Lack of sewage treatment facilities has been caused by underdeveloped drainage facilities, lack of sufficient capacity and aging of the existing drainage facilities. To address such issues in water supply, sewerage and drainage in Lahore, Government of Pakistan submitted to Government of Japan an official request for studies and loan assistance through Japan International Cooperation Agency (JICA). And JICA, prioritizing water supply and sanitation under this assistance strategy, recognizes the need for the Preparatory Study ("the Study") to formulate the Lahore Water Supply, Sewerage, and Drainage Improvement Project ("the Project"), for which loan assistance may be considered subsequently.

The Study aims to formulate "the Lahore Water Supply, Sewerage and Drainage Improvement Project" through basic study, review of vision and strategy on development and management of water supply, sewerage, and drainage facilities in Lahore and based on this study, preparation of the project plan and of plan for implementation, operation and maintenance, confirmation of environment, social considerations, thereby improving efficiency of water supply, improving sanitary environment and water quality in public water bodies, alleviating flooding and improving management capacity.

The Study will cover Lahore City, but conditions of surrounding area is taken into consideration, as required.

The Scope of Work of the Study are as follows:

TOR1: Basic study
- 1-1 Review of the existing studies and development plan
- 1-2 Water quality survey
- 1-3 Review of water sources and water supply facilities
- 1-4 Review of sewerage and drainage facilities
- 1-5 Socio-economic survey
- 1-6 Analysis of water-related problems and their effect on people living in and around

Lahore

1-7 Analysis of status and problems in development and management of water supply, sewerage and drainage facilities

1-8 Analysis of status and problems in water quality management in public water bodies

1-9 Analysis of status and problems in groundwater management

TOR2: Review of vision and strategy on development and management of water supply, sewerage and drainage facilities

2-1 Demand projection

2-2 Preparation of vision and strategy of water supply, sewerage and drainage facilities

2-3 Recommendations for improving management of water supply, sewerage and drainage and preparation of an action plan for improvement

2-4 Recommendations for improving water quality management in public water bodies and preparation of an action plan for improvement

2-5 Recommendations for improving groundwater management and regulation and preparation of an action plan for improvement

2-6 Recommendations for recycle of industrial water and preparation of an action plan for improvement

TOR 3: Preparation of the project plan

3-1 Supplemental study including soil quality survey and measurement

3-2 Project scope

3-3 Basic designing of facilities

3-4 Cost estimation

3-5 Financing plan

3-6 Implementation schedule

3-7 Procurement methods including tendering methods and packaging

3-8 Project effect including establishment of items and targets for monitoring and effect indicators an

TOR 4: Preparation of the plan for implementation and operation and maintenance

4-1 Project implementation and institutions

4-2 Operation and maintenance institutions

4-3 Plan for institutional strengthening of related organizations

4-4 Financial plan for related organizations

4-5 Methods to accelerate household connections to sewerage system

TOR 5: Confirmation of environmental and social consideration

5-1 Confirmation of required procedure, including EIA, in accordance with domestic environmental laws and regulation

5-2 Implementation of EIA in accordance with domestic environmental laws and Environmental Guidelines of Japan Bank for International Cooperation (JBIC)
5-3 Confirmation of details of land acquisition and resettlement and required procedures, and preparation of countermeasures including a resettlement action plan
5-4 Preparation of plan for improving water supply and sewerage services to the socially disadvantaged people

2 Water Source (Groundwater)

(1) Water Level

The drawdown of groundwater which seems to be unending is a potential threat to WASA which fully relies on groundwater for the water source.

The 1975 CDM report estimated the maximum drawdown of groundwater at 45 ft near Shadman Colony for the period of 1955 to 1974 or an annual drawdown rate of 2.25 ft/yr (0.68 m/yr).

"Integrated Master Plan for Lahore – Volume 1 (2002)" says that an annual average drawdown rate of groundwater is 2.03 ft/yr (0.62 m/yr) for the period of 1987 to 2000.

Table 1 shows the drawdown of groundwater at representative WASA tube-wells in the respective sub-divisions for 2005 to 2008. The drawdown occurs at 20 points out of 22 points and annual average drawdown is 0.92 m, say 1 m for three years, which is faster than afore -mentioned estimates.

(2) Water Quality

The Pakistan Council for Research in Water Resources (PCRWR) of the Ministry of Science and Technology, Government of Pakistan has conducted water quality survey of tube-wells at the representative points dividing the urban area of Lahore into 16 squares for 2002 to 2006. Among others, the variation of arsenic concentration is notable. The drinking water standards for arsenic concentration are 10 ppb in WHO and 50 ppb in Pakistan (tentatively). The points that exceeded the WHO standard were 11 out of 16 points in 2002, but all in 2003. Two points with As of 55 ppb and 52 ppb exceeded the Pakistani standard in 2004 and one point showed an As concentration of 71.6 ppb in 2006. As a whole, the arsenic concentration is in the ascending trend obviously. This trend has been also confirmed in the JICA study in 2009 as shown in **Figure 1**.

Table 1 Drawdown of Groundwater at WASA Tube-wells (2005-2008)

Sr. No	Name of Sub Division	Static Water Level (SWL)				Difference			
		FEB./05 (m)	FEB./06 (m)	FEB./07 (m)	FEB./08 (m)	05/06 (m)	06/07 (m)	07/08 (m)	05/08 (m)
1	Shahdara	10.97	12.14	11.93	13.12	-1.17	0.21	-1.19	-2.15
2	City	25.15	26.07	26.99	27.34	-0.92	-0.92	-0.35	-2.19
3	Data Nagar	20.16	21.77	23.12	25.33	-1.61	-1.35	-2.21	-5.17
4	Misri Shah	25.70	26.43	27.69	28.42	-0.73	-1.26	-0.73	-2.72
5	Baghban Pura	25.45	26.94	27.75	29.03	-1.49	-0.81	-1.28	-3.58
6	Mughal Pura	28.45	30.41	31.33	32.01	-1.96	-0.92	-0.68	-3.56
7	Mustafabad	32.67	33.63	33.95	35.43	-0.96	-0.32	-1.48	-2.76
8	Taj Pura	28.95	29.14	28.53	31.94	-0.19	0.61	-3.41	-2.99
9	Ravi Road	23.65	23.68	23.55	23.35	-0.03	0.13	0.20	0.30
10	Islam Pura	23.94	24.59	23.84	23.72	-0.65	0.75	0.12	0.22
ll	Shimla Hill	30.72	32.06	33.12	33.87	-1.34	-1.06	-0.75	-3.15
12	Mozang	33.04	35.33	35.72	36.61	-2.29	-0.39	-0.89	-3.57
13	Gulberg	32.85	34.29	35.11	36.65	-1.44	-0.82	-1.54	-3.80
14	Samanabad	24.95	26.27	27.27	27.25	-1.32	-1.00	0.02	-2.30
15	Allama Iqbal Town	25.24	24.89	25.14	25.33	0.35	-0.25	-0.19	-0.09
16	Ichhra	32.82	34.33	35.02	35.02	-1.51	-0.69	0.00	-2.20
17	LA.Johar Town	24.08	25.20	25.65	25.80	-1.12	-0.45	-0.15	-1.72
18	Garden Town	30.09	31.49	33.10	34.18	-1.40	-1.61	-1.08	-4.09
19	Industrial Area	25.95	27.59	29.55	30.21	-1.64	-1.96	-0.66	-4.26
20	Town Ship	29.77	31.58	33.11	34.96	-1.81	-1.53	-1.85	-5.19
21	Green Town	22.01	23.36	24.61	26.45	-1.35	-1.25	-1.84	-4.44
22	M.E.S. Tubewells	26.25	26.59	27.67	27.67	-0.34	-1.08	0.00	-1.42
					Average	-1.13	-0.73	-0.91	-2.77
					Interval (yr)	1	1	1	3

Source: Prepared by JICA Study Team based on "Monthly Progress Report of February March", Hydology Division, WASA

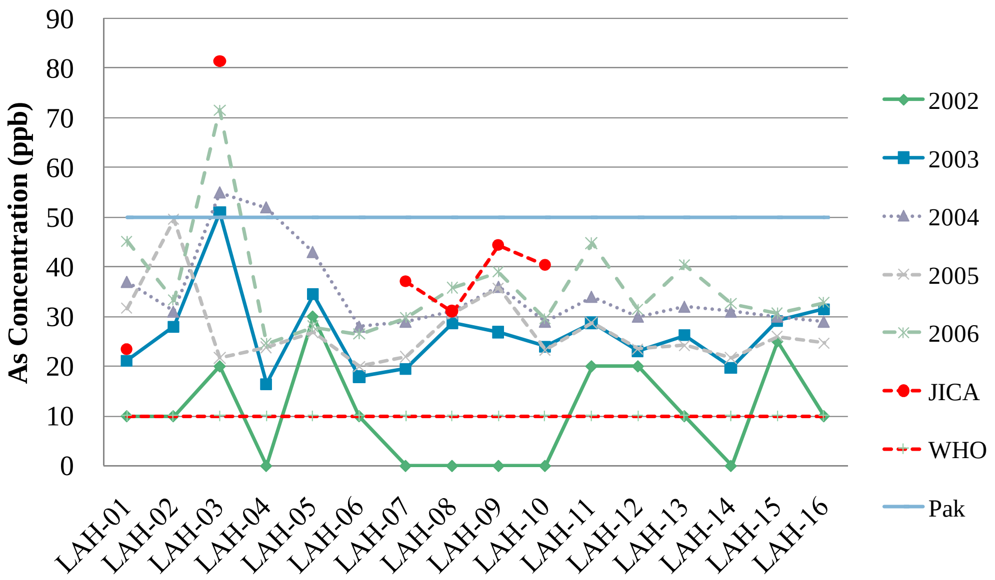


Figure 1 Movement of Arsenic concentration of groundwater (2002-2006)

(3) Groundwater Use

Lahore is located at the northernmost end of Bari Doab under which one giant groundwater basin is formed. **Table 2** shows the groundwater use in Bari Doab but not limited to them. Groundwater is now used for drinking, industrial, agricultural purposes, but the actual situation of its overall water use has not been clarified.

Table 2 Groundwater Use at Bari Doab

Area	Category	Water Use	No. of tube-wells	Groundwater Abstraction (Est.) (million m^3/day)
Lahore Urban	WASA	Drinking	417	1.610
	Cantonment	Drinking	173	0.774
	Private	Industrial, etc.	4,003	0.450
Lahore Rural	PHED/TMAs	Drinking	16	?
	Agricultural Sector*1	Irrigation	5,829*2	0.987
Outside of Lahore	Agricultural Sector*1	Irrigation	194,258*2	32.879
	Agricultural Sector*1	Irrigation	669*3	?

* Source: "*Agricultural Machinery Census in 2004*" in "Punjab Development Statistics 2008", Bureau of Statistics, the Government of the Punjab

*2 Groundwater abstraction is estimated with the same assumption as those in "*Groundwater Resources Evaluation and Study of Aquifer under Lahore*" in 1991

*3 Groundwater abstraction is unknown due to lift stations.

(4) Measures to Be Taken in Future

From the situation mentioned-above, it is recommended to take the following actions for groundwater resource conservation:

a) Conduct the follow-up study of the arsenic concentration in groundwater.
b) Conduct the groundwater resource evaluation with the latest knowledge and information.
c) Establish the Bari Doab groundwater committee.
d) Study the control and regulation of groundwater.
e) Enforce the regulation of groundwater control.

(5) Water Right from the River Ravi

Aside from the above, WASA should take action for an acquisition of water right from the River Ravi to which water is supplemented from the River Chenab via Malara Canal. The required water amount is estimated at 1,420,000 m^3/day for 514,000 m^3/day groundwater assuming that the arsenic concentration should be kept below the interim Pakistan drinking water standard of 50 ug/L at the target year of 2035. In this calculation, the future arsenic concentration is predicted using the least square method by a linear equation and the past five-year data of 2002-2006 by PCRWR.

3 Population Projection and Design Flow

(1) Population

The higher level plan which is fundamental to formulating this project is the "**Integrated Master Plan for Lahore-2021**". In this plan, the future population in the ex-MCL area up to 2021 is estimated by an annual population growth rate based on census data. As at 2009, this projected population is almost equal to the actual population in the current WASA area (design area). Therefore, it was decided to extend this projection up to 2035 as the design population in the designated area.

(2) Water Demand

Water demand is estimated based on the following assumptions.

- Water consumption includes non-domestic water use such as commercial use.
- Current per capita water production of 75 gpcd will be reduced to 45 gpcd at 2035.
- It is aimed that unaccounted for water rate will be around 20% at 2035.
- Water service rate in the service area will be 100% at 2035.

Table 3 Water Demand Forecast (Current WASA Area)

Description	Unit	2009	2012	2017	2022	2027	2032	2035
Population	million	5.671	6.041	6.815	7.592	8.282	9.014	9.453
Water coverage	%	87	89	91	94	96	99	100.0
Served population	million	4.934	5.347	6.202	7.099	7.950	8.879	9.453
Water demand per capita	gpcd	75	72	66	60	54	49	45
Water demand	10^3 m^3/d	1,682	1,739	1,855	1,938	1,963	1,960	1,934
Unaccounted-for water	%	34	33	30	28	25	23	20
Water consumption	10^3 m^3/d	1,110	1,174	1,299	1,405	1,472	1,519	1,547
Water supply per capita	lpcd	225	220	209	198	185	171	164

(3) Sewage Flow

According to a WHO report, sewerage flow could be assumed as 90% of water use if water use is well defined. Considering the present sewage discharge volumes in the current WASA area, 100% is applied as the conversion rate of water use to sewage flow.

Meanwhile in Lahore, tube-wells are also used at about 4,000 factories as their water sources with an estimated discharge volume of approximately 450,000 m^3/day into sewers or drains. These discharges are included in per capita sewage flow. Discharge volumes are assumed to be maintained at the present level by an adoption of industrial water recycling in future.

Table 4 Sewage Flow Forecast (Current WASA Area)

Description	Unit	2009	2012	2017	2022	2027	2032	2035
Population (WASA area)	million	6.104	6.503	7.335	8.172	8.914	9.702	10.175
(Cantonment)	million	0.752	0.807	0.907	1.063	1.252	1.373	1.452
Sewerage coverage	%	84	86	89	92	95	98	100
Sewered Population	million	5.759	6.276	7.333	8.501	9.674	10.883	11.627
Water supply per capita	lpcd	225	220	209	198	185	171	164
Sewage flow per capita	lpcd	225	220	209	198	185	171	164
Industrial wastewater flow	10^3 m^3/d	450	450	450	450	450	450	450
Total sewage flow	10^3 m^3/d	1,746	1,831	1,983	2,133	2,240	2,311	2,357

4 Institutional Improvement

Institutional improvement includes the following issues.

1. Development of Adequate Policy and Regulatory Environment

1-1 preparation and enactment of Punjab Urban Water Act and WASCO Act (or Lahore WASA Act)

1-2 establishment of (a) a concrete road map for increasing tariff to the adequate level, (b) a mechanism for adequate tariff revision, and (c) measures of financial supports by the government

2. Timely Data Acquisition and Preparation of Definitive Vision and Strategies

2-1 regular preparation of mid-term and annual business plans

2-2 establishment of performance monitoring indicators and regular monitoring system

2-3 implementation of comprehensive asset survey and preparation of asset inventories and drawings in the entire WASA area

3. Reduction of Unaccounted-for-water and Non-revenue-water

3-1 clarification of rights and responsibilities in relations with customers

3-2 installation of meters in 40% of connections

3-3 establishment of leakage detection teams

3-4 implementation of distribution network improvement in the priority area in the central Lahore based on asset study and preparation of distribution network improvement plan in the entire WASA area.

3-5 implementation of stringent measures against defaulters and illegal connections and phasing-out of uncharged public stand posts

3-6 entrustment of metering and billing to private companies

4. Human Resource Development and Organizational Streamlining

4-1 organizational restructuring
4-2 improvement of personnel management and human resource development
4-3 entrustment of certain facilities to private companies
4-4 establishment of Management Information System
4-5 procurement of O&M equipment

5. Improvement of Customer Services

5-1 clarification of rights and responsibilities in relations with customers
5-2 regular implementation of customer survey
5-3 improvement of complaint handling system
5-4 expansion of payment options for customers
5-5 preparation of public relation strategy and its implementation

6. Groundwater Monitoring and Regulation

6-1 follow up survey and analysis on groundwater quality and quantity
6-2 establishment of groundwater committee
6-3 preparation of groundwater control and regulation plan
6-4 establishment of regular monitoring system of groundwater

Subjects “**1. Development of Adequate Policy and Regulatory Environment**”, “**2. Timely Data Acquisition and Preparation of Definitive Vision and Strategies**” except for 2-3 and “**3-1 clarification of rights and responsibilities in relations with customers**” will be carried out mainly in 2010 before conclusion of the Loan Agreement. The JICA expert will assist the works.

The study on some issues such as 4-4, 4-5 and 5-3 will be commenced using the local individual consultants under loan.

The remaining issues will be assisted by the international consultants under loan as well as the detailed design, tender assistance, construction supervision, etc.

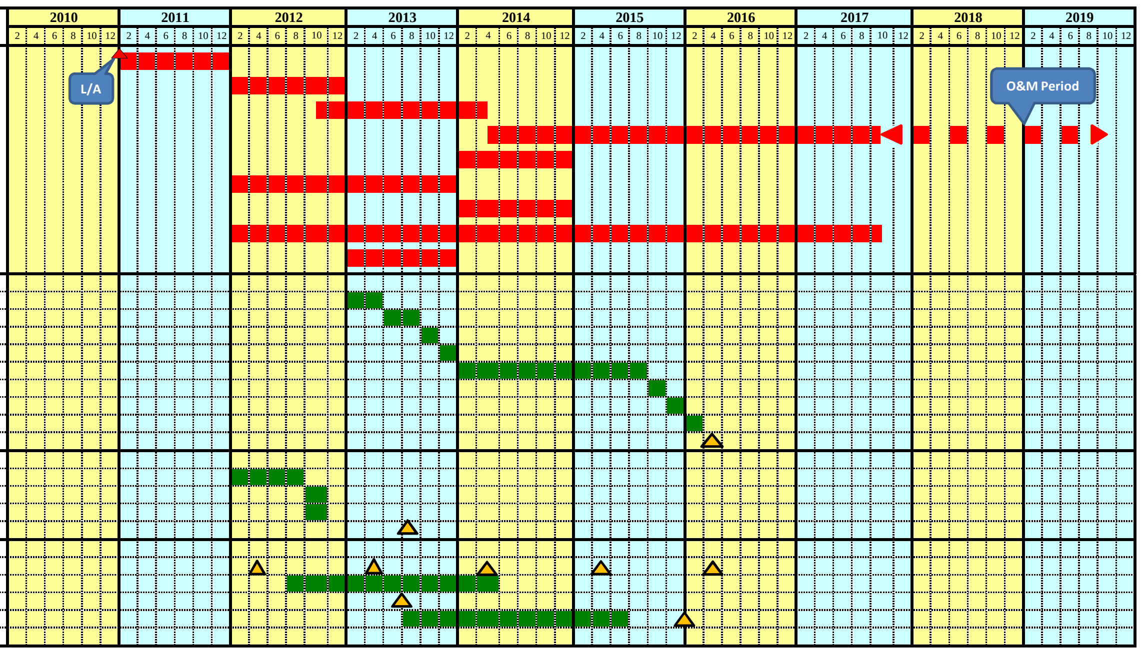
Action plans for institutional improvement are summarized in **Figure 2**.

Figure 2 Action Plan for Institutional Improvement of Lahore WASA

No.	Measures / Actions	Responsible Person (Agency)	In charge	Target Date
(1)	**Selection of Consultants**			
(2)	**Detailed Design for Phase 1 Project**			
(3)	**Tendering for Phase 1 Project**			
(4)	**Construction for Phase 1 Project**			
(5)	**Detailed Desigtn for Phase 2 Project**			
(6)	**Preparation of Master Plan for Lahore Water Supply System**			
(7)	**Detailed Desigtn of A Surface Water Supply System for Phase 2 Project**			
(8)	**Study on Institutional Improvement**			
(9)	**Preparation of M/P and F/S for Water Supply, Sewrage and Drainage outside the WASA's Current Jurisdiction**			
1-1	**Preparation and enactment of Punjab Urban Water Act and WASCO Act**			
1)	Establish the committee for the Acts	P&D+HUD		completed
2)	Prepare the draft Acts	P&D+HUD	Committee	May. 2010
3)	Revise the draft through discussions	P&D+HUD	Committee	Oct. 2010
4)	Disscuss and approve the bill in the provincial assembly	P&D+HUD	Committee	Dec. 2010
5)	Enact the Acts	Assembly		Apr. 2011
1-2	**Establishment of a mechanism for adequate tariff revision**			
1)	Establish the WASA working team	MD		Feb. 2010
2)	Prepare the road map and mechanism for adqequte tariff revision	MD	WASA WT	Jul. 2010
3)	Approve the road map and mechanism	P&D+HUD	P&D+HUD	Sep. 2010
4)	Develop the adequate rule by the provincial government	P&D+HUD	P&D+HUD	Nov. 2010
5)	Enforce the rule	P&D+HUD		Dec. 2010
2-1	**Regular preparation of mid-term and annual business plans**			
1)	Investigate the current situation of business plans		JICA Study	Completed
2)	Make a problem analysis		JICA Study	Completed
3)	Prepare the plan format by JICA experts, fill the contents by WASA, and report with recommendations by JICA experts	DMD(FA&R)	JICA Consult.	May. 2010
4)	Review and make comments on the prepared first mid-term plan for 2010/11 to 2012/13	DMD(FA&R)	DMD(FA&R)	Jul. 2010
5)	Prepare the first annual business plan for 2010/11	DMD(FA&R)	DMD(FA&R)	Jul. 2010
6)	Prepare mid-term business plan in the subsequent years	DMD(FA&R)	DMD(FA&R)	
7)	Prepare annual business plan in the subsequent years	DMD(FA&R)	DMD(FA&R)	
2-2	**Establishment of performance monitoring indicators and regular monitoring system**			
1)	Investigate the current situation of management monitoring indicators		JICA Study	Completed
2)	Set the targets for indicators		JICA Study	Completed
3)	Review the monitoring indicator which are prepared by JICA study team	DMD(FA&R)	DMD(FA&R)	Mar. 2010
4)	Consider and approve the targets for indicators	WASA IC		May. 2010
5)	Enforce (Monitor) the indicators	DMD(FA&R)		
2-3	**Implementation of comprehensive asset survey and preparation of asset inventories and drawings**			
1)	Investigate the current situation of asset management	DIR(A)	Consul	Jul. 2012
2)	Develop a comprehensive asset management system	DIR(A)	Consul	Sep. 2012
3)	Study and establish the GIS team	DIR(A)	Consul	May. 2012
4)	Prepare the bidding documents and cost estimation for GIS	DIR(P&S)	Consul	Jul. 2012
5)	Procure and set up the IT system for GIS	DIR(GIS)	Consul	Dec. 2012
6)	Prepare the facility ledger for the model area, using GIS	DIR(A)	Consul	Dec. 2013
7)	Survey the location of facility for the model area, using GIS	DIR(A)	Consul	May. 2014
8)	Review existing information and records available in WASA for GIS	DIR(GIS)	Consul	Apr. 2013
9)	Input the exisitng data in the GIS in the entire WASA area	DIR. PMU	Consul	Apr. 2014
10)	Prepare the report with recommendations	DIR(A)	Consul	Jun. 2014
11)	Start the preparation of the facility ledger for the entire WASA area	DIR(A)	Consul	Jun. 2014
12)	Prepare the facility ledger for the entire WASA area, using GIS	DIR(A)	Consul	Dec. 2015
13)	Complete the facilitiry ledger for the entire WASA area, using GIS	DIR(A)	Consul	Dec. 2015
3-1	**Clarification of rights and responsibilities in relations with customers**			
1)	Clarify the current rights and responsibilities for evaluation		JICA Study	Completed
2)	Develop the new rights and responsibilities for evaluation		JICA Study	Completed
3)	Review the new rights and responsibilities which are prepared by JICA study team	WASA IC	WASA IC	Mar. 2010
4)	Revise the rights and responsibilities through discussions with WASA IC	WASA IC	JICA Consul	Jun. 2010
5)	Finalize the rights and responsibilities through discussions	Same as 1-1		Aug. 2010
6)	Issue the customer charter	WASA IC		Sep. 2010
7)	Enact the Acts	Assembly		Apr. 2011
3-2	**Installation of meters in 40% of connections**			
1)	Investigate the condition of customer meter instalation	DMD(O&M)	Consul	Apr. 2012
2)	Study the cost burden and how to prioritise the service connections	DIR(R)	Consul	Jun. 2012
3)	Prepare the bidding documents and cost estimation	DIR(P&S)	Consul	Sep. 2012
4)	Conduct the bidding process	DIR(P&S)	DIR(P&S)	Jun. 2014
5)	Provide training to water fitting plumbers	DIR(T)	Consul	Dec. 2014
6)	Install the customer meters through contractors	DIR. PMU	Contractors	Sep. 2017
3-3	**Establishment of leakage detection teams**			
1)	Evaluate the current capacity of UFW reduction staff members and equipment	DIR. CONST:I	Consul	Apr. 2012
2)	Study the necessary organization of the UFW reduction team	DIR. CONST:I	Consul	Jun. 2012
3)	Increase the staff members for the UFW reduction	DIR(A)	DIR(A)	Dec. 2012
4)	Prepare the bidding documents and conduct bidding for UFW equipment	DIR(P&S)	Consul	Apr. 2013
5)	Procure the UFW reduction equipment	DIR(P&S)	Contractors	Dec. 2014
6)	Conduct a training and prepare the manual	DIR(LC)	Consul	Dec. 2016
3-4	**Implementation of distribution network improvement**			
1)	Select a pilot area for UFW reduction	DIR(LC)	Consul	Jun. 2012
2)	Complete the facilitiry ledger for the model area, using GIS (refer 2-3)	DIR(A)	Consul	Apr. 2014
3)	Develop the distribution network improvement plan for the pilot area	DIR(C-1)	Consul	Dec. 2014
4)	Prepare the bidding documents and conduct bidding for the pilot area	DIR(P&S)	Consul	Apr. 2015
5)	Replace the deteriorated pipes and other facilities for the pilot area	DIR. PMU	Contractors	Dec. 2016
6)	Complete the facilitiry ledger for the entire area, using GIS (refer 2-3)	DIR(A)	Consul	Dec. 2015
7)	Develop the distribution network improvement plan for the entire area	DIR(C-1)	Consul	Dec. 2016
3-5	**Imple. of stringent measures against defaulters and illegal connections and phasing-out of uncharged public stand posts**			
1)	Study current situation of measures for defaulters and illegal connections	DIR(R)	Consul	Apr. 2012
2)	Evaluate the effectiveness of current measures	DIR(R)	Consul	Jun. 2012
3)	Study the alternatives, if any	DIR(R)	Consul	Sep. 2012
4)	Prepare the report with recommendations	DIR(R)	Consul	Dec. 2012
5)	Enforce the recommendations	DMD(FA&R)		Mar. 2013
3-6	**Entrustment of metering and billing to private companies**			
1)	Investigate the current situation of entrustment of certain works in WASA	DIR(R)	Consul	Apr. 2012
2)	Evaluate the entrustment of metering and billing to private companies	DIR(R)	Consul	Jun. 2012
3)	Approve the entrustment plan	WASA IC	WASA IC	Sep. 2012
4)	Start entrustment, if any	DMD(FA&R)	DMD(FA&R)	Dec. 2012
4-1	**Organizational restructuring**			
1)	Investigate the current situation and problems of WASA organization	WASA IC	Consul	Jun. 2012
2)	Develop the draft organizational restructuring plan	WASA IC	Consul	Aug. 2012
3)	Improve the organizational restructuring plan through discussions	WASA IC	Consul	Oct. 2012
4)	Prepare the report with recommendations for organizational restructuring	WASA IC	Consul	Nov. 2012
5)	Approve the organizational restructuring plan	WASA IC	WASA IC	Dec. 2012
6)	Implement the organizational restructuring	MD	MD	Jun. 2013
4-2	**Improve. of personnel management and human resource development**			
1)	Investigate the current situation and problems	DIR(A)	Consul	Apr. 2012
2)	Develop a strategy and programme	DIR(A)	Consul	Dec. 2012
3)	Improve the strategy and programme through discussions with WASA IC	WASA IC	Consul	Feb. 2013
4)	Approve the strategy and programme	WASA IC	WASA IC	Apr. 2013
4-3	**Entrustment of certain facilities to private companies**			
1)	Investigate the current situation of entrustment of certain works in WASA	DIR(F)	Consul	Apr. 2012
2)	Extract and evaluate the possible works for entrustment	DIR(F)	Consul	Aug. 2012
3)	Approve the entructment plan	WASA IC	WASA IC	Dec. 2012
4)	Start entrustment	DMD(FA&R)	DMD(FA&R)	Jul. 2013
4-4	**Establishment of Management Information System**			
1)	Investigate the fields required for MIS	DIR(P&E)	Indiv. Consult.	Apr. 2011
2)	Design a MIS	DIR(P&E)	Indiv. Consult.	Aug. 2011
3)	Prepare the bidding documents and conduct bidding	DIR(P&S)	Indiv. Consult.	Oct. 2011
4)	Procure the devices/instruments	DIR(P&S)	Contractors	Jun. 2012
5)	Construct a MIS	DIR. PMU	Contractors	Oct. 2012
6)	Make a trial operation	DIR(P&E)	Contractors	Dec. 2012
7)	Prepare the manual for a MIS	DIR(P&E)	Contractors	Apr. 2013
8)	Make training by fields to WASA staff	DIR(T)	Contractors	Jun. 2013
9)	Turn over a MIS to WASA	DIR(P&E)	Contractors	Jun. 2013
4-5	**Procurement of O&M equipment**			
1)	Investigate the current situation of O&M equipment		JICA Study	Completed
2)	Evaluate the necessity and priority of O&M equipment		JICA Study	Completed
3)	Prepare the bidding documents and conduct bidding	DIR(P&S)	Indiv. Consult.	Apr. 2011
4)	Procure O&M equipment	DIR(P&S)	Contractors	Aug. 2012
5)	Make a trial operation and training	DIR(O&M-GB	Contractors	Feb. 2013
6)	Completely turn over O&M equipment to WASA	DMD(O&M)	Contractors	Feb. 2013
5-1	**Clarification of rights and responsibilities in relations with customers**			
	(See **3-1**)			
5-2	**Regular implementation of customer survey**			
1)	Investigate the customer survey in other public services	DIR(P&E)	Consul	Feb. 2012
2)	Prepare the questionnaire	DIR(P&E)	Consul	Apr. 2012
3)	Conduct of the questionnaire survey using a local social survey firm	DIR(P&E)	Consul	Aug. 2012
4)	Analyze the survey results	DIR(P&E)	Consul	Oct. 2012
5)	Improve the qustionnaire and survey method	DIR(P&E)	Consul	Dec. 2012
6)	Prepare the manual for the questionnaire survey	DIR(P&E)	Consul	Dec. 2012
7)	Turn over to WASA and conduct the questionnaire survey	DIR(P&E)	Consul	
5-3	**Improvement (quick and transparent) of complaint handling system**			
1)	Evaluate the existing complaint handling system	DIR(P&E)	Indiv. Consult.	Apr. 2011
2)	Design the new complaint handling system using a MIS	DIR(P&E)	Indiv. Consult.	Oct. 2011
3)	Prepare the bidding documents and conduct bidding	DIR(P&E)	Indiv. Consult.	Apr. 2012
4)	Procure the devices/instruments	DIR(P&S)	Contractors	Oct. 2012
5)	Construct a complaint handling system	DIR. PMU	Contractors	Feb. 2013
6)	Make a trial operation	DIR(P&E)	Contractors	Apr. 2013
7)	Prepare the Manual	DIR(P&E)	Contractors	Aug. 2013
8)	Make a training to WASA staff	DIR(P&E)	Contractors	Oct. 2013
9)	Turnover to WASA	DIR(P&E)	Contractors	Oct. 2013

Figure 2 Action Plan for Institutional Improvement of Lahore WASA

	Measures / Actions	Responsible Person (Agency)	In charge	Target Date
(1)	**Selection of Consultants**			
(2)	**Detailed Design for Phase 1 Project**			
(3)	**Tendering for Phase 1 Project**			
(4)	**Construction for Phase 1 Project**			
(5)	**Detailed Desigtn for Phase 2 Project**			
(6)	**Preparation of Master Plan for Lahore Water Supply System**			
(7)	**Detailed Desigtn of A Surface Water Supply System for Phase 2 Project**			
(8)	**Study on Institutional Improvement**			
(9)	**Preparation of M/P and F/S for Water Supply, Sewrage and Drainage outside the WASA's Current Jurisdiction**			
5-4	**Expansion of payment options for customers**			
1)	Investigate the existingf payment methods by customers	DIR(R)	Consul	Apr. 2013
2)	Evaluate the payment methods available	DIR(R)	Consul	Aug. 2013
3)	Design the payment system	DIR(R)	Consul	Oct. 2013
4)	Prepare the bidding documents and conduct bidding	DIR(R)	Consul	Dec. 2013
5)	Procure the devices/instruments	DIR(R)	Consul	Aug. 2015
6)	Construct the payment system	DIR(R)	Consul	Oct. 2015
7)	Make a trial operation and training to WASA staff	DIR(R)	Consul	Dec. 2015
8)	Prepare the manual	DIR(R)	Consul	Feb. 2016
9)	Turn over to WASA	DIR(R)	Consul	Mar. 2016
5-5	**Preparation of public relation strategy and its implementation**			
1)	Investigate the current situation and problems of public relations	DIR(P&E)	Consul	Aug. 2012
2)	Prepare the report with recommendations	DIR(P&E)	Consul	Oct. 2012
3)	Approve the strategy	WASA IC	WASA IC	Oct. 2012
4)	Start improved public relations	DIR(P&E)		Jul. 2013
6	**Groundwater Monitoring and Regulation**			
1)	Monitor the water quality of groundwater	DIR(Hydrogy)	Consul	Every year
2)	Evaluate the groundwater resource	DIR(Hydrogy)	Consul	Jun. 2014
3)	Establish the Bari Doab Groundwater Committee (BDGC)	DIR(Hydrogy)	Consul	Dec. 2013
4)	Study the control and regualtion of groundwater	BDGC	Consul	Jun. 2015
5)	Enforce groundwater control	BDGC	Consul	Dec. 2015



SC: Steering Committee
WASA IC: WASA Internal Committee
DIR(A): for Administration
DIR(R): for Revenue
DIR(P&E): for Planning & Evaluation
DIR(P&S): for Procurement & Storage
DIR(LC): for Leakage Control
DIR(T): for Taining
DIR. PMU: for Project Management Unit
DIR. CONST:1: for Construction I
Committee: Established by the notification of "Committee for Establishment of An Authority to Regulate Drinking Water and Sanitation in The Province" dated Lahore the September 5, 2009
JICA Consul.: Consultants hired by JICA
Indiv. Consult. : Individual consultant hired under loan
Consul: Consulting firm hired under loan

5 Scope of Phase 1 Project

(1) Water Supply

The unaccounted-for water (UFW) should be reduced to improve the efficiency of utilization of existing groundwater sources. Installing bulk flow meters and customer meters as well as replacement of deteriorated pipelines will helps a lot to reduce and control leakage. In Phase 1, bulk flow meters are to be installed to all the tube-wells. Customer meters will be mainly installed in Phase-1 (40%) and Phase-2 (60%), respectively. For UFW reduction, the pilot area is selected to give exercise to leakage detection teams, replace the deteriolated pipes identified and verify the UFW reduction effect. This approach is extended to other areas in Phase-2 to roll out the active leakage control program

(2) Sewerage (see **Figure 3** and **Figure 4**)

The existing sewerage system in the Central Area, which was laid in the early twentieth century, has proved to be grossly inadequate to cater for the flows generated from very critical areas of the city. In the recent past, there has been significant increase in the population making these systems inadequate for the present population. Therefore, the existing sewerage system does not function well. In order to improve the existing situation, and as a temporary countermeasure, a number of lift stations were constructed to pump the wastewater into open drains. However, this countermeasure caused many other problems such as environmental problems around the open drains, increases in operation and maintenance costs for lift stations and decreases in the original cross-section of the open drains for storm water. Therefore, the proposed project for the improvement of a sewerage system in the Central Area is an essential requirement.

In addition, all of wastewater from the Central Area is discharged directly into the River Ravi without treatment through pumping stations, namely Chotta Ravi, Main Outfall, Gulshan-e-Ravi and Multan Road Disposal Stations. The total wastewater flow from the Central Area is estimated at about 640,000 m^3/day in the year 2009 and causes a very serious environmental issue. In order to improve the existing situation, the construction of a wastewater treatment plant including collector channels and lift stations is proposed. The collector channel will intercept wastewater from respective pumping stations to covey to the proposed wastewater treatment plant.

(3) Drainage (see **Figure 5**)

The drainage system in the Central Area is primarily dependent on the Cantonment Drain in addition to other main and secondary drains. Initially, these drains were designed and constructed only for storm water disposal but with the passage of time, wastewater outfalls from a number of adjoining areas have been connected to them either by gravity or through lift stations without considerations of future planning and growth. Therefore, the existing drains have become sullage carriers at present. Also as drains usually pass through residential and commercial areas, it has negative impacts on the overall environment of the region. As the cross-section of drains has been reduced due to the sullage flow in the drain, there is inadequate space left to carry storm water during the rainy season. The existing drainage system is not sufficient to cope with the increased surface run-off due to rapid urbanization in the Central Area as well. As a result of these problems, this area always has the risk of inundation in the rainy season and habitually suffers from poor environmental conditions through stagnation at a number of locations. In view of the above problems, the project for drainage improvement in the Central Area is an absolute necessity.

In order to improve the existing drainage system, new drains will be proposed, however, due consideration should be given to fully utilize the existing system since construction of new drains may prove to be difficult due to the limited space, existence of underground utilities and attendant traffic problems.

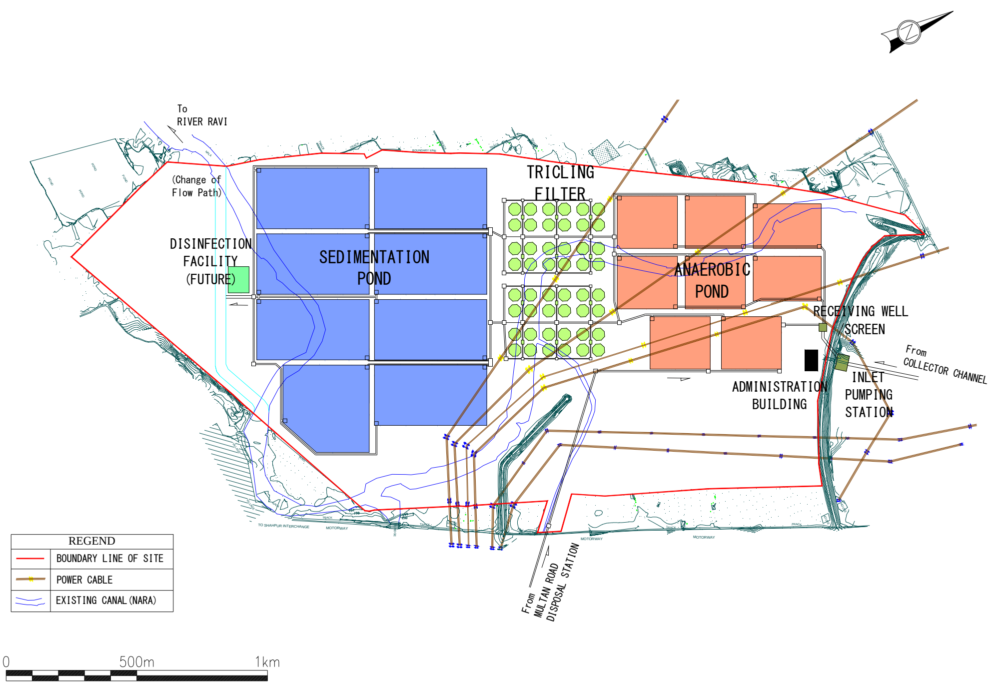


Figure 3 Plan of South West Wastewater Treatment Plant

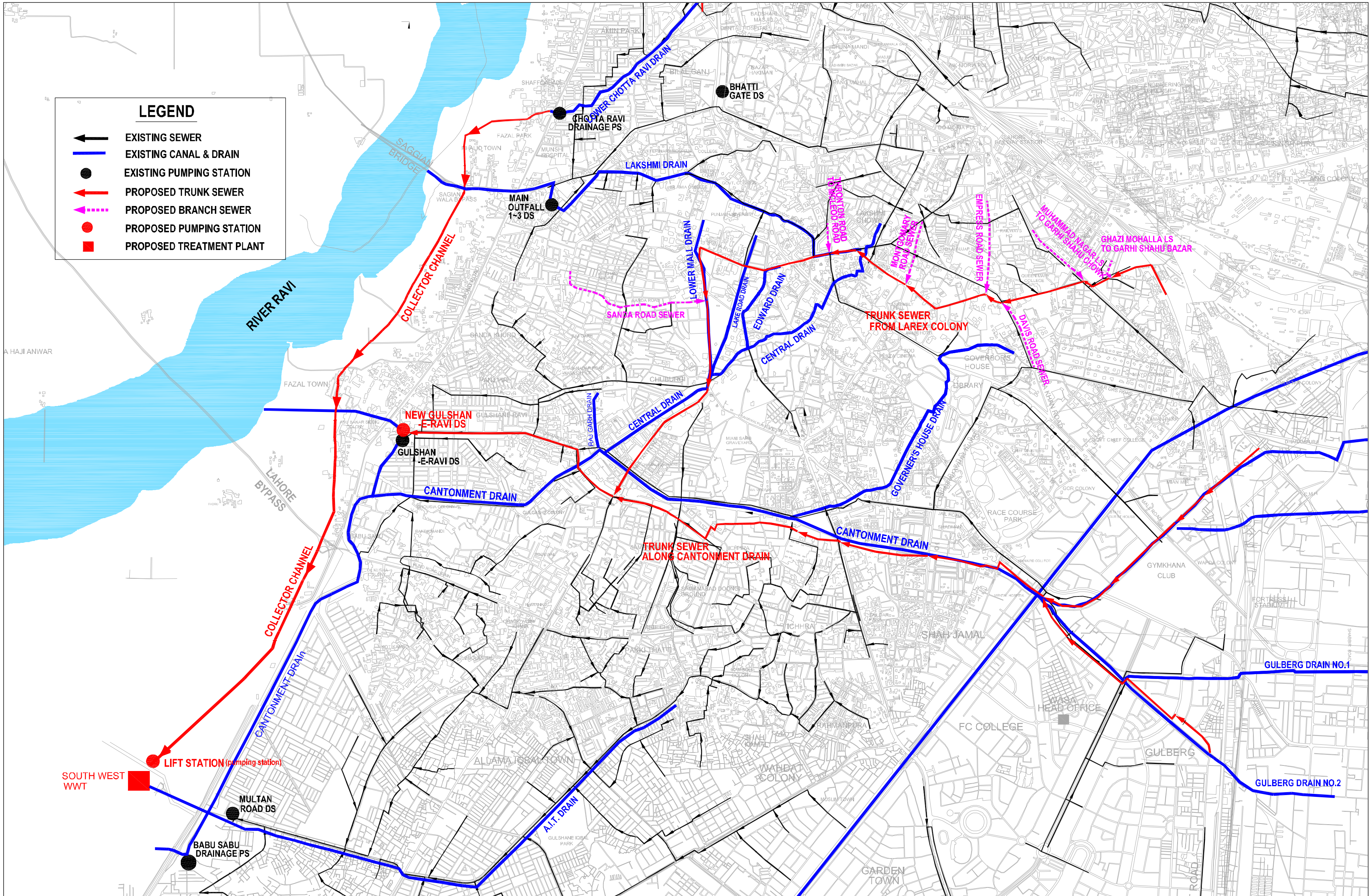


Figure 4 Plan of Proposed Sewerage Facilities of Phase1 Project

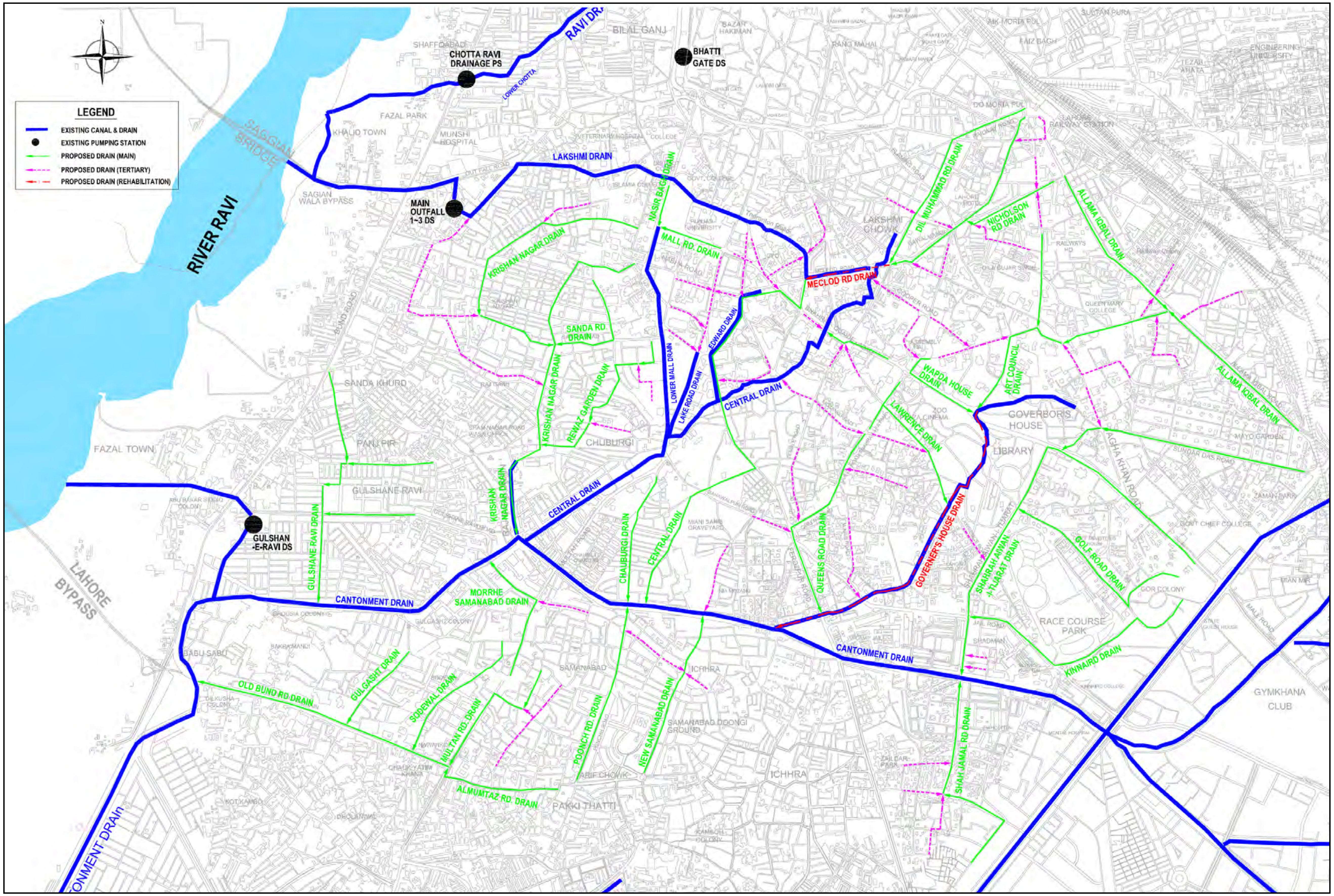


Figure 5 Plan of Proposed Drainage Facilities of Phase 1 Project

The outline of project components for Phase 1 are summarized in **Table 5**
.

Table 5 Outline of Project Components for Phase 1

Phase 1 (2010-2017)	**Specifications/Remarks**
Water supply	
1. Preparation for Using Alternative water Source for Drinking Water 1-1: Preparation of a master plan to develop alternative water source and related facilities, including examination on integration of the existing groundwater supply system and new surface water supply system 1-2: Implementation of preparatory activities including acquisition of rights of surface water	**(Refer to Consulting Services)** The surface water is indispensable for water supply in future due to chronic groundwater drawdown and the ascending trend of arsenic concentration in groundwater. The work is done as one of consulting services For this purpose, consulting services is necessary for the study of acquisition of rights of surface water, preparation of a master plan for conjunctive management of surface- and groundwater.
2. Reduction of Unaccounted-for-water and Non-revenue-water 2-1: Installation of meters in 40% of connections 2-2: installation of bulk flow meters for all tube-wells 2-3: Execution of asset study and preparation of a distribution network improvement plan in the entire WASA area 2-4: Implementation of distribution network improvement in the priority area in the central Lahore within agreed loan amount and period (refer to Management section on other institutional measures)	Water meter Ø 15mm (typical) × 308,000 units Bulk Flow Meter (BFM) Ø 8” × 159 units for 1.0 to 2.5 cusec tube-wells Ø 10” × 233 units for 3.0 to 4.0 cusec tube-wells Each tube-well equipment include one (1) unit of pressure gauge. **(Refer to Institutional Improvement 2-3)** The consultants to be employed at the D/D stage assists the asset study and prepare the distribution network plan, based on the results of a pilot study **(Not Specified)** Details will be fixed based on the study in the pilot area during the detailed design stage. 1) The priority is given to the town with high UFW ratio. 2) The pipes that leakage is found will be replaced by new pipes. 3) If the trend that the older the pipes installed the more the leakage becomes clear, the older pipes will be replaced with priority.
3. Improvement of Water Quality 3-1: Installation of chlorinators for all tube-wells (certain measures for UFW reduction are also relevant for improvement of water quality)	For each tube-well specified in 4-5 below Chemical feed pump with a storage container (10 liter/hr x 10 bar) x 342 units
4. Procurement of Operation and Maintenance Equipment 4-1: Dewatering equipment 4-2: Water supply equipment and sewer cleaning equipment (vehicles) 4-3: Water meter repair workshop equipment 4-4: Water quality analyzer 4-5: Vehicles for employees’ transportation 4-6: On-site measuring instrument	(see **Appendix 10.8**)
Sewerage	
1. Sewer – Central Area – connecting to South West Treatment Plant	

1-1: Construction of trunk sewer from Larex Colony to Gulshan-e-Ravi Disposal Station 1-2: Construction of branch sewers from Larex Colony to Gulshan-e-Ravi Disposal Station 1-3: Construction of trunk sewer along Cantonment Drain	Ø 24" – 90" × 34.766 ft Ø 15" – 54" × 15,632 ft Ø 42" – 78" × 22,805 ft 6.0 ft W x 6.0 n H x 3,000 ft 7.0 ft W x 6.0 n H x 1,500 ft 8.0 ft W x 6.0 n H x 7,000 ft 12.0 ft W x 8.0 n H x 8,275ft
2. Disposal Station – Central Area – connecting to South West Treatment Plant 2-1: Construction of New Gulshan-e-Ravi DS	 Volute pimps : 13 units (including 3 units as standby) 40 cusecs
3. Wastewater Treatment Plant– South West Area – 3-1 : Construction of Collector Channel 3-2 : Construction of Lift Station 3-3: Construction of South West Wastewater Treatment Plant including collector channel and pumping station	 3.0 m W x 1.8 n H x 1,490 m 5.5 m W x 1.8 n H x 2,750 m 10.0 m W x 2.2 n H x 3,150 m Screw Punmps : 12 units (including 2 units as standby) Q = 80 cusecs Q = 323 cusecs (790,000 m^3/day) Anaerobic ponds + Trickling filters + Sedimentation ponds
Drainage	
1. New Construction of Drains in Central Lahore **Package A** 1-1: Central Drain 1-2: Dil Muhammad Road Drain 1-3: Art Council Drain 1-4: Allama Iqubal Road Drain 1-5: WAPDA House Drain 1-6: Lawrence Road Drain 1-7: Nicholson Road Drain 1-8: Poonch Road Drain 1-9: Chauburji Drain 1-10: new Samanabad Drain 1-11: Morrhe Samanabad Drain 1-12: Multan Road Drain 1-13: Almumtaz Road Drain 1-14: Old Bund Road Drain 1-15: Sodewal Drain 1-16: Gulgasht Drain 1-17: Nasir Bagh Drain 1-18: Mall Road Drain **Package B** 1-19: Queens Road Drain 1-20: Shahra Awane Tijarat Road Drain 1-21: Golf Road Drain 1-22: Kinnaird Drain 1-23: Shah Jamal Drain 1-24: Gulshan-e-Ravi Drain 1-25: Sanda Road Drain 1-26: Krishan Nagar Drain 1-27: Rewaz Garden Drain 1-28: Tertiary Drain	 3.0 - 12.0 ft W x 4.0 - 6.0 ft H x 17,600 ft 3.5 - 4.0 ft W x 3.0 - 4.0 ft H x 5,500 ft 7.5 ft W x 5.0 ft H x 2,900 ft 3.0 – 7.5 ft W x 3.0 - 6.0 ft H x 13,838 ft 3.0 ft W x 3.0 ft H x 3,110 ft 3.5 ft W x 3.0 ft H x 3,688 ft 3.0 ft W x 3.0 ft H x 2,463 ft 5.0 ft W x 4.0 ft H x 4,838 ft 3.5 ft W x 4.0 ft H x 3,548 ft 4.0 – 4.5 ft W x 4.0 ft H x 4,540 ft 3.5 ft W x 4.0 ft H x 3,548 ft 3.5 – 4.0 ft W x 3.0 - 4.0 ft H x 4,242 ft 3.5 ft W x 3.0 ft H x 3,188 ft 4.5 – 5.0 ft W x 4.0 ft H x 6,715 ft 4.0 ft W x 3.0 ft H x 5,038 ft 3.5 ft W x 3.0 ft H x 2,435 ft 3.0 ft W x 3.0 ft H x 1,100 ft 3.0 ft W x 2.0 ft H x 1,725 ft 4.0 ft W x 5.0 ft H x 5,382 ft 4.0 – 8.0 ft W x 3.0 - 4.0 ft H x 17,490 ft 3.0 – 4.0 ft W x 3.0 - 4.0 ft H x 5,648 ft 4.0 ft W x 5.0 ft H x 6,690 ft 3.0 – 6.0 ft W x 3.0 - 4.0 ft H x 5,956 ft 3.0 – 10.0 ft W x 3.0 - 5.0 ft H x 11,413 ft 3.5 ft W x 3.0 ft H x 3,579 ft 3.0 – 12.0 ft W x 3.0 - 6.0 ft H x 17,021 ft 2.0 – 3.5 ft W x 3.0 - 4.0 ft H x 5,031 ft 2.0 – 3.0 ft W x 2.0 - 3.0 ft H x 74,646 ft
2. Improvement and Rehabilitation of Drain in Central Lahore	

Package A 2-1: Meclod Road Drain 2-2: Governor House Drain	 6.0 ft W x 5.0 ft H x 2,000 ft 7.5 – 10.0 ft W x 5.0 - 7.0 ft H x 8,435 ft
Institutional Improvement	
2. Timely Data Acquisition and Preparation of Definitive Vision and Strategies 2-3: implementation of comprehensive asset survey and preparation of asset inventories and drawings in the entire WASA area	
3. Reduction of Unaccounted-for-water and Non-revenue-water 3-2 installation of meters in 40% of connections 3-3 establishment of leakage detection teams 3-4 implementation of distribution network improvement in the priority area in the central Lahore based on asset study and preparation of distribution network improvement plan in the entire WASA area. 3-5 implementation of stringent measures against defaulters and illegal connections and phasing-out of uncharged public stand posts 3-6 entrustment of metering and billing to private companies	 **See Water Supply 2-1 above, Assisted by the consulting firm** **Assisted by the consulting firm** **See Water Supply 2-3 above, Assisted by the consulting firm** **Assisted by the consulting firm** **Assisted by the consulting firm**
4. Human Resource Development and Organizational Streamlining 4-1 organizational restructuring 4-2 improvement of personnel management and human resource development 4-3 entrustment of certain facilities to private companies 4-4 establishment of Management Information System 4-5 procurement of O&M equipment	 **Assisted by the consulting firm** **Assisted by the consulting firm** **Assisted by the consulting firm** **Assisted by the individual consultant** **Assisted by the individual consultant**
5. Improvement of Customer Services 5-2 regular implementation of customer survey 5-3 improvement of complaint handling system 5-4 expansion of payment options for customers 5-5 preparation of public relation strategy and its implementation	 **Assisted by the consulting firm** **Assisted by the individual consultant** **Assisted by the consulting firm**
6. Groundwater Monitoring and Regulation 6-1 follow up survey and analysis on groundwater quality and quantity 6-2 establishment of groundwater committee 6-3 preparation of groundwater control and regulation plan 6-4 establishment of regular monitoring system of groundwater	**Assisted by the consulting firm**
Consulting Services	
1. Detailed design for Phase-1 Project 2.Tender assistance for Phase-1 Project 3. Construction supervision for Phase-1 Project 4. Detailed design of sewerage and drainage facilities for Phase-2 Project 5. Preparation of master plan for Lahore Water Supply System 6. Detailed design of Lahore Water Supply System for Phase-2 Project 7. Study on institutional improvement 8. Preparation of master plan and feasibility study for water supply, sewerage and drainage outside the WASA's current jurisdiction	

6 Conditions and Assumptions for Cost Estimation

6.1 Estimation of Capital Cost (see Table 6)

(1) Eligible Portion

1) Exchange Rate

- Base year : September 2009
- Exchange Rate : US$ 1 = JY 92.53

: Rs. 1 = JY1.26 (Average of TTS in September, 2009)

2) Construction Costs : Based on "Market Rate for 3rd Quarter of 2009", Lahore

3) Consulting Services : Based on the personnel work schedule

4) Physical Contingency : 5% of the direct construction costs

5) Price Escalation : Foreign currency : 2.6 % per annum

: Local currency : 3.6% per annum

(2) Non-Eligible Portion

1) Custom Duty : Based on "Custom Tariff [2009-2010]" by FBR

For consultancy services a custom tariff of 16% is applied to the charge

2) Sales tax : = (Net value + Custom duty) x 0.16

Special federal excise duty : = (Net value + Custom duty) x 0.01

(3) Commitment Charge : = (Loan balance not-used) x 0.1% per annum

(4) Interest during Construction

For sewerage and drainage

Interest during Construction = direct construction cost x 0.65% x 10 years

For water supply and institutional improvement

Interest during Construction = direct construction cost x 1.40% x 10 years

For consultancy services

Interest during Construction = direct construction cost x 0.01% x 10 years

6.2 Estimation of Operation and Maintenance Cost (see Table 7)

(1) Expected lifetime

- Concrete structures : 40 years
- Pump : 15 years
- Water meter : 8 years
- Mechanical equipment : 15 years
- Electrical equipment : 20 years

(2) Energy cost (Rs./yr) = Power consumption (kWh/day) x 8 (Rs./kWh) x 365 (day/yr)

(3) Personnel Cost (Rs./yr) = Required M/M x Monthly rate (Rs./month) x 12 (month/yr)

(4) Repair Cost (Rs./yr) = [(Energy cost) + (Personnel Cost)] x 0.01

Table 6 Cost for Phase-1 Project (Full Components)

Annual Fund Requirement

Base Year For Cost Estimation:	September 2009		FC & Total:	49,228	million	JPY
Exchange Rates	PK·Rupee = yen 1.26		LC :	21,821	million	PK·Rupee
PriceEscaration:	FC: 2.6%	LC: 3.6%				
Physical Contingency	5%					
Physical Contingency for Consultant	5%					

Item	Total			2010			2011			2012			2013			2014			2015			2016			2017			2018			2019		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION																																	
I) Procurement / Construction	15,683	13,813	33,088	0	0	0	0	0	0	0	0	0	0	0	0	5,207	5,942	12,694	2,500	2,767	5,986	4,261	2,872	7,879	3,716	2,233	6,529	0	0	0	0	0	0
Water Supply	1,384	326	1,795	0	0	0	0	0	0	0	0	0	0	0	0	496	117	642	323	76	418	323	76	418	244	57	316	0	0	0	0	0	0
Sewerage	8,592	7,588	18,153	0	0	0	0	0	0	0	0	0	0	0	0	3,866	3,415	8,169	1,718	1,518	3,631	1,718	1,518	3,631	1,289	1,138	2,723	0	0	0	0	0	0
Drainage	0	2,690	3,389	0	0	0	0	0	0	0	0	0	0	0	0	0	1,210	1,525	0	538	678	0	538	678	0	403	508	0	0	0	0	0	0
Management	2,699	7	2,708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,350	4	1,354	1,350	4	1,354	0	0	0	0	0	0
Base cost for JICA financing	12,675	10,611	26,045	0	0	0	0	0	0	0	0	0	0	0	0	4,362	4,742	10,336	2,041	2,131	4,727	3,391	2,135	6,081	2,882	1,603	4,901	0	0	0	0	0	0
Price escalation	2,261	2,545	5,468	0	0	0	0	0	0	0	0	0	0	0	0	597	917	1,753	340	504	975	667	600	1,423	657	524	1,317	0	0	0	0	0	0
Physical contingency	747	658	1,576	0	0	0	0	0	0	0	0	0	0	0	0	248	283	604	119	132	285	203	137	375	177	106	311	0	0	0	0	0	0
II) Consulting services	3,053	728	3,970	0	0	0	0	0	0	748	122	902	278	49	340	1,125	234	1,419	371	130	535	300	118	448	182	71	271	24	2	27	25	2	28
Base cost	2,567	576	3,293	0	0	0	0	0	0	660	105	792	239	41	290	942	187	1,177	303	100	429	239	88	349	141	51	205	18	1	20	18	1	20
Price escalation	347	120	499	0	0	0	0	0	0	53	12	68	26	6	34	129	36	174	50	24	80	47	25	78	32	17	53	5	1	5	5	1	6
Physical contingency	145	35	189	0	0	0	0	0	0	36	6	43	13	2	16	54	11	68	18	6	25	14	6	21	9	3	13	1	0	1	1	0	1
Total (I +II)	18,736	14,542	37,059	0	0	0	0	0	0	748	122	902	278	49	340	6,332	6,176	14,113	2,871	2,897	6,521	4,561	2,989	8,327	3,898	2,304	6,800	24	2	27	25	2	28
B. NON ELIGIBLE PORTION																																	
a Land acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Administration cost	0	1,176	1,482	0	0	0	0	0	0	0	29	36	0	11	14	0	448	565	0	207	261	0	264	333	0	216	272	0	1	1	0	1	1
(Environmental and social consideration cost)	0	40	50	0	0	0	0	0	0	0	7	8	0	7	8	0	7	8	0	7	8	0	7	8	0	7	8			0			0
c Custom duty	0	3,100	3,906	0	0	0	0	0	0	0	112	141	0	43	54	0	1,057	1,332	0	496	625	0	752	947	0	640	806	0	0	0	0	0	0
Base cost	0	2,495	3,143	0	0	0	0	0	0	0	101	127	0	37	47	0	886	1,116	0	401	506	0	587	740	0	482	608	0	0	0	0	0	0
Price escalation	0	606	763	0	0	0	0	0	0	0	11	14	0	6	7	0	171	216	0	95	120	0	165	208	0	158	199	0	0	0	0	0	0
d Sales tax	2,998	2,823	6,554	0	0	0	0	0	0	120	38	167	44	15	63	1,013	1,157	2,471	459	543	1,143	730	599	1,484	624	471	1,217	4	0	4	4	0	4
e Special federal excise duty	0	180	226	0	0	0	0	0	0	0	7	9	0	3	3	0	61	77	0	28	35	0	44	55	0	37	47	0	0	0	0	0	0
Total (a+b+c+d+e)	2,998	7,279	12,170	0	0	0	0	0	0	120	185	353	44	71	134	1,013	2,723	4,445	459	1,274	2,065	730	1,659	2,820	624	1,364	2,343	4	1	6	4	1	6
TOTAL (A+B)	21,734	21,821	49,228	0	0	0	0	0	0	868	308	1,255	322	120	474	7,345	8,899	18,557	3,330	4,171	8,586	5,290	4,648	11,147	4,522	3,668	9,143	28	3	33	29	4	33
C. INTEREST DURING CONSTRUCTION	2,031	0	2,031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. COMMITMENT CHARGE	153		153						37			36			36			22			15			7			0			0			0
GRAND TOTAL (A+B+C+D)	21,734	21,821	49,228	0	0	0	0	0	0	868	308	1,255	322	120	474	7,345	8,899	18,557	3,330	4,171	8,586	5,290	4,648	11,147	4,522	3,668	9,143	28	3	33	29	4	33

Administration Cost = 4% of the Eligible portion
Sales Tax= 16% of the Eligible portion
Special Federal Excise Duty= 1% of the expenditure in foreign currency of the eligible portion

Price Escalation

	Total			2010			2011			2012			2013			2014			2015			2016			2017			2018			2019		
Price Escale				1.026	1.036		1.052676	1.073296		1.080046	1.111935		1.108127	1.151964		1.136938	1.193435		1.166498	1.236399		1.196827	1.280909		1.227945	1.327022		1.259871	1.374795		1.292628	1.424287	
d Price Escal				0.026	0.036		0.052676	0.073296		0.080046	0.111935		0.108127	0.151964		0.136938	0.193435		0.166498	0.236399		0.196827	0.280909		0.227945	0.327022		0.259871	0.374795		0.292628	0.424287	

Loan interest during const.
Financing rate 100% ← Non-eligible Percentage 24.7%
Interest rate for YEN loan

	Total			2010			2011			2012			2013			2014			2015			2016			2017			2018			2019		
Temporaly alocation			49,228	0		0	0		0	1,255		1,255	474		474	18,557		18,557	8,586		8,586	11,147		11,147	9,143		9,143	33		33	33		33
Debt at the end of term				0			0			1,255			1,729			20,286			28,872			40,019			49,162			49,195			49,228		
Interest during const				0			0			0			0			0			0			0			0			0			0		

Cumulative Disbursement

Item	Total			0			1			2			3			4			5			6			7			8			9		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
									0			902			1,242			15,355			21,876			30,204			37,004			37,031			37,059

Table 7 Operation and Maintenance Costs (Full Component)

Unit: Million Rupees

Year	Water Supply	Sewers and Collector Channel	Disposal Station	Lift Station and WWTP	Drainage	O&M Equipment	Total
2016	10,288	9,932	103,902	449,784	56,036	22,571	652,514
2017	10,474	10,053	105,083	455,091	56,717	22,845	660,263
2018	10,660	10,175	106,382	460,397	57,406	23,122	668,142
2019	10,846	10,299	107,563	465,704	58,103	23,403	675,917
2020	11,031	10,424	108,743	471,011	58,809	23,687	683,706
2021	11,217	10,551	110,042	476,318	59,523	23,975	691,626
2022	11,330	10,679	110,751	479,424	60,246	24,266	696,696
2023	11,443	10,809	111,459	482,531	60,978	24,561	701,781
2024	11,556	10,940	112,167	485,637	61,719	24,859	706,879
2025	11,669	11,073	112,876	488,743	62,469	25,161	711,992
2026	11,782	11,207	113,584	491,850	63,228	25,467	717,119
2027	11,868	11,343	114,057	494,050	63,996	25,776	721,090
2028	11,954	11,481	114,647	496,251	64,773	26,089	725,194
2029	12,039	11,620	115,119	498,451	65,560	26,406	729,195
2030	12,125	11,761	115,592	500,651	66,356	26,727	733,212
2031	12,210	11,904	116,182	502,852	67,162	27,052	737,362
2032	12,267	12,049	116,536	504,534	67,978	27,381	740,745
2033	12,323	12,195	116,890	506,217	68,804	27,714	744,144
2034	12,380	12,343	117,245	507,900	69,640	28,051	747,558
2035	12,493	12,493	118,071	511,265	70,486	28,392	753,200

7 Bidding Procedure

The proposed contract packages are summarized in **Table 8**.

Table 8 Contract Package List

Package	Bidding Procedure	Estimated Cost (Rs.)	Estimated Cost (JY)
1. Procurement of water meters	ICB	928,900,000	1,170,400,000
2: Installation of customer meters	LCB	203,300,000	256,100,000
3: Installation of tube-well equipment including distribution network improvement in a pilot area	ICB	248,000,000	312,500,000
4: Procurement of UFW Control Equipment	LCB	44,100,000	55,900,000
5: Development of sewerage and drainage networks including a collector channel	ICB	6,367,300,000	8,022,800,000
6: Construction of South West Treatment Plant	ICB	10,729,300,000	13,519,000,000
7: Management Monitoring System (MIS)	LCB	1,586,900,000	1,999,500,000
8: O&M Equipment	LCB	562,500,000	708,800,000

ICB: International competitive bidding LCB: Local competitive bidding

Note: Estimated cost shows the direct construction cost and does not include price escalation and physical contingency.

8 Project Implementation Schedule

Project implementation schedule is shown in **Figure 6**, respectively, which is prepared on the assumption that the procedures in both the Pakistani side and Japanese side will be smoothly progressed, starting from the Loan Agreement to be expectedly concluded by the end of the year 2010.

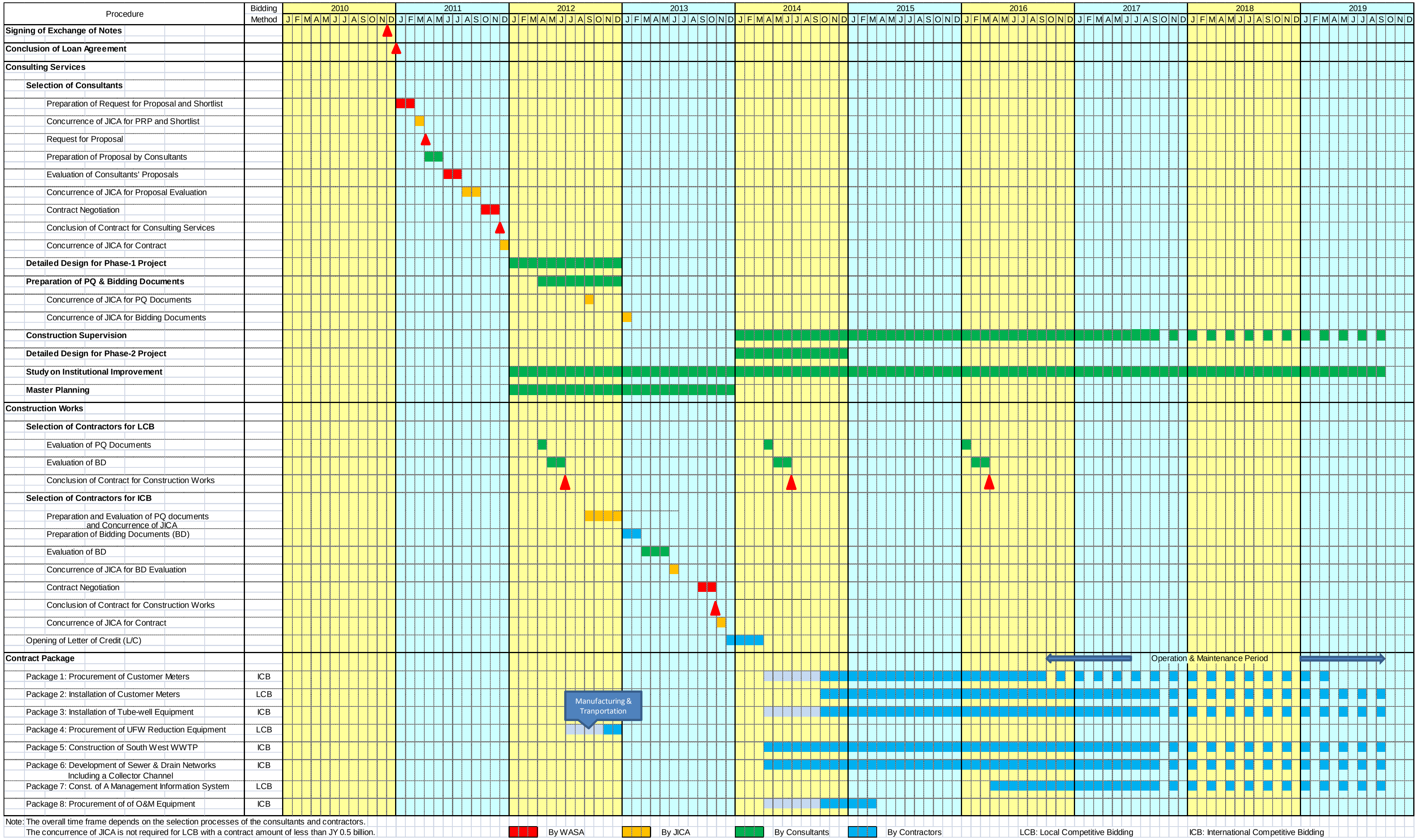
This project implementation schedule is tentative and would be discussed later.

The operation and maintenance period shall be two years after the completion of construction works including three month trial operation accompanied with the training to WASA staff. During this period, if any defects will be found in facilities/equipment, the contractor shall be required for their repair and replacement with no cost to WASA. In addition, the contractor shall provide training on operation and maintenance of facilities/equipment in collaboration with the consultants under loan.

The engineering services to be undertaken by the international consultants under loan are as follows:

1) Detailed Design for Phase-1 Project
2) Tender Assistance for Phase-1 Project
3) Construction Supervision for Phase-1 Project
4) Detailed Design for Phase-2 Project
5) Preparation of Master Plan for Lahore Water Supply System
6) Detailed Design of Lahore Water Supply System for Phase-2 Project
7) Study on Institutional Improvement
8) Preparation of master plan and feasibility study for water supply, sewerage and drainage outside the WASA’s current jurisdiction

Figure 6 Project Implementation Schedule



9 Organizations during and after Project Implementation

9.1 Organization during Project Implementation

For the project implementation, the organization as shown in **Figure 7** is proposed to control the construction works and to solve a variety of problems to be faced, assuming the case that all proposed components will be included in Phase 1 Project.

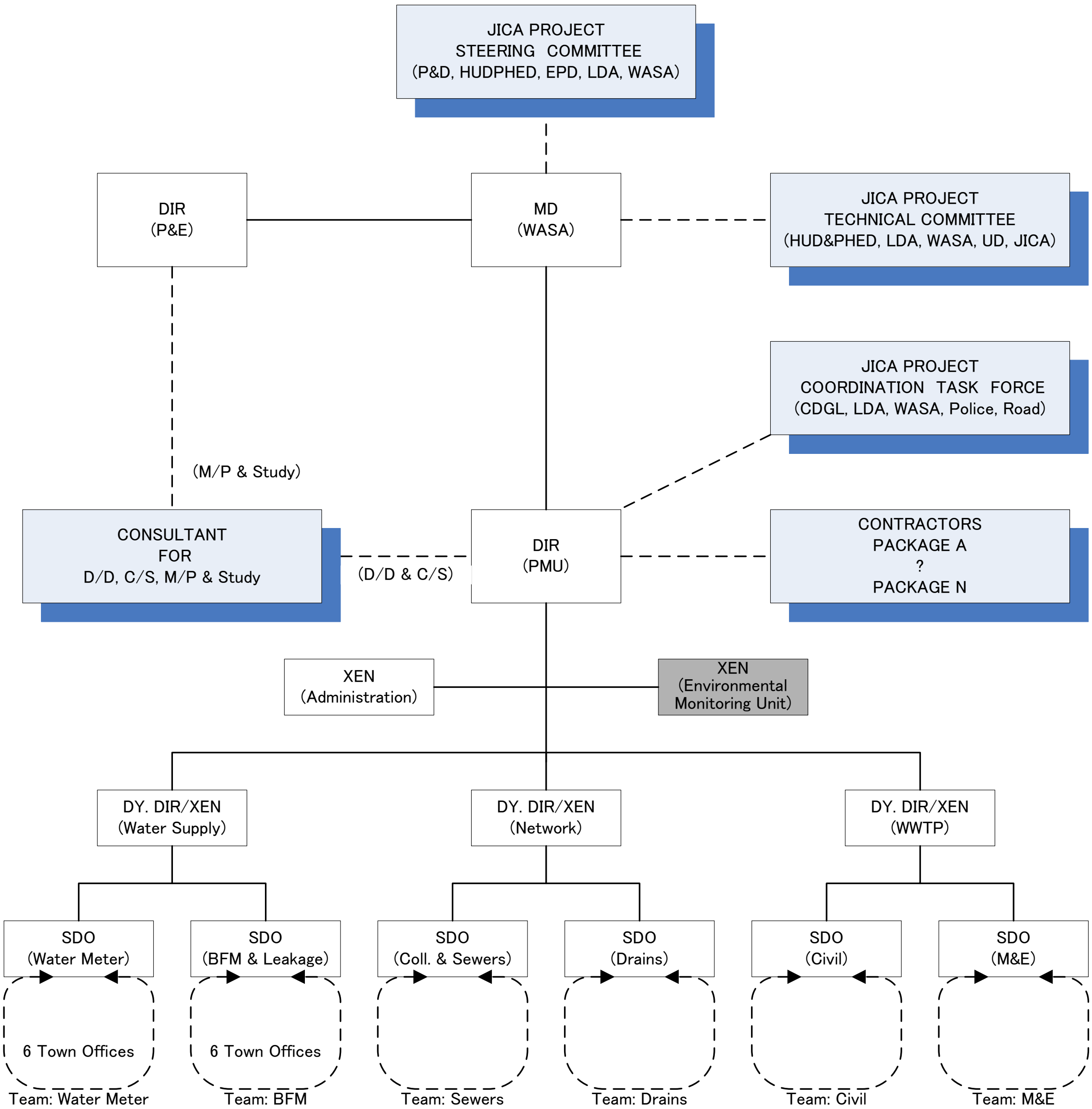


Figure 7 Organization During the Project Implementation

The following organization will be newly established for project implementation.

1) Steering Committee for JICA Project
2) Technical Committee for JICA Project

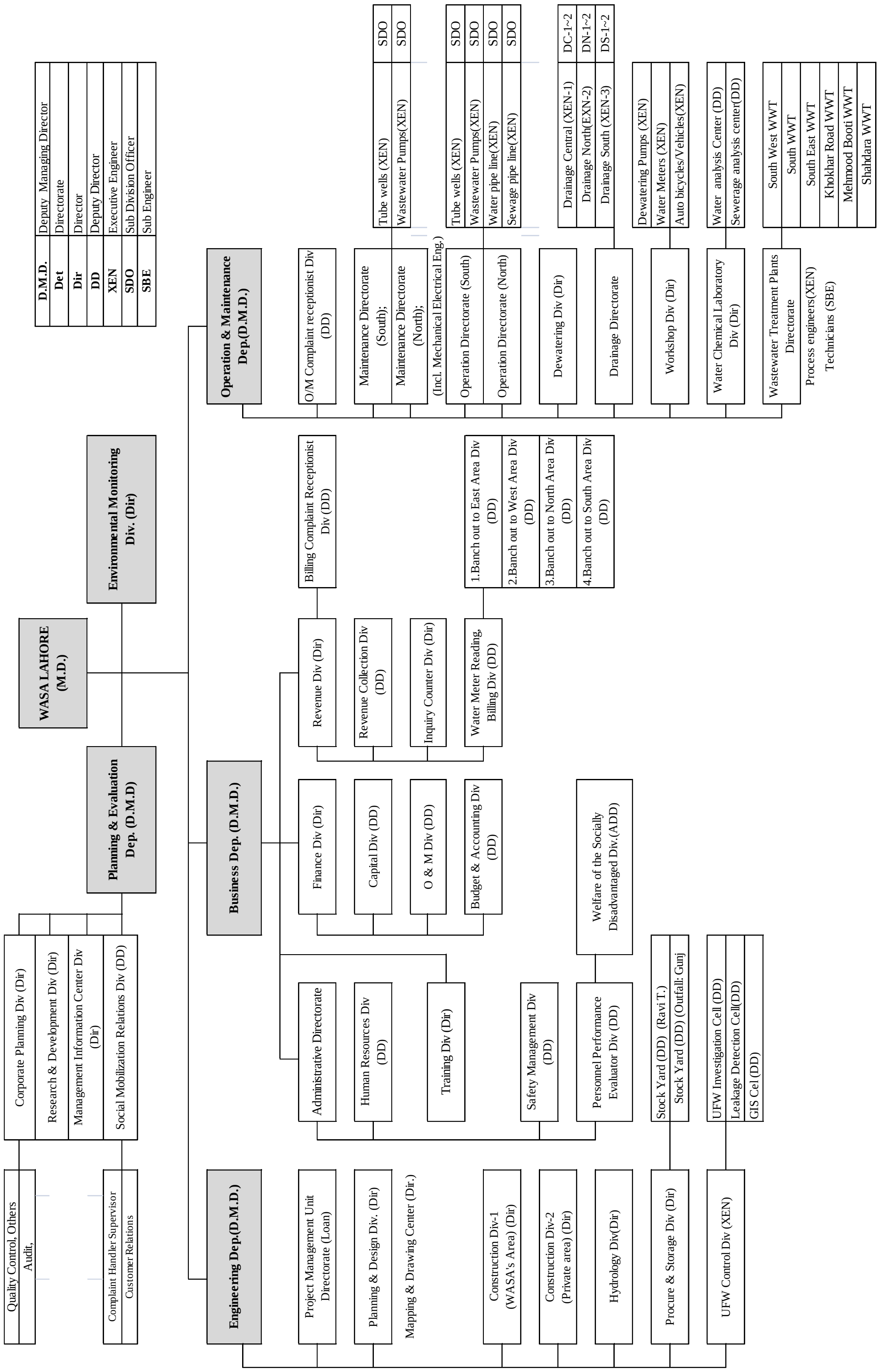
3) Coordination Task Force for JICA Project
4) Project Management Unit (PMU)
5) Environmental Monitoring Unit

9.2 Organization after Project Completion

Figure 8 shows the organization after project completion.
The major changes in relation to the facilities to be constructed under the Project are as follows:

1) The directorate of Project Management Unit will remain for the subsequent Phase-2 Project.
2) The directorate for environmental monitoring will be established to continue the environmental monitoring
3) The UFW control will be upgraded to undertake GIS survey,
4) The workshop and laboratory will be upgraded to the directorate due to an increase of its importance and working volume.
5) The directorate for WWTP will be newly established for operation and maintenance of plants.

Figure 8 Organization After the Project Completion



10 Management Monitoring Indicators

The purpose to set management monitoring indicators is to understand the operational and managerial situation of not only the entire WASA but also individual systems in order to identify the location and cause of problems. The entire WASA is composed of individual systems such as water supply, sewerage and drainage. Furthermore, for example, the service area by a sewerage system is subdivided into the areas covered by respective WWTPs to be constructed in future. The data should be collected so as to clarify the system covered by each WWTP as much as possible, since each system is basically operated and maintained independently from others. For this purpose, the adequate instruments to measure the flow, weight and power should be provided at the construction of new WWTP. The administrative and financial data stocked in WASA should be also categorized so as to meet such operational units, even though such works are complicated and take a time.

The monitoring indicators are proposed as shown in **Table 9**.

Table 9 Operation and Effect Indictors for Water Supply, Sewerage and Drainage

	Indicators	Unit	2009 (Base)	2019 (Target)	Remarks
1. Water Supply					
(1)	**Operation Indicator**				
1-1	Population served by water supply	mil. pers.	4.934	6.505	
1-2	Amount of water supply	MGD	244.2	296.1	
		Mm^3/day	1.110	1.346	
1-3	Number of functional metered connections	nos.	68,576	376,600	+308,000
1-4	Rate of unaccounted-for water (UFW)	%	34	29	
1-5	Rate of non-revenue water (NRW)	%	40	36.4	
1-6	Amount of groundwater abstraction	MGD	370.0	416.9	
		Mm^3/day	1.682	1.895	
1-7	Rate of tap water unfitness for drinking	%			
(2)	**Effect Indicator (For Entire WASA Area)**				
1-11	Percentage of population served	%	87	92	
1-12	Water supply per capita	Lpcd	225	2055	
1-13	Revenue on water supply	Rs. mil.	1,819.3	5,260.0	
2. Sewerage					
(1)	**Operation Indicator**				
2-1	Population served by sewerage	mil. pers.	5.759	7.799	Entire area
2-2	Population treated	mil. pers.	0.0	2.784	
2-3	Rate of facility utilization	%	-	35.7	Entire area

2-4	Influent BOD_5	mg/L	-	250	
	Effluent BOD_5	mg/L	-	50	
	BOD_5treatment efficiency	%	-	80	
2-5	Influent SS	mg/L	-	350	
	Effluent SS	mg/L	-	70	
	SS treatment efficiency	mg/L	-	80	
2-6	Amount of dried sludge	DS t/day	-	100	+85,251 m^3/y (70%)
(2)-1	**Effect Indicator (For Project Area: Central)**				
2-11	Percentage of population served	%	84	90	
2-12	Improvement of water quality in the receiving water body	%	-		
2-13	Total length of sewers	Km	1,325	1,348	+34,766 ft +15,632 ft +7,390 m
(2)-2	**Effect Indicator (For Entire Area)**				
2-21	Percentage of population served	%	84	90	
2-22	Percentage of wastewater treated	%	-		
2-23	Total length of sewers	km	3,508	3,531	+34,766 ft +15,632 ft +7,390 m
3. Drainage					
(1)	**Operation Indicator**				
3-1	Annual highest water level at the base point		-		
(2)-1	**Effect Indicator (For Project Area)**				
3-11	No. of inundated areas at the maximum rainfall	areas	50		
3-12	Total inundated area at the maximum rainfall	ha	49.75		
3-13	Frequency of inundation at the typical point	times			
3-14	Total length of sewers	Km	79.94	122.52	+42,580 m
(2)-2	**Effect Indicator (For Entire Area)**				
3-21	No. of inundated areas at the maximum rainfall	areas	80		
3-22	Total inundated area at the maximum rainfall	ha	85.33		
3-23	Frequency of inundation at the typical point	times			
3-24	Total length of sewers	Km	215.68	258.26	+42,580 m

11 Economic and Financial Evaluation

(1) Economic and Financial Evaluation

A main objective of the economic evaluation here is to examine the efficiency of the project investment in Phase I from the viewpoint of the national economy using cost-benefit analysis.

Preconditions

Price level	:	Year of 2009
Exchange rate	:	USD 1.00 =JPY 92.53 Pakistan Rupee 1.00 = JPY 1.26
Social discount rate	:	12%, the same figure that is employed in the *Study on Water Supply and Sewerage System in Karachi in the Islamic Republic of Pakistan, July 2008, JICA.*

Table 10 Project Component, Expected Effect, and Benefit

Project Component	Expected Effect	Benefit
<Water Supply>		
• Install bulk flow meters to control the Unaccounted for water (Target: All the rube-wells)	To help decrease UFW and increase the revenue of WASA	As the effect is the transfer of money, no additional benefit is expected.
• Install customer meters to control the Unaccounted for water (Target: Establish the system of installing meters and install meters to 40% of customers)	To help decrease UFW and increase the revenue of WASA	As the effect is the transfer of money, no additional benefit is expected.
• Establish the system of UFW control (Target: Increase the number of staff and strengthen the capacity enough to control UFW)	To increase the water supply within the existing water supply system	Water is supplied in an increased amount.
• Install chlorinators for complete disinfection (Target: All the rube-wells)	To improve the water quality and reduce water-born diseases	Medical costs are reduced. Time which has been spent for medical treatment can be allocated to productivity or leisure.
<Sewerage>		
• Construction of new treatment plant in Central Area	To increase the water quality of Ravi River	Agricultural productions using the water of Ravi River increase.
• Interception of drains and diversion for treatment	To improve the sanitary conditions of the area	Living environment of the residents in the area improves.
• Major trunk sewer and new disposal station required to service densely populated areas and convey waste water to treatment works	To improve the sanitary conditions of the area To eliminate lift stations which pump up the wastewater into drainage lines	Living environment of the residents in the area improves. The operation and maintenance cost of the lift stations is reduced.
<Drainage>		
• Construction of new main and secondary drains in Central Area	To reduce inundation	Production activities which have been halted by inundation can be reduced.
• Rehabilitation and cleaning of existing drains in Central Area	To reduce inundation	Production activities which have been halted by inundation can be reduced.
<Management>	To improve the management of WASA	As this component helps other components realize their effects effectively, it has no additional benefit by itself.

EIRR for the combined components is calculated at 15.7 %.

FIRR for the combined components is calculated at -18.2 %.

(2) Cash Flow Analysis

Prices of Water and sewerage for households are calculated with the assumptions. Prices are set to just cover the costs both with existing facilities and those to be installed in the proposed projects. They are set from 2011 and revised at every five years.

Table 11 Water and Sewerage Price for Households (Original)

	2011	2016	2021	2026	2031
Total Cost for Household Use (Rs. Million)	3,391.7	8,615.1	7,105.0	7,795.0	7,950.2
Water Price (Rs./10^3m^3)	7,267.0	13,516.8	11,762.5	11,724.1	11,363.5
Water Price per Capita (Rs./day)	1.6	2.9	2.4	2.2	2.0
Affordability for Water (Rs./day)	4.5	5.3	6.3	7.5	8.9
Water Price for 5 Year Average (Rs./10^3m^3)	10,052.0	12,550.4	11,700.5	12,106.0	11,146.1
Sewerage Price (Rs./10^3m^3)	2,493.5	8,967.5	5,643.2	6,855.9	6,848.1
Sewerage Price per Capita (Rs./day)	0.6	1.9	1.1	1.3	1.2
Affordability for Sewerage (Rs./day)	1.1	1.3	1.6	1.9	2.2
Sewerage Price for 5 Year Average (Rs./10^3m^3)	6,085.4	6,790.8	5,954.5	6,963.2	6,907.7

(3)Tariff Revision.

1) Water Supply Tariff

Based on the considerations given before, it can be recommended that the water tariff for households be revised according to the following policy:

Price of water supply is regulated and managed by price-cap regulation method to cover necessary operating costs with due consideration of affordability for the households and "lifeline tariff" for the poor.

2) Sewerage Tariff

It is important to keep in view the users for keeping the sewerage tariff at 70% of the water supply tariff. If this reduction of the percentage is difficult for the reason of revenue shortage, the increase in the charge of the lowest bracket should be postponed for a certain period because the charge for the lowest bracket is assumed to be that applied to the poorest households.

12 Environmental and social Considerations

12.1 Social and Environmental Impacts

By considering the characteristics of environmental and social aspect in Lahore and project components of Phase 1, the following environmental and social impacts are predicted during construction and operation stages.

Social and environmental impacts are summarized in **Table 12** and **Table 13**, respectively.

Table 12 Initial Assessment of Possible Social Impacts by each Project

Proposed Projects	Possible Impacts					
	Resettlement		Evacuation/ Demolition		Living and Livelihood	
	Construction	Operation	Construction	Operation	Construction	Operation
Sewers[1]	No	No	No	No	In some degree	No
WWTP[2]	No	No	In some degree	No	In some degree	No
Drains[3]	No	No	No	No	In some degree	No
Water[4]	No	No	No	No	No	No

Note
1. Construction of trunk sewers and branch sewers in Lahore central areas and construction of new Gulshan-e-ravi disposal station
2. Construction of South West wastewater treatment plant (WWTP) including the collector channel
3. Construction of new drains and improvement of existing drains in Lahore
4. Reduction of UFW in public water supply through metering system & Improvement of water quality through replacement of Chlorinators at tube wells.

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Table 13 Initial Assessment of Possible Environmental Impacts by Each Project

Proposed Projects	Possible Impacts					
	Noise, Vibration		**Air pollution (Exhaust)**		**Treatment Sludge**	
	Construction	Operation	Construction	Operation	Construction	Operation
Sewers[1]	Yes	No	Yes	No	No	In some degree
WWTP[2]	Yes	In some degree	Yes	In some degree	No	Yes
Drains[3]	Yes	No	Yes	No	No	In some degree
Water[4]	No	No	No	No	No	No

Note
1. Construction of trunk sewers and branch sewers in Lahore central areas and construction of new Gulshan-e-ravi disposal station
2. Construction of South West wastewater treatment plant (WWTP) including the collector channel
3. Construction of new drains and improvement of existing drains in Lahore
4. Reduction of UFW in public water supply through metering system & Improvement of water quality through replacement of Chlorinators at tube wells.

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12.2 Social Considerations for WWTP and Collector Channel

1) Evacuation of Illegal Cultivators on the premises for WWTP

In spite of those 95 illegal cultivators who are not eligible for new compensations (compensated already), in order to avoid negative social impacts such that the living standards of those 95 are fallen by the implementation of the projects, WASA is planning to do the following as social consideration for the evacuation;

- To carry out scrutiny on the present situation of the cultivation and cultivators before the evacuation
- To elaborate an evacuation plan based on results of the scrutiny
- To convene stakeholders (including those 95 cultivators) consultation/meeting on the evacuation periodically in order to come to terms with sooth evacuations
- To manage the civil and construction work will be stated after harvesting
- To monitor their occupational, income and living conditions after the evacuation

periodically based on an environmental monitoring plan will be discussed in an EIA report to be elaborated for the project

- To take individually care of those who would be impacted (such as job introduction) in order to recover their living standards at the time of before the project implementation.

2) Encroachments on the premises for Collector Channel

Magnitude of social impacts by the construction of the collector channel is not such a level as heavily affecting the lives of the people. On the other hand it is identified that some portion of building walls and encroachments are partially protruded on the construction premises of the WASA land. However, the following countermeasures will be taken in order to mitigate and avoid possible impacts on the walls and encroachments by the construction of collector channel.

- Access roads to be constructed on the both sides will be adjusted and narrowed.
- Depth of the Collector channel is to be made deeper as the narrowing the width of the collector channel

In cases where acquisitions of some of the land can not be avoided by the construction of the collector channel, WASA will consider replacement compensations for those whose lands can not be acquired.

12.3 Living and Livelihood during Construction Stage

Attention will be paid for the following issues:

(1) Traffic Management

(2) Signboards, Warning Boards

(3) Coordination with Solid Waste Management

(4) Deployment of Security Guards

(5) Occupational Safety

12.4 For Other Possible Impacts

For other possible impacts below, proper mitigation measures shall be taken.

(1) Noise and Vibration

(2) Air Pollution during Construction and Operation Stages

1) Air Pollution

2) Bad Odor

(3) Generation of Sludge during Operation Stage

1) Sludge Treatment

2) Contamination by the Sludge

(4) Other Possible Impacts

1) Discharge Water Quality for WWTP

2) Surplus Soils

3) Protected Areas and Heritage

4) Landscape

PART I BASIC STUDY

CHAPTER 1 INTRODUCTION

The present study was carried out in accordance with the Scope of Works on Preparatory Study for Lahore Water Supply, Sewerage, and Drainage Improvement Project agreed upon between the Water and Sanitation Agency, Lahore Development Authority ("LDA") and Japan International Cooperation Agency ("JICA") on the 25th day of December 2008 as shown below.
This Draft Final Reports covers TOR 1: Basic study and TOR 2: Review of vision and strategy on development and management of water supply, sewerage and drainage facilities, TOR 3: Preparation of the project plan, TOR 4: Preparation of the plan for implementation and operation and maintenance and TOR 5: Confirmation of environmental and social consideration.

1.1 Introduction

Water supply and sanitation in Pakistan, experiencing rapid population increase and influx to the urban sector is significantly underdeveloped in urban area and up to 2005, access to safe drinking water and to proper sanitation are as low as 66% and 44% of population respectively, Local Governments Town municipal Administration, which are charged with, provision of such public services, in general lacks in management capacities, adequate number and quality of personnel, sufficient tariff revenues, and sound financial bases. This has resulted in inadequate planning and implementation of new projects and improper operation and maintenance of existing facilities. For instance, non-revenue water in major cities is more than 35% and urban effluents are treated partially in Islamabad and Karachi only. Such lack of facilities and capacities have caused significant adverse impacts on people's lives, including shortage of drinking and domestic water, unfit quality of drinking water, deteriorated water quality in public water bodies, flooding in the cities, and worsening sanitary environment.
To tackle the above issues, Government of Pakistan under "Vision 2030" puts emphasis on efficient water use and integrated water resource management to address the increasing demand and to overcome water shortage and aims at 90% coverage in access to safe drinking water and 70% coverage in access to proper sanitation by 2015 as indicated by National Environmental Policy and other policy documents.
Lahore is the second largest city in Pakistan with a population of more than 7 million. Whereas 87% population has access to safe water supply, increase in water supply and efficiency improvements through water conservation and water loss reduction are required to meet the demands of rapidly increasing population. As for sewerage and drainage facilities, underdeveloped sewer network has caused aggravated sanitary environment for the people in Lahore. Lack of sewage treatment facilities has been caused by underdeveloped drainage facilities, lack of sufficient capacity and aging of the existing drainage facilities. To address such issues in water supply, sewerage and drainage in Lahore, Government of Pakistan

submitted to Government of Japan an official request for studies and loan assistance through Japan International Cooperation Agency (JICA). And JICA, prioritizing water supply and sanitation under this assistance strategy, recognizes the need for the Preparatory Study (“the Study”) to formulate the Lahore Water Supply, Sewerage, and Drainage Improvement Project (“the Project”), for which loan assistance may be considered subsequently.

The Project, to be formulated under the Study, envisage to provide safe drinking water and improve sanitary environment in Lahore by constructing and upgrading prioritized sewerage and drainage facilities, upgrading water supply facilities, and improving management, operation and maintenance, thereby improving the quality of life for the people in the concerned areas. Whereas according to the original proposal the project scope included (a) development of sewer networks in South Lahore, (b) construction of a sewage treatment plant in South Lahore, (c) upgrading of trunk drains, (d) installation of meters, and (e) construction of overhead reservoirs, at present the tentative project scope includes (a) Construction of Southwest Sewage Treatment Plant, (b) Rehabilitation and construction of sewerage and drainage network in central and southwest Lahore surrounded by railway line in the north, upper Bari Doab Canal in the East and south, and River Ravi in the west, (c) Distribution Network Improvement (DNI) in entire Lahore, and (d) Institutional strengthening in water supply, sewerage, and drainage for the entire Lahore. These are subject to review and prioritization by the Study and discussion with JICA.

1.2 Objectives of the Study

The Study aims to formulate "the Lahore Water Supply, Sewerage and Drainage Improvement Project" through basic study, review of vision and strategy on development and management of water supply, sewerage, and drainage facilities in Lahore and based on this study, preparation of the project plan and of plan for implementation, operation and maintenance, confirmation of environment, social considerations, thereby improving efficiency of water supply, improving sanitary environment and water quality in public water bodies, alleviating flooding and improving management capacity.

1.3 Study Area

The Study will cover Lahore City, but conditions of surrounding area should be taken into consideration, if necessary.

1.4 Scope of Work

TOR1: Basic study

1-1 Review of the existing studies and development plan
1-2 Water quality survey
1-3 Review of water sources and water supply facilities

1-4 Review of sewerage and drainage facilities
1-5 Socio-economic survey
1-6 Analysis of water-related problems and their effect on people living in and around Lahore
1-7 Analysis of status and problems in development and management of water supply, sewerage and drainage facilities
1-8 Analysis of status and problems in water quality management in public water bodies
1-9 Analysis of status and problems in groundwater management

TOR2: Review of vision and strategy on development and management of water supply, sewerage and drainage facilities

2-1 Demand projection
2-2 Preparation of vision and strategy of water supply, sewerage and drainage facilities
2-3 Recommendations for improving management of water supply, sewerage and drainage and preparation of an action plan for improvement
2-4 Recommendations for improving water quality management in public water bodies and preparation of an action plan for improvement
2-5 Recommendations for improving groundwater management and regulation and preparation of an action plan for improvement
2-6 Recommendations for recycle of industrial water and preparation of an action plan for improvement

TOR 3: Preparation of the project plan

3-1 Supplemental study including soil quality survey and measurement
3-2 Project scope
3-3 Basic designing of facilities
3-4 Cost estimation
3-5 Financing plan
3-6 Implementation schedule
3-7 Procurement methods including tendering methods and packaging
3-8 Project effect including establishment of items and targets for monitoring and effect indicators an

TOR 4: Preparation of the plan for implementation and operation and maintenance

4-1 Project implementation and institutions
4-2 Operation and maintenance institutions
4-3 Plan for institutional strengthening of related organizations
4-4 Financial plan for related organizations
4-5 Methods to accelerate household connections to sewerage system

TOR 5: Confirmation of environmental and social consideration

5-1 Confirmation of required procedure, including EIA, in accordance with domestic environmental laws and regulation

5-2 Implementation of EIA in accordance with domestic environmental laws and Environmental Guidelines of Japan Bank for International Cooperation (JBIC)

5-3 Confirmation of details of land acquisition and resettlement and required procedures, and preparation of countermeasures including a resettlement action plan

5-4 Preparation of plan for improving water supply and sewerage services to the socially disadvantaged people

The chapters covering the descriptions required in the above Terms of Reference (TOR) are summarized in **Table 1.1**.

Table 1.1 Summary of References to TOR

TOR	Reference
TOR1: Basic study	
1-1 Review of the existing studies and development plan	Chapter 7
1-2 Water quality survey	Chapter 3
1-3 Review of water sources and water supply facilities	Chapter 5.1-5.2
1-4 Review of sewerage and drainage facilities	Chapter 5.3-5.4
1-5 Socio-economic survey	Chapter 2.3
1-6 Analysis of water-related problems and their effect on people living in and around Lahore	Chapter 2.2.4 Appendix 5.3
1-7 Analysis of status and problems in development and management of water supply, sewerage and drainage facilities	Chapter 6
1-8 Analysis of status and problems in water quality management in public water bodies	Chapter 10.2
1-9 Analysis of status and problems in groundwater management	Chapter 10.3
TOR2: Review of vision and strategy on development and management of water supply, sewerage and drainage facilities	
2-1 Demand projection	Chapter 9
2-2 Preparation of vision and strategy of water supply, sewerage and drainage facilities	Chapter 11
2-3 Recommendations for improving management of water supply, sewerage and drainage and preparation of an action plan for improvement	Chapter 10.1
2-4 Recommendations for improving water quality management in public water bodies and preparation of an action plan for improvement	Chapter 10.2
2-5 Recommendations for improving groundwater management and regulation and preparation of an action plan for improvement	Chapter 10.3
2-6 Recommendations for recycle of industrial water and preparation of an action plan for improvement	Chapter 10.4
TOR 3: Preparation of the project plan	
3-1 Supplemental study including soil quality survey and measurement	Chapter 13.1
3-2 Project scope	Chapter 12

3-3 Basic designing of facilities	Chapter 13.2-13.6
3-4 Cost estimation	Chapter 14.3 & 14.4
3-5 Financing plan	Chapter 14.9
3-6 Implementation schedule	Chapter 14.8
3-7 Procurement methods including tendering methods and packaging	Chapter 14.6
3-8 Project effect including establishment of items and targets for monitoring and effect indicators an	Chapter 14.12
TOR 4: Preparation of the plan for implementation and operation and maintenance	
4-1 Project implementation and institutions	Chapter 14.10
4-2 Operation and maintenance institutions	Chapter 14.11
4-3 Plan for institutional strengthening of related organizations	Chapter 10.1.3 & 10.1.4
4-4 Financial plan for related organizations	Chapter 14.9 & 15
4-5 Methods to accelerate household connections to sewerage system	Chapter 14.7
TOR 5: Confirmation of environmental and social consideration	
5-1 Confirmation of required procedure, including EIA, in accordance with domestic environmental laws and regulation	Chapter 16.2
5-2 Implementation of EIA in accordance with domestic environmental laws and Environmental Guidelines of Japan Bank for International Cooperation (JBIC)	Chapter 16.10
5-3 Confirmation of details of land acquisition and resettlement and required procedures, and preparation of countermeasures including a resettlement action plan	Chapter 16.4
5-4 Preparation of plan for improving water supply and sewerage services to the socially disadvantaged people	Chapter 16.12

CHAPTER 2 DESCRIPTION OF THE STUDY AREA

2.1. Natural Conditions

2.1.1 Topography

Lahore is located on a flat alluvial plain on the left bank of River Ravi. Lohore district lies between 31° -15' and 31° -42' north latitude, 74° -01' and 74° -39' east longitude. It is bounded on the east by India (International border). Total area of the Lahore district is 1,772 km^2. The general altitude of the area is about 208 to 213 meters above sea level. The study area is generally flat and slopes towards south and south-west at an average gradient of 1:3000. Urbanization is progressing along the River Ravi. Infrastructure connected with adjoining district and India, such as Pakistan railway and main roads, are developed (Refer to **Figure 2.1**).

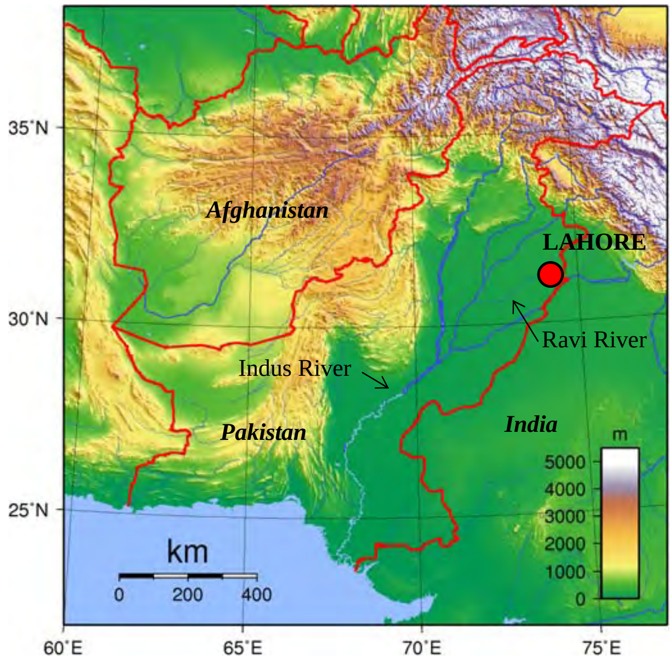


Figure 2.1 Location map of Lahore

2.1.2 Hydrogeology

Lahore area is underlain by unconsolidated alluvial deposits. The alluvial sands constitute the aquifer material. The aquifer is composed of unconsolidated alluvial of more than 400 meters thickness. Groundwater exists in 10 to 30 meters depth from ground level. Water source for drinking water is pumped up from Underground 120 to 200 meters.

Many canals and drains are flowing in the city. BRB Canal for irrigation is flowing into the eastern part, and Lahore Canal branched from BRB Canal is flowing through central part of the city. Hudiara Drain coming from India is flowing into the southern part.

The embankment (Bund) along the river Ravi is made in order to prevent a flood. However, since the dam was built in the upper stream (in India), the water level of the River Ravi has hardly gone up in recent years.

2.1.3 Climate

Weather condition in Lahore is shown in **Table 2.1** and **Figure 2.1**.

The summer season starts in April and continues till September. The hottest months are May, June and July. The maximum temperature rises to 40 degrees C. On the other hand, the lowest temperature in December, January and February is less than 10 degrees C

The average annual rainfall in Lahore is about 629 mm. Maximum rainfall occurs in July and August when the monsoon depression travels westward. In this season, heavy rain may amount to 200 mm/month.

Table 2.1 Temperature and Precipitation in Lahore

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Temperature (°C) Ave. High	18	20	25	33	37	39	34	33	33	31	25	19	Ave. 29
Ave. Low	9	11	16	22	26	29	28	28	26	25	14	9	Ave. 20
Precipitation Ave. mm/day	2	2	2	1	1	3	15	13	6	1	-	1	-
Ave. mm/month	23	29	41	20	22	37	202	164	61	12	4	14	629 mm

Source : http://pportal.punjab.gov.pk

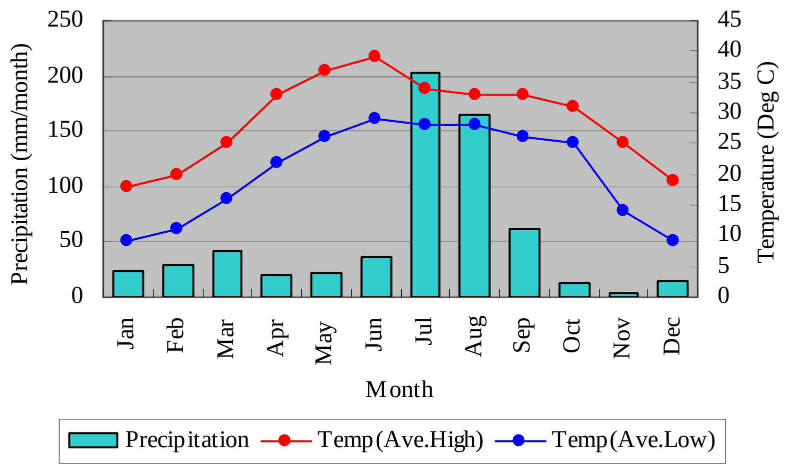


Figure 2.2 Temperature and Precipitation in Lahore

Regarding the wind, in winter the wind mainly blows from north-west while in summer it is from the opposite direction i.e. south-east which bring the monsoon rains.

However, the average 60 % of the days during a year are calm when wind movement is negligible.

2.2 Socio-economic Conditions

2.2.1 Population Growth

Although population is continuously increasing in Lahore, yet there is no data which expresses present condition of population correctly. Now, the formal data currently arranged is only a Census up to 1998. Census is due to be carried out in 2009.

According to 1998 population and housing census, total population of Lahore district is 6,319 thousands persons. Percentage break-up of the rural and urban population is 17.6 % and 82.4 % respectively. Tehsil-wise distribution of urban and rural population is given in **Table 2.2.** Although population is increasing after the Census in 1998, official population in at present is not released.
According to the official website of Punjab police (www.punjabpolice.gov.pk), it is said that population of Lahore city at 2009 is 8,870 thousands persons.

Table 2.2 Population of Lahore District

Name of Tehsil	Population (Thousand persons)		
	Urban	Rural	Total
Lahore Cantonment	566	-	566
Lahore City	4,643	1,110	5,753
Total	5,209	1,110	6,319

Source : District Census Reports, Lahore

Table 2.3 and **Figure 2.3** show the transition of Annual Compound Growth Rates (ACGRs) in Lahore district. The overall district growth rate has been declining, but at a slower pace.

Table 2.3 Population Increase in Lahore District

Census Year	Intercensal Period (Years)	Lahore District		Lahore District Urban	
		Population	ACGR	Population	ACGR
1951	-	1,134,757	-	861,279	-
1961	10.00	1,625,810	3.66	1,312,495	4.30
1972	11.67	2,587,621	4.06	2,189,530	4.48
1981	8.46	3,544,942	3.79	2,988,486	3.75
1998	17.00	6,318,745	3.46	5,209,088	3.32

Note: ACGR means “Annual Compound Growth Rate”

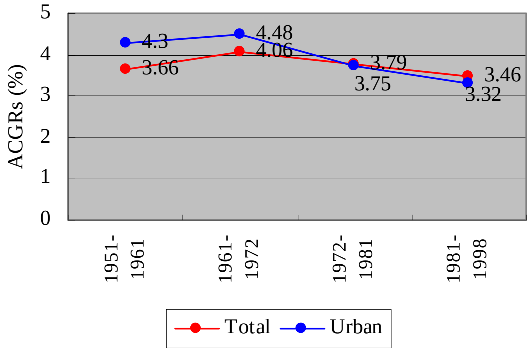


Figure 2.3 Transition of ACGRs in Lahore District

2.2.2 Population by Area

The urban area of District Lahore practically comprises the Ex-MCL (Metropolitan Corp. of Lahore) area and the Cantonment. More than 72% of whole population lives in Ex-MCL area.

Table 2.4 Population of Lahore District by Area

Area	Urban			Rural	Total
	Ex-MCL	Cantonment	Other Urban Areas		
Population	4,577,744	565,751	65,593	1,109,657	6,318,745
Percentage (%)	72.4	9.0	1.0	17.6	100

Source : District Census Reports, Lahore

2.2.3 Age and Sex Composition

Intercensal change in composition of population and area-wise sex distribution are shown in the **Table 2.5** and **Table 2.6**.

Working age's (15 to 65 years) rate is increasing and a male ratio is large more than 10%.

These facts show that single male migrants have influenced the increase of population in Lahore.

Table 2.5 Intercensal Change in Composition of Population by Broad Age Groups

Age Group (Years)	Population (Percent) in Lahore District		
	1991	1998	Variation
Below 5	14.8	12.6	-2.2
5-10	14.6	13.5	-1.1
10-15	13.4	13.2	-0.2
Sub-total below 5	42.8	39.3	-3.5
15-65	53.7	57.5	+3.8
65 above	3.5	3.2	-0.3
Total All Ages	100.0	100.0	0.0

Source : District Census Reports, Lahore, 1981 and 1988

Table 2.6 Area-wise Sex Distribution

Area		Both Sexes	Male	Female	Sex Ratio
Ex-MCL	No.	4,577,744	2,403,001	2,174,743	110.5
	%	100.0	52.5	47.5	
Lahore Cantonment	No.	565,751	304,219	261,532	116.3
	%	100.0	53.8	46.2	
Lahore Urban	No.	5,209,088	2,741,403	2,467,685	111.1
	%	100.0	52.6	47.4	
Lahore Rural	No.	1,109,657	587,099	522,558	112.4
	%	100.0	52.9	47.1	
Lahore District	No.	6,318,745	3,328,502	2,990,243	111.3
	%	100.0	52.7	47.3	

Source : District Census Reports, Lahore, 1988

2.2.4 Incidence of Water-related Diseases

Figure 2.4 shows transition of monthly cases of diarrhea. There are many cases from May to August obviously. This is assumed to have the influence of the inundation which occurs frequently in the city at monsoon season.

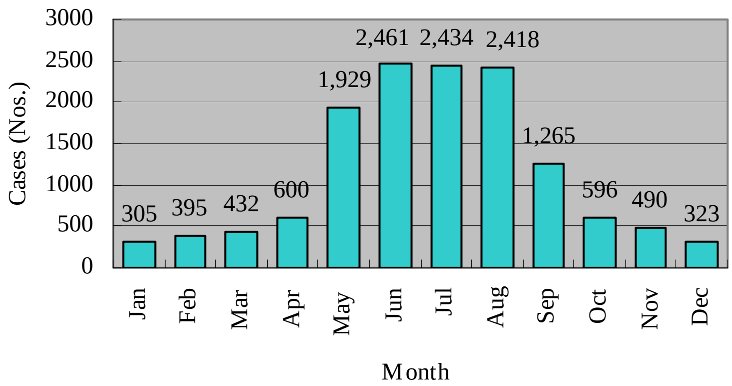


Figure 2.4 Cases of Acute watery Diarrhea in Lahore

Source: Health Department, Government of Punjab
Note: These are reported cases of public sector which covers only 18%.

2.2.5 Per Household Members

The per household members in Pakistan are 6.83 persons for the country and 6.65 persons in the urban area.

Table 2.7 Per Household Members (2005/06)

Average household size	Quintiles					
	Total	1st	2nd	3rd	4th	5th
Pakistan						
No. of sample households	15,453	2,627	2,853	2,971	3,083	3,919
Percentage of households	100.00	15.65	17.34	19.27	21.47	26.24
Average (Number)						
Members per household	6.83	8.74	7.89	7.10	6.35	5.19
Male	3.41	4.38	3.90	3.55	3.14	2.62
Female	3.42	4.35	3.99	3.55	3.20	2.56
Urban						
No. of sample households	6,240	582	820	995	1,336	2,507
Percentage of households	100.00	7.12	11.64	15.03	22.73	43.47
Average (Number)						
Members per household	6.65	9.12	8.79	7.69	6.84	5.20
Male	3.35	4.48	4.37	3.83	3.41	2.69
Female	3.29	4.64	4.41	3.86	3.43	2.51

Source: "Social Indicators of Pakistan 2007" (FBS-393-550), Federal Bureau of Statistics, Statistics Division, Government of Pakistan, pp.17-18

2.2.6 Per household Income and Expenditure

(1) Income

As shown in **Table 2.8**, the per house hold monthly incomes are Rs.12,326 for the country, Rs.14,968 for the urban area and Rs.10,929 in the rural area in 2005/06 with increase rates of 27.3%, 11.9% and 37.8%, respectively from the previous year. An increase of income in the rural area is distinctive and the gap between the urban and rural areas reduced 1.68 times to 1.37 times. But as the income is an average of the people with different income sources, the condition of a general employee depending on its income only from the company is unknown from these data.

Table 2.8 Per household Monthly Income

2004/05

Area	Average monthly income per household (Rs.)	Percentage (%)						
		Total	Wages & Salaries	Self Employment	Property other than owner occupied houses	Gifts & assistance	Sale of Assets	Other sources
All Area	9685	100	29.68	43.39	0.97	8.46	1.39	16.12
Rural	7929	100	23.04	50.57	0.45	9.95	1.43	14.56
Urban	13,371	100	37.94	34.43	1.62	6.61	1.34	18.06

2005/06

Area	Average monthly income per household (Rs.)	Percentage (%)							
		Total	Wages & Salaries	Self Employment	Property other than owner occupied houses	Owner occupied houses	Social Insurance Benefits	Sale of Assets	Other sources
All Area	12326	100	35.33	39.71	3.67	10.04	1.28	9.24	0.72
Rural	10929	100	25.57	51.53	3.29	5.89	0.9	11.76	1.08
Urban	14968	100	48.81	23.42	4.19	15.76	1.82	5.75	0.23

Source: "Social Indicators of Pakistan 2007" (FBS-393-550), Federal Bureau of Statistics, Statistics Division, Government of Pakistan, pp.25

Table 2.9 shows the quintile of income distribution. In Pakistan, the income in the urban area is distributed almost evenly in each quintile, while in rural area, the lower the quintile, the higher percentage (especially 43.48% are concentrated in the lowest quintile) that shows a considerable gap in income. The trend of Punjab Province is almost same as that in Pakistan for the rural area, but there is a slight uneven distribution in the urban area.

Table 2.9 Quintile of Income Distribution

Area	Quintiles (%)					
	Total	1st	2nd	3rd	4th	5th
Pakistan						
All Area	100.00	15.65	17.35	19.27	21.47	26.25
Rural	100.00	7.12	11.64	15.03	22.73	43.48
Urban	100.00	20.16	20.37	21.52	20.81	17.14
Punjab						
All Area	100.00	13.75	15.72	19.48	20.09	27.94
Rural	100.00	7.00	11.61	14.26	23.00	44.12
Urban	100.00	16.90	17.65	21.92	23.14	20.39

Source: "Social Indicators of Pakistan 2007" (FBS-393-550), Federal Bureau of Statistics, Statistics Division, Government of Pakistan, pp.26

(2) Expenditure

The per household monthly average expenditure is Rs.10,583.0, out of which 64.0% is spent on food, apparel and rent, 8.0% on fuel and lighting and 28.5% on miscellaneous as shown in **Table 2.10**.

The per capita water consumption in WASA is 378 gallon/day or 11,340 gallon/month on an average of January and February, 2009. For the customer with a water meter, the monthly water rate is Rs.146.1 (= 11,340 × 12.88 / 1,000) equivalent to 1.4% of expenditure. While for the customer without a water meter, using the water rate up to Rs.720 of Annual Rental Value: ARV that is applied to 95.6% of unmetered customers with flat rates of Rs.98.77 to 259.42, the monthly water rate is Rs.162 on average equivalent to 1.5% of expenditure. In comparison with 4.0% that the World Bank regards as affordable percentage of water to the total expenditure WASA's water rate is controlled significantly low.

While the sewage rate is set at 70% of the water rate and the percentage to the household expenditure is 1.0% (= 1.4% × 0.70) for the metered customer that is almost equivalent to 1.0 % that the World Bank regards as affordable percentage of sewage.

Table 2.10 Per Household Monthly Expenditure (2005/06)

Average monthly consumption expenditure per household (Rs.)	Percentage Distribution of Expenditure (%)					
	Food, beverages & tobacco	Apparel, textile & footwear	Rent	Fuel & lighting	Household Furniture & Equipment	Miscellaneous
10,583.0	43.1	5.7	15.2	8.0	-	28.5

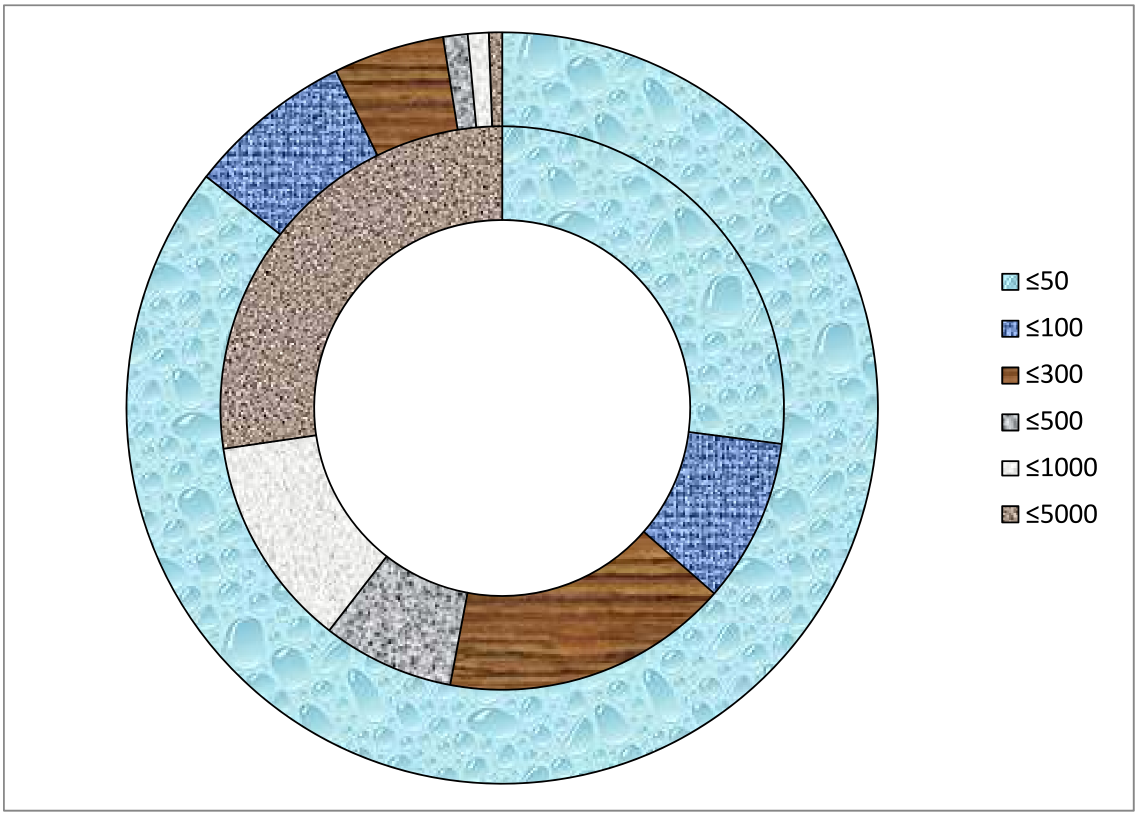
Source: "Social Indicators of Pakistan 2007" (FBS-393-550), Federal Bureau of Statistics, Statistics Division, Government of Pakistan, pp.37

2.2.7 Industry in Lahore

In Lahore, 2,692 industries in 118 types are registered, of which total employees counts 141,266 persons. Even though considering its family (per household members: 7.1 persons in the urban area in 1998 census), its percentage is not so high to the total population of Lahore City (2009 estimated population: 8.87 million persons). The population in the cantonment is 566 thousand persons for reference.

The industrial type that provides the largest employment opportunity is readymade garments with employees of 32,667 persons equivalent to 23.1% to the total. When textile spinning (5.1%), textile processing (2.8%), textile weaving (1.7%), textile madeups (0.8%), woollen textile spinning weavings (0.8%) is added to readymade garments, textile related industry shares almost one-thirds of the total. It can be said that employees are widely distributed in a various kinds of industries

Watching the establishments from the employee size, the establishments with employees of less than 50 persons share 84.7% of the total establishments in which 27.0% of total employees are working. For the establishments with employees of less than 300 persons, 96.5% of the total establishments and 52.9% of total employees. There are 15 establishments with employees of more than 1,000 persons in which 27.3% of total employees are working. The biggest establishment has employees of approximately 4,100 persons. No outstanding establishment is the characteristics of Lahore.



Source: Prepared based on CDGL data on "Directory of Industrial Establishments Punjab - District: Lahore"

Figure 2.5 Industries and Employees in Lahore

2.2.8 Power Supply Condition

(1) Power Supply Condition

Power generation in Pakistan is composed of hydro-power（80%）and thermal and nuclear power (20%). Design voltage for power supply is single phase, 230V for domestic use and three phase, 400V for industrial/tube-wells/dewatering pumps. Voltage fluctuation is relatively stable at 80 to 90%

(2) Power Failure

The power shortage becomes serious due to the water shortage and a demand increase since 2007 and especially in the dry season programmed power failure is implemented. In 2007, the power failure for load management was two hours a day, but the power supply conditions in 2008/09 are, depending on the service area, dry and rainy seasons and rainfall, are power supply of 3 to 12 hours, power failure of 3 to 15 times a day, and power failure duration time of about one hour per failure. The situation has deteriorated year by year and besides this instantaneous power failures occur frequently. The power supply condition in the rainy season is roughly half of the dry season. The information on weekly programmed power failure is available at the media and electric company.

For reference, the operational condition of a stand-by generator (natural gas, single phase, 220V) at Royal Residence Hotel in Gulburg-II is as follows:

Table 2.11 Operational Condition of A Stand-by Generator at Royal Residence Hotel

Electric Power failure		
At Royal Residence Hotel		
Date	Period of time	Total Hour
1-April, 2009	24PM-01AM	1
(Wednesday)	03AM-04:05AM	1.05
	09AM-10AM	1
Total	**3 times**	**3.05**
11-April, 2009	24PM-01AM	1
(Saturday)	03AM-04AM	1
	9AM-10AM	1
	13PM-14PM	1
	16PM-15PM	1
	21PM-20PM	1
	23PM-24PM	1
Total	**7 Times**	**7**
12-April, 2009	0AM-01Am	1
(Sunday)	03AM-04AM	1
	09AM-10AM	1
	11:04AM-12:12PM	1.09
	13PM-14PM	1
	16PM-17PM	1
Total	**Times**	**6.09**

(3) Standby Arrangement for Power Failure

The high income people, business industry, and commercial and industrial area are equipped with exclusive stand-by generators (natural Gas or diesel oil), while the general houses use candle lights or star lights in general.

(4) Thunderbolt

There are many thunderbolts at the change of seasons. According to the past experience, the burning accident of an arrester occurs once in three to five years.

2.3 Socio-Economic Survey

2.3.1 Survey Method

(1) Objectives

The questionnaire survey aims at collecting the socio-economic data/information of the study area including present conditions and objectives of water use, methods of obtaining daily life water, waste water discharge, required water volume, resident's consciousness on services of water supply and sewerage, and affordability of service charges.

(2) Sampling

Samples were selected with considering the population distribution of the survey area. Housewives were selected on preferential basis as much as possible for the interviewees since they were the main users of water in the households. Since the majority of the interviewees are housewives with the above-mentioned reason, the interviewers were female as much as possible considering the social habits and customs of Pakistan.

Universe	The universe of this survey consisted of all urban and rural areas of Lahore city.
Sampling Frame	The samples consist of ➢ 500 samples in the area covered by WASA's water supply ➢ 100 samples in the area NOT covered by WASA's water supply ➢ 50 samples for the poorest segment of the population Total sample size is 650.
Sample Element	One household is considered one sample element.

2.3.2 Respondents

The majority of respondents are house wives as it is mentioned above and the number of their family members is 5 to 10 (median: 6.51 in Slum Area, 5.13 in Non WASA Area, and 4.69 in WASA Area).

Table 2.12 Respondents' Gender

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Female	49	98.0	95	95.0	451	90.2
Male	1	2.0	5	5.0	49	9.8
Total	50	100.0	100	100.0	500	100.0

Table 2.13 Respondents' Profession

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Business	1	2.0	1	1.0	20	4.0
House Wife	42	84.0	80	80.0	348	69.6
Job	2	4.0	14	14.0	83	16.6
Student	4	8.0	4	4.0	46	9.2
Other	1	2.0	1	1.0	3	0.6
Total	50	100.0	100	100.0	500	100.0

Table 2.14 Respondents' Number of Family Members

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
< 5 Persons	10	20.0	39	39.0	220	44.0
5-10 Persons	37	74.0	61	61.0	265	53.0
11-15 Persons	3	6.0	0	0	13	2.6
15 <	0	0.0	0	0.0	2	0.4
Total	50	100.0	100	100.0	500	100.0

2.3.3 Contents of Questionnaire

The questionnaire used for the interview survey has the following contents in line with the objectives of the survey:

- Status of households/respondents to be interviewed
- Conditions of water supply and sewage (water usage, water and sewer connection, etc.)
- Sanitary condition (sanitation facilities, public toilets etc.)
- Residents' affordability for water and sewage service
- Information about hygiene and waterborne diseases
- Others

2.3.4 Results of the Survey

(1) Financial Status of the Households

The medians of monthly household income are Rs. 6,719 in Slum Area, Rps. 9,935 in Not WASA Area, and Rps. 17,724 in WASA Area respectively.

Table 2.15 Monthly Household Income

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
< Rs. 5000	11	22.0	5	5.0	23	4.6
Rs. 5000-10000	32	64.0	46	46.0	124	24.8
Rs. 11000-20000	6	12.0	26	26.0	134	26.8
Rs. 21000-30000	0	0.0	8	8.0	78	15.6
Rs. 30000 <	1	2.0	15	15.0	141	28.2
Total	50	100.0	100	100.0	500	100.0

According to JICA's *Research Paper "Kaihatsu Chosa Ni Okeru Keizaihyoka Shuho Kenkyu" (in Japanese)* issued in March 2002, benchmarks of households' maximum affordability for water supply and sewerage services are 4% and 1% of their disposable income respectively. As the sales tax rate is 16%, their disposable income is estimated at 84% of their gross income. Thus the medians of their affordability can be estimated as follows.

Table 2.16 Estimated Monthly Maximum Affordability of Water Supply and Sewerage Services (median, temporary)

	Slum Area	Area Not Covered by WASA	Covered by WASA
Water Supply	Rs. 226	Rs. 334	Rs. 596
Sewerage	Rs. 56	Rs. 83	Rs. 149

More precise estimation will be made in the later stage of the study.

(2) Water Supply

All the households do not necessarily get piped water in WASA Area while the same percentage (78%) of the households in Slum Area get piped water. On the other hand, only a half of the households get piped water in Non WASA Area. Such households in Non WASA Area get water from hand pumps, public water stand posts and so on and mainly husbands fetch water from there. In the three areas, the minority of households spend more than 20 minutes for fetching water.

Table 2.17 Water Source

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Piped Water	39	78.0	49	49.0	390	78.0
Hand Pump	0	0.00	6	6.0	18	3.6
Public Water Stand	0	0.00	18	18.0	0	0.0
Others	11	22.0	14	14.0	88	17.6
N/A	0	0.00	13	13.0	4	0.8
Total	50	100.0	100	100.0	500	100.0

Table 2.18 Family Member Who Fetches Water

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Children	3	6.0	2	2.0	0	0
Husband	3	6.0	18	18.0	2	0.4
Wife	1	2.0	0	0.0	8	1.6
Elderly	0	0.0	2	2.0	0	0.0
Any Other	0	0.0	1	1.0	9	1.8
N/A	43	86.0	77	77.0	481	96.2
Total	50	100.0	100	100.0	500	100.0

Table 2.19 Time Spent for Fetching Water

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
= or < 5 Minutes	0	0.0	13	13.0	25	5.0
6-10 Minutes	5	10.0	3	3.0	7	1.4
11-15 Minutes	1	2.0	0	0.0	4	0.8
16-20 Minutes	0	0.0	0	0.0	1	0.2
20 Minutes <	1	2.0	14	14.0	2	0.4
N/A	43	86.0	70	70.0	461	92.2
Total	50	100.0	100	100.0	500	100.0

Most of the respondents in all the three areas reported that they often get muddy water and sometimes suffer from water shortage. In terms of water quantity, the majority of the respondents in WASA Area and Non WASA Area reportedly get enough water (70.6% and 67.0% respectively) while those who get enough water in Slum Area is only 44.0%.

Table 2.20 Quantity of Water Supply

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Enough	22	44.0	67	67.0	353	70.6
Not Enough	28	56.0	33	33.0	147	29.4
Total	50	100.0	100	100.0	500	100.0

Concerning water quality, the majority of the respondents in WASA Area and Non WASA Area reportedly get fair or better water (around 80% and 60-70% respectively) while those who get enough water in Slum Area is around 25%.

Table 2.21 Water Quality - Color

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Very Bad	2	4.0	25	25.0	74	14.8
Bad	35	70.0	4	4.0	17	3.4
Fair	9	18.0	42	42.0	162	32.4
Good	4	8.0	23	23.0	191	38.2
Very Good	0	0.0	6	6.0	56	11.2
Total	50	100.0	100	100.0	500	100.0

Table 2.22 Water Quality - Odor

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Very Bad	3	6.0	34	34.0	73	14.6
Bad	36	72.0	4	4.0	16	3.2
Fair	7	14.0	36	36.0	177	35.4
Good	4	8.0	21	21.0	174	34.8
Very Good	0	0.0	5	5.0	60	12.0
Total	50	100.0	100	100.0	500	100.0

Table 2.23 Water Quality - Taste

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Very Bad	3	6.0	38	38.0	77	15.4
Bad	35	70.0	4	4.0	20	4.0
Fair	6	12.0	32	32.0	160	32.0
Good	6	12.0	22	22.0	180	36.0
Very Good	0	0.0	4	4.0	63	12.6
Total	50	100.0	100	100.0	500	100.0

If the water quality in WASA Area is closely examined on Town basis, people in Nishtar Town enjoy fair or better water in very high percentage (96.6% - 98.3%) while those in Saman Abad Town receive it in the least percentage (63.0% - 73.9%). These data show the areal difference of water quality even in WASA Area.

Table 2.24 Water Quality in WASA Area

Town Name	Color		Odor		Taste	
	Fair or Better	Bad and Very Bad	Fair or Better	Bad and Very Bad	Fair or Better	Bad and Very Bad
Allama Iqbal Town	78.9%	21.1%	80.3%	19.7%	80.3%	19.7%
Data Ganj Bukhsh Town	75.8%	24.2%	75.0%	25.0%	83.6%	16.4%
Nishtar Town	96.6%	3.4%	98.3%	1.7%	96.6%	3.4%
Ravi Town	86.9%	13.1%	87.4%	12.6%	82.7%	17.3%
Saman Abad Town	63.0%	37.0%	63.0%	37.0%	73.9%	26.1%

(3) Water Consumption

Larger percentage of water is used for clothes washing, bathing and house cleanliness in all the three areas, which amounts to 92.3% of the total water use in Slum Area, 80.92% in Non WASA Area and 71.88% in WASA Area. It is noticeable that water used for car washing is relatively large in WASA Area reflecting a larger number of car owners there.

Table 2.25 Amount of Water Necessary in a Day

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Avg Volume (litre)	percentage	Avg Volume (litre)	percentage	Avg Volume (litre)	percentage
Cooking	4.3	1.35	4.28	2.46	12.29	4.57
Drinking	15.78	4.97	14.82	8.51	20.23	7.52
Clothes Washing	114.48	36.06	37.12	21.31	64.04	23.80
Gardening	1.09	0.34	2.17	1.25	4.8	1.78
Car Washing	2.05	0.65	7.24	4.16	23.07	8.58
Bathing	110.04	34.67	73.62	42.25	87.25	32.43
House Cleanliness	68.48	21.57	30.24	17.36	42.11	15.65
Other Use	1.21	0.38	4.74	2.72	15.23	5.66
Total	317.43	100.00	174.23	100.00	269.02	100.00

(4) Sanitation and Sewerage

Almost all the households have toilet in their house while only 21 households (4.2%) in WASA Area have septic tanks.

Table 2.26 Toilet Availability

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Inside of House	50	100.0	100	100.0	493	98.6
Public Toilet	0	0.00	0	0.00	2	0.4
Others	0	0.00	0	0.00	3	0.6
Not Available	0	0.00	0	0.00	2	0.4
Total	50	100.0	100	100.0	500	100.0

More than 90% of the households in WASA Area can use facility for discharging wastewater while only small number can use in Slum Area and Non WASA Area (14.0% and 11.0% respectively).

Table 2.27 Facility for Discharging Wastewater

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Yes	7	14.0	11	11.0	471	94.2
No	28	56.0	81	81.0	26	5.2
N/A	15	30.0	8	8.0	3	0.6
Total	50	100.0	100	100.0	500	100.0

(5) Health Status

Households which have family member(s) who had suffered from a waterborne disease (e.g. cholera, dysentery, etc.) in last 12 months reach 74.0% in Slum Area, 54.0% in Not WASA and 37.2% in WASA Area. Their expenditure for such disease amounts to Rs. 750.00, Rs. 702.30, and Rs. 871.21 respectively (medians of valid responses).

Table 2.28 Family Members Who Suffered from Waterborne Disease in Last 12 Months

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Yes	37	74.0	54	54.0	186	37.2
No	13	26.0	46	46.0	314	62.8
Total	50	100.0	100	100.0	500	100.0

Table 2.29 Expenditure for Waterborne Disease in Last 12 Months

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
= or < Rs. 500	11	22.0	19	19.0	50	10
Rs. 501-1000	16	32.0	21	21.0	66	13.2
Rs. 1001-2000	9	18.0	9	9.0	34	6.8
Rs. 2001-3000	1	2.0	2	2.0	14	2.8
Rs. 3000 <	0	0.0	3	3.0	33	6.6
N/A	13	26.0	46	46.0	303	60.6
Total	50	100.0	100	100.0	500	100

(6) Resident Consciousness on Services of Water Supply and Sewerage

In general, respondents made complaint that they need to use electric motors to get enough water pressure. Since the majority of the respondents are unaware of the role and responsibilities of WASA, they claimed that they had no idea of the evaluation of WASA's services. After they got information about the water supply and sewerage services by WASA, more than two thirds of respondents expressed their satisfaction of the services in WASA Area. It can be suggested that WASA should promote the public relations about its services.

Table 2.30 Satisfaction of Water Supply by WASA

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Yes	1	2.0	0	0.0	334	66.8
No	1	2.0	0	0.0	166	33.2
N/A	48	96.0	100	100.0	0	0.00
Total	50	100.0	100	100.0	500	100.0

Table 2.31 Satisfaction of Public Sewerage

	Slum Area		Area Not Covered by WASA		Covered by WASA	
	Value	percentage	Value	percentage	Value	percentage
Yes	6	12.0	7	7	361	72.2
No	4	8.0	11	11	137	27.4
N/A	40	80.0	82	82	2	0.4
Total	50	100.0	100	100	500	100.0

CHAPTER 3 WATER QUALITY MONITORING

3.1 Regulation

3.1.1 Domestic and Industrial Wastewater

Currently in Pakistan, the National Environmental Quality Standard (NEQS) that limit the concentration of 32 parameters, are available as the authorized regulation for domestic and industrial wastewater (Statutory Notification: S.R.O. 549 (I)/2000) as shown in **Appendix 3.1**.

However, since the NEQS do not bear a direct relationship with the protection of public water bodies, the new regulation, "National Surface Water Classification Criteria & Irrigation Water Quality Guidelines for Pakistan", is proposed to the Ministry of Environment, as shown in **Appendix 3.2**. This regulation is prepared by WWF in February 2007 through consultations with stakeholders from government departments such as irrigation, agriculture, environment, industry and water management, as well as from NGOs/CBOs. But it is not yet authorized and is utilized as a guideline.

3.1.2 Drinking Water

In Pakistan, WHO standards have been applied as the regulation for the drinking water. But some quality parameters of the standards are not suitable considering the water quality condition of Pakistan. For instance, a number of tube-wells in Pakistan are regarded as "unfit" for drinking water in light of the WHO standards of Arsenic (0.010 mg/l) due to the high concentration of Arsenic observed in groundwater.

Under the circumstances, the new regulation "National Standards for Drinking Water Quality" is proposed as shown in **Appendix 3.3**. The regulation is prepared by EPA in collaboration with the Ministry of Health, WHO and UNICEF in June 2008. But it is not yet authorized and is utilized as a guideline.

3.2 Water Quality Monitoring

3.2.1 River and Drainage Channel

In Lahore City, water quality monitoring for river (Ravi River) and drainage channels is conducted once a year by EPA at 19 points as shown in **Figure 3.1**

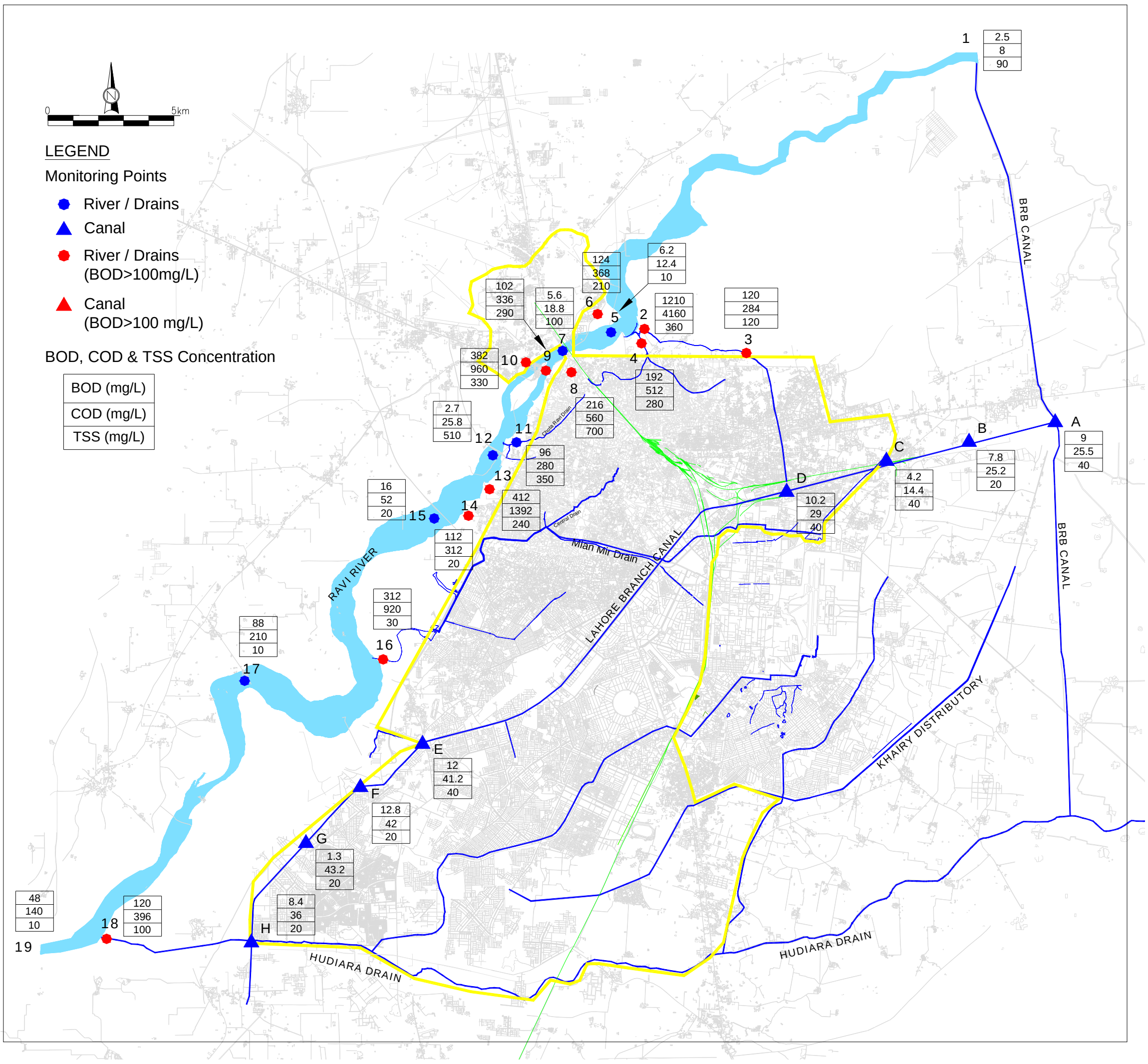


Figure 3.1 Monitoring Results of River, Drains and Canal (EPA)

According to the monitoring result of year 2008 presented in **Figure 3.1** (see details in **Appendix 3.4)**, significantly high contamination is observed in Mehmood Buti Drain (S. No.2), Furakhabad Drain (S. No.10), Main Out Fall Drain (S. No.13) and Babu Sabu Drain (S. No.16) with the BOD values of 1,210 mg/l, 382 mg/l, 412 mg/l and 312 mg/l, respectively.

As for the main stream of Ravi River, Shahdara Lahore, near railway bridge, (S. No.9) is the worst-affected point with the BOD value of 102 mg/l. The second worst is Chung Lahore after mixing with Babu Sabu Drain (S. No.17) followed by Maraka Lahore after mixing with Hudiara Drain (S. No.19) with the BOD values of 88 and 48 mg/l, respectively.

3.2.2 Canal

Water quality monitoring for canal (Lahore Branch Canal) is conducted by EPA at 8 points as shown in **Figure 3.1** with the frequency of once a year.

The results in **Figure 3.1** (see details in **Appendix 3.5**) show the monitoring result of year 2008. According to the result, the BOD and COD value ranges from 4.2 to 12.8 mg/l and 14.4 to 43.2 mg/l, respectively. As for longitudinal variation, in the most urbanized area (from Point C to Point H), high organic contamination is continuously observed.

3.2.3 Groundwater

Water monitoring for groundwater is conducted by 3 agencies, namely, WASA, PCRWR (Pakistan Council of Research in Water Resources) and EPA, as follows:

(1) WASA

WASA, currently monitors 438 tube-wells and tap water in his jurisdiction. The monitoring frequency is not fixed, but according to the available data, WASA is monitoring their wells at least once a year (more than 438 tube wells are therefore monitored in a year). From January 2008 to March 2009, for instance, WASA monitored 584 tube-wells as shown in **Appendix 3.6** (1) (495 wells from January to December in 2008, and 89 wells from January to March in 2009), and analyzed the parameters tabulated in **Appendix 3.6** (2). Of the 584 tube-wells, 15 tube-wells presented in **Appendix 3.6** (3) and **Figure 3.2** proved unfit for drinking water. Most of the unfit tube-wells are located in old Lahore or along drainage channels.

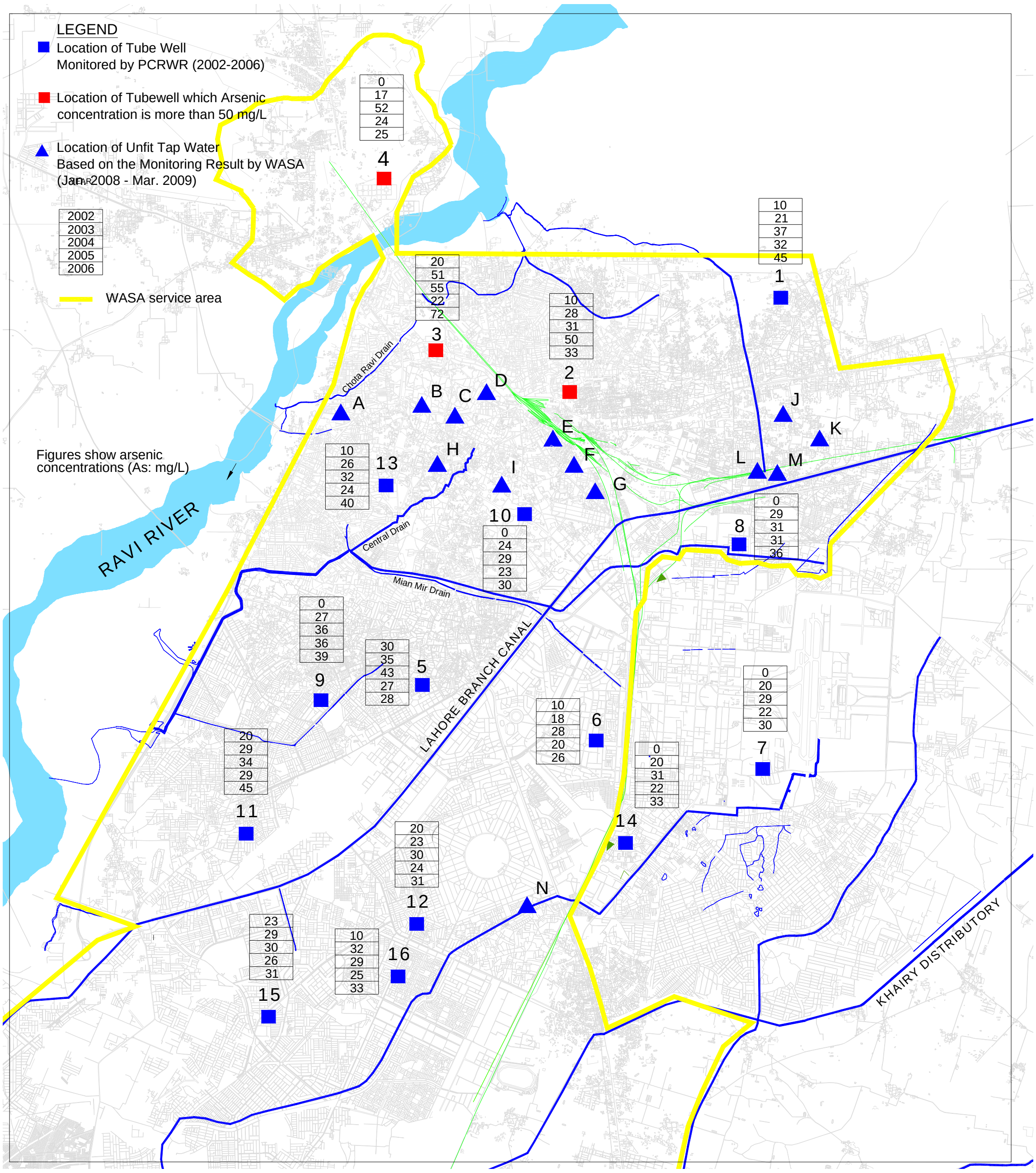


Figure 3.2 Arsenic Concentration of Tube-wells (PCRWR), and Location of Unfit Tube-wells (WASA)

(2) PCRWR

PCRWR is a laboratory under the Ministry of Science and Technology. Based on National Water Quality Monitoring Programme (NWQMP), PCRWR monitored drinking water of 23 major cities in Pakistan from 2002 to 2006. In Lahore, PCRWR selected 16 tube-wells as shown in **Figure 3.2** (see details in **Appendix 3.7**), and monitored 25 water quality parameters every year as well as a series of trace substances once in several years.

Appendix 3.7 show monitoring results of Electric Conductivity (EC), TDS, and Arsenic as well as the number of times total/fecal coliform are detected. According to the data, EC and TDS of the tube-wells located in southern part of Lahore, are higher than those in northern part of Lahore.

PCRWR find “unsafe” for drinking water with the presence of total and/or fecal coliform or the Arsenic concentration of more than 0.01 mg/l (10 ppb). The percentages of “unsafe” from 2002 to 2006 were 37.5% (2002) and 100% (2003 to 2006)..

(3) EPA

In 2008, EPA conducted water quality monitoring of 345 tube-wells in Lahore. The monitoring survey is conducted on irregular basis. According to the monitoring results, 204 tube-wells or 59 % of the total proved unfit as shown in **Appendix 3.8**.

In response to the above mentioned results of EPA, WASA pointed out the difference in the definition of “unfit” between EPA and WASA. That is, EPA finds “unfit” with the presence of total coliform, whereas WASA finds “unfit” with the presence of fecal coliform.

At the same time WASA selected 78 tube-wells out of the “unfit” 204 tube-wells and carried out additional water quality monitoring survey. According to the results, of the 78 tube-wells, only 4 tube-wells remain unfit in spite of the remediation measures such as flushing of water-supply pipe and increase of chlorine dosing, and the rest recovered from “unfit”.

3.2.4 Industrial Wastewater

In Lahore, approximately 2,700 factories are registered by City District Government. Of the total, 75 factories are categorized as large scale factories.

Monitoring of industrial wastewater is implemented by EPA. But due to the limitation of budget and human resources, the implementation of monitoring is irregularly based only on the complaints from inhabitants. **Appendix 3.9** shows the list of factories monitored by EPA in 2008, but the concrete data such as water quality and quantity is not well-organized and not available yet.

Inspection works for the factories are currently carried out by District Officer Environment of Lahore City, with only 8 inspectors which is not sufficient in number compared to the considerable number of factories in Lahore.

Meanwhile, based on NEQS (Self-Monitoring and Reporting by Industry), the EPA formulate a voluntary monitoring system using SMART (Self Monitoring and Reporting Tool) in 2001.

Under the monitoring system all the factories registered in the SMART system have to submit analysis report to EPA with authorization from the laboratory registered by EPA. By expanding this system, EPA is able to strengthen their industrial wastewater monitoring function effectively, and for the factories they are entitled to be eco-friendly factories.

Currently in Punjab Province, EPA registered 19 factories in the SMART system, out of which 5 factories are located in Lahore City. Compared to the total number of the factories, the registered factories in Lahore is relatively small in number.

3.3 Site Visit to Factories

The study team selected several factories in Lahore and conducted site visit to know the present condition of the industrial wastewater. Considering the way of treating and discharging wastewater, the following 3 factories are selected, namely, 1) Steel mill discharging wastewater without treatment, 2) Motorcycle factory discharging wastewater after dilution with groundwater, and 3) Textile factory treating wastewater by using activated sludge process.

(1) Steel Mill

Name of factory	: Jamal Steel Re-rolling Mills (See Photo 1 to 2)
Location	: Near solid waste damping site along the Band Road
Wastewater Treatment plant	: No treatment plant
Condition of wastewater	: The factory use water for cooling hot iron. Turbidity is not observed but sedimentation of iron powder was found in the cavity region.

Photo-1 Condition of Wastewater (Steel Mill)

Photo-2 Inside of Steel Mill

(2) Motorcycle Factory

Name of factory : Rustam & Sohreab Cycle Factory (See Photo 3 to 4)

Location : Shardara Town

Wastewater treatment plant : No treatment plant

Condition of wastewater : Electro plating process generates light-yellow colored wastewater contaminated by Nickel and Chromium material. The wastewater is discharged to sewer pipe of WASA after dilution with approximately ten times of groundwater.

Photo-3 Condition of Wastewater (Motorcycle Factory)

Photo-3 Plated Bath (Motorcycle Factory)

(3) Textile Factory

Name of factory	: Shahkam Industries (Pvt) limited (See Photo 5 to 6)
Location	: Along Hudiara Drain
Wastewater treatment plant	: Activated sludge process with the capacity of 80 m^3/hr (1,920 m^3/day)
Condition of wastewater	: Due to the dyeing process, purple colored wastewater is discharged to the treatment plant. Treated water is discharged to Hudiara Drain and is colored light brown. The factory monitors water quality on monthly basis with the contract to a private laboratory. According to the monitoring results, the wastewater is discharged with BOD value of less than 10 mg/l.

Photo-5 Condition of Wastewater (Textile Factory)

Photo-6 Condition of Reactor (Textile Factory)

3.4 Water Monitoring Survey conducted by the Study Team

This survey is carried out to clarify the water quality of river, drains, canal, tube-wells and tap water in the Study area.

3.4.1 Monitoring Points

The water samples are collected at the points itemized below and the locations are shown in (see locations and objectives in **Appendix 3.10**).

- River : six (6) points
- Drain : thirteen (13) points
- Canal : five (5) points
- Tube-well : ten (10) points
- Tap water : ten (10) points

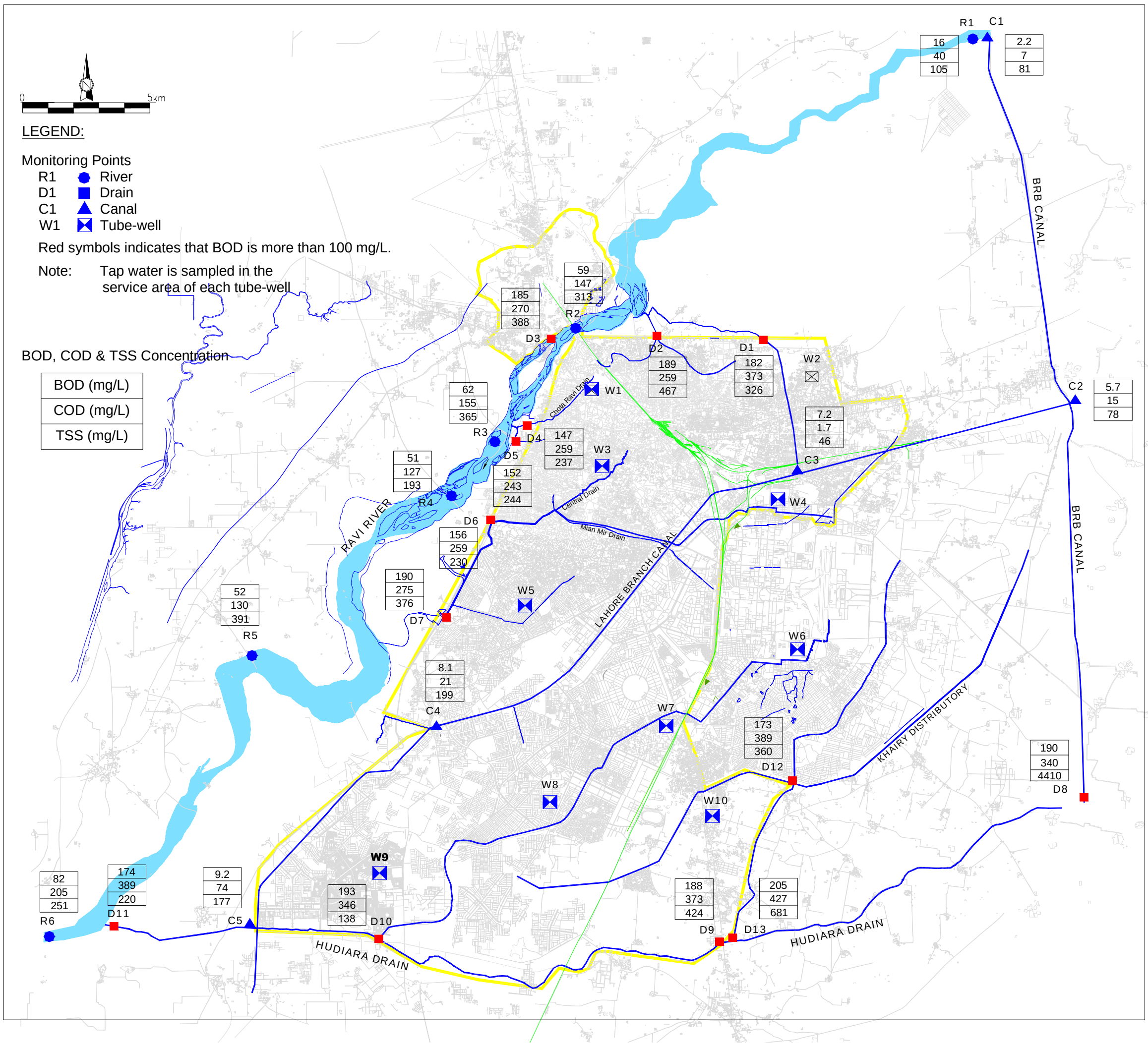


Figure 3.3 Monitoring Results of River, Drains, Canal, and Tube-wells (Study Team)

3.4.2 Water Quality Parameters

For the drinking water or possible water sources, the parameters in Category 1 are analyzed, and for the wastewater, the parameters in Category 2 are analyzed as shown in **Table 3.1**.

Table 3.1 Water Quality Parameters

Category		Parameters	Remarks
Category 1	Drinking water or possible water sources	Water Temperature, pH, DO, Total hardness, BOD, COD, TSS, NO_2, NO_3, NH_4, Fe, Mn, Mg, As, F, Ca, Cl, SO_4, Total Coliform, Fecal coliform	20 Parameters
Category 2	Wastewater	Water Temperature, pH, DO, Total hardness, BOD, COD, TSS, T-N, T-P, SO_4, As, Hg, Cr^{6+}, Total Coliform, Fecal coliform	15 Parameters

3.4.3 Monitoring Results

(1) River

Water samples are taken from the mainstream of Ravi River, which starts from the crossing point of BRB canal siphon (R1) and ends at the downstream of confluence with Hudiara drain (R6), as shown in **Figure 3.3** (see details in **Appendix 3.11**). At the crossing point of BRB canal siphon (R1), which might be a possible drinking water sources, the parameters for drinking water or possible water sources (parameters in Category 1) are analyzed. At R2 to R6, which is heavily contaminated with wastewater discharged from drainage channels, the parameters for wastewater (parameters in Category 2) are analyzed and **Figure 3.4** show the longitudinal variation of BOD, COD, TSS, T-N, and T-P. And **Appendix 3.11** enumerates the monitoring results of all parameters. According to **Figure 3.4**, from R2 to R6, which is receiving the wastewater discharged from drainage channels, BOD, COD and TSS is considerably high, especially with the BOD value of more than 50 mg/l. At R6 in particular, the BOD value reaches as much as 82 mg/l.

According to **Appendix 3.11,** DO concentration is considerably low ranging from 0.2 to 1.0 mg/l.

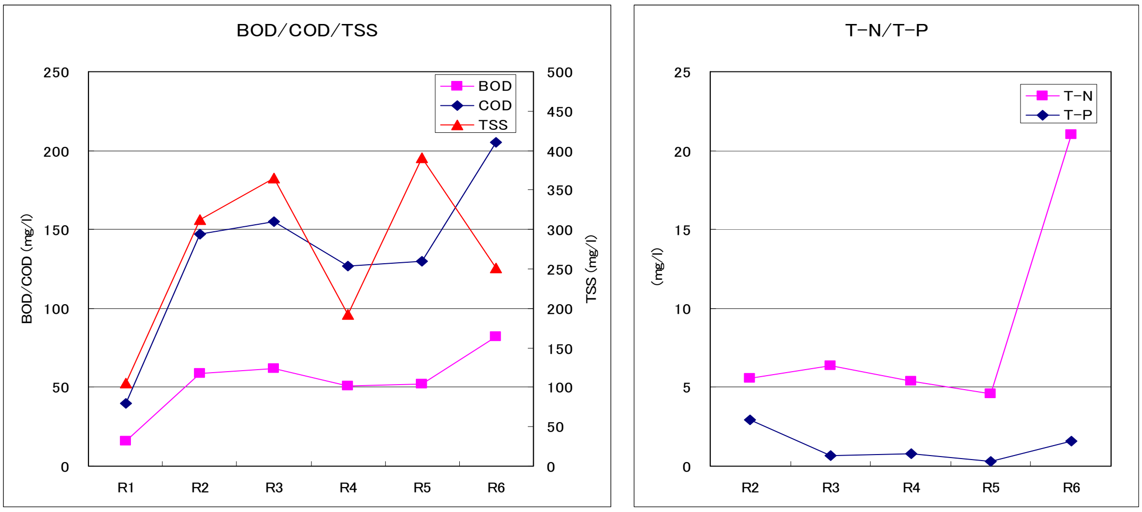


Figure 3.4 Monitoring Results of River by the Study Team

(2) Drains

For the drains, 13 monitoring points (see **Figure 3.3**) are selected with the objectives as shown in **Appendix 3.10** (2), and the water quality for wastewater (Category 2) are analyzed. **Figure 3.5** shows the results of BOD, COD, TSS, T-N, and T-P. And **Appendix 3.12** enumerates the monitoring results of all parameters.

According to **Figure 3.5**, BOD value ranges from 147 to 205 mg/l. At D1, and D8 to D13 which are located in the southern part of Lahore City, the COD values are higher than those of other points. The high COD concentration of D8 indicates that the water received from India is heavily contaminated. The big gap between COD and BOD of D8 to D13 imply the increase of persistent substance.

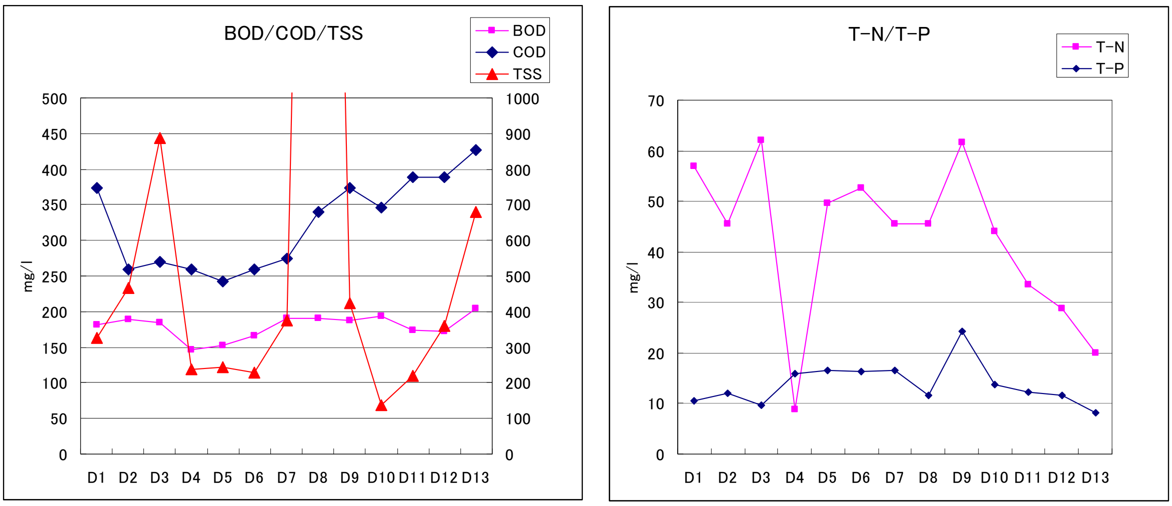


Figure 3.5 Monitoring Results of Drains by the Study Team

The range of T-N is relatively big, namely, 8.8 to 62 mg/l. The maximum value of 62 mg/l is observed at D3 followed by 61.6 mg/l at D9. The T-P ranges from 8.1 to 24.3 mg/l. The maximum value of 24.3 mg/l is observed at D9.

According to **Appendix 3.12,** DO concentration is considerably low, ranging from 0.12 to 0.25 mg/l

(3) Canal

Water sampling is conducted at 5 locations as shown in **Figure 3.3**. At the monitoring points of C1 to C3, which might be a possible water source, the parameters for drinking water or possible water sources (Category 1) are analyzed. At the monitoring points of C4 and C5, which is contaminated with wastewater discharged from drainage channels, the parameters for wastewater (Category 2) are analyzed.

shows the results of BOD, COD, TSS. And **Appendix 3.13** enumerates the monitoring results of all parameters.

According to the result, the BOD and COD value ranges from 3.2 to 9.2 mg/l and 7 to 24 mg/l, respectively. As for longitudinal variation, the concentration of BOD and COD in most urbanized area (from Point C2 to C5) is increasing gradually.

(4) Tube-well

For the tube-wells, 10 monitoring points (see **Figure 3.3**) are selected with the objectives summarized in **Appendix 3.10** (4)**.** And the water quality parameters in Category 1 are analyzed.

Figure 3.6 shows the results of Arsenic and Total/Fecal Coliform. And **Appendix 3.14** enumerates the monitoring results of all parameters.

According to the results, at W2 and W9, the concentration of Arsenic exceeds 50 ppb (0.05 mg/l). At W6 and W8, relatively high Fecal Coliform number, which might have resulted from contamination, is observed.

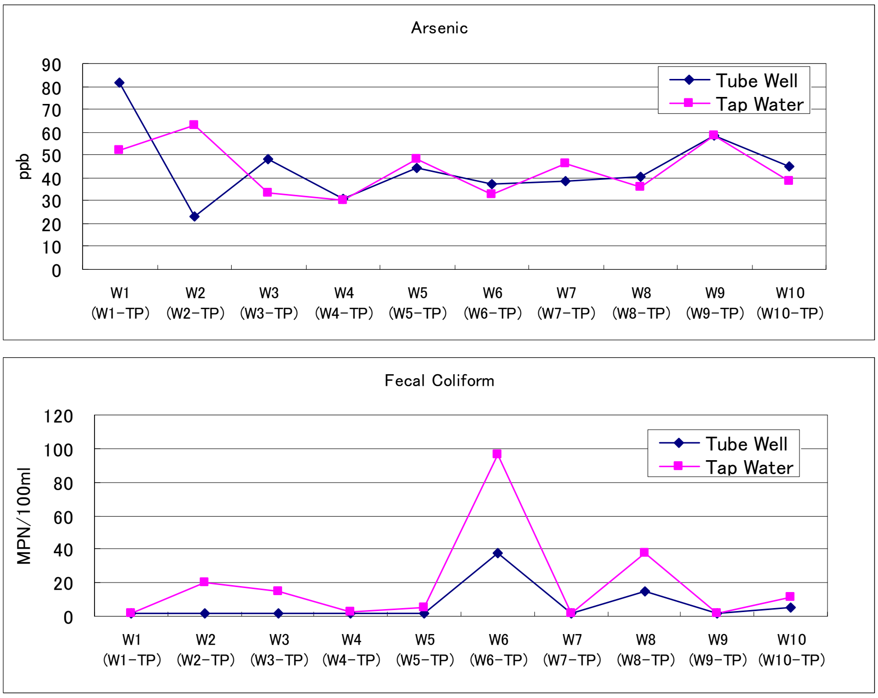


Figure 3.6 Monitoring Results of Tube-well and Tap Water by the Study Team

(5) Tap Water

All of the tap water is sampled in the service area of each tube-well monitored in the survey, and the parameters in Category 1 are evaluated as shown in **Figure 3.6**.

Figure 3.6 in the previous sub-section shows the results of Arsenic and Total/Fecal Coliform. And **Appendix 3.14** enumerates the monitoring results of all parameters.

In general, concentrations of Arsenic as well as total/fecal coliform are proportional to those of the tube-well from which the tap water is provided. At W1-TP, W2-TP and W9-TP, the concentration of Arsenic exceeds 50 ppb (0.05 mg/l). At W2-TP, W3-TP, W6-TP, W8-TP and W10-TP, relatively high fecal coliform number, which might have resulted from contamination, is observed.

3.5 Present Situation of the River Ravi in the Punjab Irrigation System

The present situation of the River Ravi is summarized as follows, based on the study results mentioned above and suggestions in other references presented in **Appendix 3.15**.

- The Punjab Irrigation System is accompanied by a network of drainage system, which were originally constructed to counter the problem of waterlogging and to collect the surplus water and flood water. But at present due to increased population and industrialization, the drains mainly carry the industrial and municipal effluents that are ultimately carried to the canals and rivers.

- Analytical data reveals that the parameters of pH, EC, SAR and RSC are within the limit of FAO standards at the four sampling sites. Amongst trace metals, only average concentration of Cu is exceeding the FAO limit of 0.2 mg/L at Balloki and Sidhani Headworks.
- The level of pollution varies from district to district and district Lahore is at the top of the list along with Sialkot, Kasur, Sheikhupura and Faisalabad. The effluent from Lahore, Kasur, Sheikhupura and Faisalabad concentrates at the Balloki Headworks, which amount to 5,054 cusecs or about 86% of total effluent in Punjab.
- The Environmental Protection Department considers that the river is under a constant threat of indiscriminate disposal of untreated Municipal Sewage from Lahore / Industrial sewage from Faisalabad through Maduana Drain and Industrial Effluent from industrial units of Kala Shah Kaku along G.T. Road, Sheikhupura Road, Township and Gulberg Industrial Estate located in Metropolitan of Lahore and untreated Industrial Waste Water of District Kasur.
- For the section of the River Ravi from the entry point into Pakistan originating from India to Ravi Siphon after Marala Ravi Link Canal joins, the river keeps a good quality such as 2.8 to 4.3 mg/L in BOD_5, 4.8 to 11.5 mg/L in COD, and 20 to 40 mg/L in SS. However it deteriorates rapidly receiving domestic and industrial wastewater from the urban area of Lahore City through drainage pumping stations and drains.
- The wide variety of fish that once swam in the Ravi has vanished, as have the tiny minnows and crabs children used to catch in the shallow waters along the banks. Even the reeds that used to line the river have gone. The river is virtually dead even when the normally dry bed carries water, such as after the rains.
- At present, the major downstream use of the River Ravi is for irrigation beyond the Balloki Headworks. However, the population and economic activities in the immediate areas along the river from Lahore to Balloki Headworks (64 km) are affected in different degrees by pollution in the river. It is estimated that waste water (domestic and industrial) from Lahore will increase significantly as a proportion of total flow in the river. In a one in twenty year minimum monthly flow, wastewater from Lahore accounted for about 47 percent of total flow in 1987, rising to about 68 percent in 2007.

- Historically, the River Ravi has not been used as a major source of potable water. Most communities in the area, including Lahore, are dependent on ground water as the major source of drinking water. In the rural areas of districts which border the river from Lahore to Balloki Headworks, only 0.3 percent of households are dependent on open surface watercourses (river, springs and streams) for their drinking water. This represents about 1,700 households and 10,600 people. There are no known plants to use the River Ravi as a major water supply source.

- During the dry season, this discharge may exceed the river's own base flow. As Ravi is also one of the sources of recharge to the ground water aquifer of Lahore, the disposal of untreated effluents including toxic metals etc. into the river may have negative impacts on the ground water quality of Lahore.

CHAPTER 4 SECTOR LEGISLATION, POLICY, REGULATIONS AND INSTITUTIONAL ARRANGEMENTS

4.1 Legislation

In Pakistan, there is no business law like the water supply act, sewerage act, etc. and the powers and responsibilities of such service providers are not clear.

The Lahore Development Authority Act (LDA Act) has the provision that the function of LDA includes water supply, sewerage and drainage.

The Lahore Development Authority (LDA) is the statutory body for the purpose to establish a comprehensive system of metropolitan planning and development in order to improve the quality of life in the metropolitan area of Lahore, establish an integrated metropolitan and regional development approach and a continuing process of planning and development, to ensure optimum utilization of resources, economical and effective utilization of land and to evolve policies and programmes relating to the improvement of the environment of housing, industrial development, traffic, transportation, health, education, water supply, sewerage, drainage, solid waste disposal and matters connected therewith and incidental thereto.

The LDA Act provides the WASA as follows (see **Appendix 4.1** for details):

(1) The WASA has the powers and functions to develop, operate and maintain water-supply sewerage and drainage systems within the service area.

(2) The WASA performs all functions and exercise all powers of the LDA with regard to water supply, sewerage and drainage with power to collect rates, fees and charges for water supply, sewerage and drainage.

(3) The Managing Director of the WASA is appointed by Government on a term of three years.

(4) The sums in respect of services related to water supply, sewerage and drainage is credited separately to the Head "WASA" and all other sums to the Head "Urban Development". The sums credited to the Head "WASA" shall be exclusively utilized for the purposes of water supply, sewerage and drainage.

(5) In case of deficit revenue of the WASA, the Government provides from its own revenues or from any other sources, such sum as may be necessary for the efficient

performance of the functions of the WASA under this Act.

(6) The WASA has the exclusive right to use ground water resources within the area.

4.2 Policy

4.2.1 Vision 2030

On 28 February, 2006, the NEC approved the Approach Paper titled “Strategic Directions to Achieve Vision 2030”, and authorized the Planning Commission to prepare a long term perspective document highlighting the strategic directions which need to be followed to achieve this national vision in the field of the institutions of State and Government, macroeconomic framework, a Agriculture, manufacturing and industry, knowledge, technology, and competition, energy, rural and urban development, and security

“Chapter 10 Agriculture Growth : Food Water and Land” states below.
While the agriculture sector will remain the predominant user of water, the requirements for industry, municipal and human use will continue to increase. Integrated water resource management, which aims at ensuring the most optimal use of water will be a major strategy for overcoming the looming water scarcity and enhancing efficiency for all water users, apart from re-cycling and re-use.
Strict prevention of discharge of industrial effluent in natural streams is another serious issue to be addressed through incentives and punitive measures, coupled with cleaning of polluted water streams.

“Chapter 10 Rural and Urban Development” describes below.
The urbanization has been going on rapidly and more and more of the economic power is concentrated in mega-cities. Cities are increasingly becoming engines of national growth, centres of economic activity, knowledge and influence.
The strategy for urban water supply would be based on meeting rapidly increasing demand for household and industrial water, increasing investments in new water delivery systems, upgrading and managing the existing systems more efficiently, ensuring provision of potable water to poor households, recycling of water, where feasible, and enhancing cost recovery. The sanitation improvement options would cover wastewater management and disposal of human wastes through cost efficient and affordable means, including improvement in the management of septic tanks. For solid waste, the strategy would be to develop integrated solid waste management systems, sanitary landfills, and to minimize waste through refuse recovery and electricity generation.

4.2.2 National Drinking Water Policy

The National Drinking Water Policy was approved by the Federal Cabinet in September 2009.

The objectives of the national drinking water policy are as follows;

- To reduce the incidence of death and illness caused by water-borne diseases by ensuring sustainable access to adequate and safe drinking water for all;
- To improve the quality of life of urban and rural populations by facilitating affordable and convenient access to water for hygiene, sanitation, and other essential domestic uses;
- To encourage water conservation by facilitating provincial regulatory authorities to assess the life cycle costs of water supply services and set appropriate tariffs for the discretionary uses of municipal water; and
- To facilitate identification of programmes for the protection of watersheds and groundwater, and partnerships for maintenance of stream flow, groundwater recharge and quality that reduce the investments required for water diversion and treatment.

The targets set out in MDGs for 2015 and MTDF for 2010, as shown below, apply to the country as a whole.

- To provide safe drinking water to 93% of the population by 2015 thereby raising the current coverage by almost 30% for the existing population and ensuring that the additional population is also provided access.
- The technical specification of schemes will be based on the provision of a minimum of 20 liters per capita per day for rural households and 40 liters per capita per day for urban areas.
- To provide at least one hand pump or spot source for every 250 persons.
- To establish district and tehsil level water filtration plants by 2007.
- To establish water treatment plants in all urban areas by the year 2015
- To ensure that water quality standards are approved and a system of surveillance, testing, monitoring and disseminating information regarding water quality is in place by 2007.

Drinking water is the constitutional responsibility of provincial governments. Local Government Ordinance 2001 has further devolved the provision of water supply to Town and

Tehsil Municipal Administrations (TMAs). Macro-functions for coordination and joint implementation across TMA jurisdictions have been devolved to City District Governments. However, decentralization is still in transition on ground. Strategic planning, budgeting and monitoring functions generally remain limited to district and higher levels, and there is considerable duplication in implementation.

4.2.3 National Sanitation Policy

The National Sanitation Policy in 2006 envisions creation of an open defecation free environment with safe disposal of liquid and solid waste and the promotion of health and hygiene practices in the country. The following scenarios concerned with water supply and sewerage are included therein to realize the hygiene environment:

- In urban areas or high-density rural settlements: flush latrines and/or pour flush latrines in homes (or privately shared) connected to an underground sewage system terminating in a sewage treatment facility.
- Minimum sewage treatment facilities will be of biological treatment and retention time will be calculated so that the effluent produced will be in keeping with the National Environmental Quality Standards (NEQS) notified under Pakistan Environmental Protection Act, 1997. The effluent from the low cost treatment plants in the rural areas will be used for agricultural purposes.
- Master Plans for treatment of municipal and industrial wastewater in urban and rural areas will be devised and implemented.
- Appropriate solid and liquid waste treatment facilities will be made integral part of all development projects.
- Disposal of storm water can be combined with sewage disposal provided the effluent can bypass the treatment plants during rains.
- The disposal of untreated industrial effluents and municipal sewage into natural water bodies will not be permitted.

4.2.4 National Environment Policy

The National Environment Policy (2005) shows the guidelines by sector, in which those for “Water Supply and Management” and “Pollution and Waste Management” are as follows:

(1) Water Supply and Management

To provide sustainable access to improved water supply and effectively manage and conserve the country's water resources, the government shall:

- Develop legal and policy framework for promotion of safe drinking water in Pakistan.
- Increase coverage of water supply and water treatment facilities.

- Establish a water quality monitoring and surveillance system.
- Make installation of water treatment plants as an integral component of all drinking water supply schemes.
- Promote low-cost water treatment technologies at the community and household levels.
- Promote appropriate technologies for rain water harvesting in rural as well as urban areas.
- Launch programs for artificial recharge of groundwater/aquifer.
- Promote metering of water consumption to discourage the indiscriminate use of water for industrial and municipal purposes.
- Enact "Water Conservation Act" and relevant standards to foster water conservation

(2) Pollution and Waste Management

Pollution caused by liquid and solid waste in the country shall be prevented and reduced. For this purpose, the government shall:

- Strictly enforce the National Environmental Quality Standards.
- Introduce self monitoring and reporting system nationwide.
- Introduce discharge licensing system for industry.
- Make installation of wastewater treatment plants an integral part of all sewerage schemes.
- Develop and implement the National Sanitation Policy.
- Implement the Master Plan for Treatment of Urban Waste Water.
- Develop and implement a strategy for establishment of combined treatment plants in industrial clusters.
- Establish cleaner production centers and promote cleaner production techniques and practices.
- Promote ISO 14000 certification.
- Encourage reduction, recycling and reuse of municipal and industrial solid and liquid wastes.
- Establish standards for receiving water bodies.
- Launch phased programs for clean up and gradual up-gradation of quality of water bodies.
- Develop and enforce regulations to reduce the risk of contamination from underground storage tanks.
- Finalize the National Oil Spill Contingency Plan.
- Implement projects for mitigation of pollution caused by oil spill from the Tsman Spirit.
- Establish a Marine Pollution Control Commission. Frame Pakistan Oil Pollution Act.

- Develop arid enforce rules and regulations for proper management of municipal solid waste and industrial, hazardous and hospital waste.
- Regulate production / import of hazardous substances and wastes.
- Develop and implement strategies for integrated management of municipal, industrial, hazardous and hospital waste at national, regional and local levels.
- Strengthen capacity of institutions involved in waste management.
- Encourage involvement of the private sector in waste management.
- Establish facilities for recovery of raw material and energy from waste. Create market for recovered and recycled materials.
- Promote research and development focusing on low-waste technologies and technologies for waste recovery and reuse.
- Develop environmental risk assessment guidelines for existing industries as well as new development interventions.
- Develop national emergency response and accidents preventions plans to prevent, and mitigate the effects of, accidents involving pollution of environment.

4.2.5 Punjab Urban Sector Water and Sanitation Policy

(1) Vision, Goals and Objectives

1) Vision:
Sustainable water and sanitation for all

2) Goals:
To provide optimum quantity and acceptable quality of water and sanitation services on a sustainable basis.

3) Objectives:
The objectives of the policy are to:

- Provide a legal, regulatory framework and efficient institutional arrangements for sustainable water supply, sanitation and wastewater treatment services
- Sustainable financing arrangements including Community Participation and Public Private Partnership

(2) Policy Measures:

1) Allocation of Property Rights:
Government of the Punjab shall prepare and notify regulatory framework for allocation of property rights for surface and groundwater to WSS utilities to further allocate user rights for the surface and groundwater resources to legitimate users.

2) Regulatory and Institutional Framework for Water Utilities:
Government of Punjab shall notify a legal and regulatory framework to transform Water and Sanitation Agencies / public sector water and Sanitation providers into

independent utilities with optimum levels of administrative, financial and operational autonomy

3) Strategic Urban Water Sector Planning and Management:
Water Utilities would be facilitated and guided towards long-term strategic interventions aimed at:

- Developing robust performance improvement and business plans for sustainable infrastructure and services.
- Structuring capital investment, provincial as well as local, to be geared towards strategic interventions focusing on human resource development, systemic improvements and sustainable infrastructure.
- Enabling Public-Private Partnership for financially, socially and environmentally sustainable infrastructure and service delivery.
- Ensuring effective community participation and promoting gradual community cost sharing models for sustainable infrastructure and service delivery.
- Adopting equitable and inclusive approaches for provision of infrastructure and services for the poor and other marginalized areas as well.
- Ensuring consumer metering of water consumption to discourage over use of water for industrial and municipal purposes.
- Treatment of water and municipal wastewater to comply with the drinking water quality standards and NEQS respectively.
- Using benchmarking of utility services as a tool towards continuous performance improvement.

4) Environmental, Health and Hygiene Education:
Government of Punjab, District Governments and Water utilities will develop and implement effective environmental conservation and health & hygiene education programs for consumers, educational institutions and other internal and external stakeholders.

(5) Statutory Instruments:
Appropriate legislation in the urban water and sanitation sector would be promulgated which includes.

- Punjab Urban Water Act for assignment and regulation of surface and ground water property rights in Cities.
- WASCO Act to establish corporate independent Water and Sanitation utilities in Cities
- Punjab Municipal Services Regulatory Authority Act for establishment of a regulator to regulate the provision of water and sanitation services by water utilities and Independent Service Providers with due consideration of property rights, quality of

services, customer satisfaction and environmental sustainability. The regulator will also regulate the inter agency agreements and disputes.

4.2.6 Provincial Government

The Provincial Government of Punjab has formulated the Middle Term Development Framework for the period of 2007-2010 and been going to implement annual development programme in accordance with its framework. The development policy for water supply and sanitation is "Improvement of living quality through the provision of water supply and sanitation services to all the people in Punjab". The following policies are indicated:

1) To promote the provision of water supply and sanitation services to the entire province, especially to brain water area and agricultural areas using rainwater aggressively.
2) To encourage the public involvement before, during and after the project implementation
3) To halve the people without an access to safe drinking water by 2015 and improve the sanitation condition of all the people by 2020
4) To strengthen the capability of relevant agency and improve the existing legislative system for improving the sanitation

4.3 Institutional Arrangement

4.3.1 Federal Government

(1) Ministry of Environment
MOE is responsible for national policy, plans and programs regarding environmental planning, pollution and ecology, including physical planning and human settlements, urban water supply, sewerage and drainage.

MOE administers the urban water supply, sewerage and drainage projects of the federal government from the viewpoints of water quality control of drinking water for water supply and wastewater from sewerage.

The legislations and policies concerned with environment including water supply and sewerage are as follows:

1) Pakistan Environment Protection Act (1997)
2) National Environmental Quality Standards for Municipal and Liquid Industrial Effluents (2000)

3) National Environment Policy (2005)
4) National Sanitation Policy (2006)
5) National Drinking Water Policy

Out of them, the National Environmental Quality Standards for Municipal and Liquid Industrial Effluents (2000) defines the effluent standards under three categories, or (1) into inland waters, (2) into sewage treatment, and (3) into sea. Other three policies are also concerned with water supply and sewerage sectors and formulated mainly by the MOE. Under the direction of the MOE, the Environmental Protection Agency is responsible for general supervision of enactment, enforcement and monitoring of environmental quality standards as the federal government level. The Environmental Protection Agency (PEPA) Punjab and Environmental Protection Department (EPD) Punjab are the organization responsible for environmental administration at the provincial government level and conducts environmental monitoring.

(2) Ministry of Water and Power (MOWP)

MOWP has functions of formulation of annual development programme in the water and power sectors to meet the future demand, financial planning for the provincial governments and Water and Power Development Authority (WAPDA) to achieve the targets, monitoring of the activities, overall supervision of electric facilities and performance of organizations, coordination among water and power sectors and monitoring of technical standards and specifications of materials and tools and plants used in water and power engineering and technologies.

MOWP is responsible for general monitoring activities such as development, management and supervision in the fields of irrigation, drainage, water logging, large-scale reservoirs for flood protection, floods and dams. The small-scale reservoirs for water supply and city water such as drinking water supply are out of its responsibility.

WAPDA and Indus River System Authority (IRSA) are under its direction.

(3) Infrastructure Project Development Facility (IPDF)

IPDF was designed and established by the Ministry of Finance in 2006 to apply Pub1ic-Private-Partnership (PPP) to the infrastructure development, which provides supporting service such as preparation of guidelines for procurement, etc. for PPP for the projects proposed by the provincial governments. The business fields mainly cover the traffic and transportation service, urban mass transit system, public services such as water supply and sewerage, solid waste disposal, low-cost housing, health and educational facilities, and small scale power supply.

Its functions are as follows:

1) Promotion of PPP projects programmed and proposed by the public institutions
2) Promotion of PPP projects proposed in line with value-for-money
3) Supervision of PPP projects at the time of preparation and implementation from the financial, environmental and social aspects
4) Support to the implementing agency or private partner to master the PPP project experience
5) Establishment of the taskforce and coordination of among stakeholders

The projects that IPDF has currently studied are the service contract concerning the water meter reading and water rate collection in Lahore and Faisalabad as well as the study on the applicability of the Build:-Operate-Transfer (BOT) system to a cold water supply system with the water source at Hub Drain in Karachi.

4.3.2 Provincial Government

The Provincial Government of Punjab is responsible for budgeting of all water supply and sewerage projects. In case of the loan project by the international assistance agency or the bilateral loan project, the federal government always becomes the borrower, who then finances it to the provincial government. The provincial government finally makes a budgetary arrangement for the district or WASA for project implementation.

For some projects, the budget may be arranged by WASA but the most projects are implemented with the budget of the provincial government. The revenue such as water rate, etc. collected by WASA is basically used for operation and maintenance of water supply、sewerage and drainage facilities.

4.3.3 Local Authority

(1) City District Government of Lahore (CDGL)

In the year 2001, under Punjab Local Government Ordinance 2001, the government introduced a devolution plan which aimed at decentralizing the powers to the elected representatives of public at union council and town level. MCL (Municipal Corporation Lahore) which was functioning till then was abolished and the city was divided into six towns (later in nine towns) for good governance.
The CDGL is the autonomous body composed of nine Towns with 150 Union Councils under the Local Government Ordinance 2001 and administers the agriculture, community development, education, finance and planning, health, information technology, law, literacy,

revenue and transport, as well as solid waste management.

4.4 Organizations Concerned with Water Supply, Sewerage and Drainage within the CDGL Area

(1) HUD&PHED

In the Provincial Government of Punjab, the Housing, Urban Development and Public Health Engineering Department (HUD&PHED) is responsible for:

1) Provision of housing facilities to the population of Punjab
2) Upgradation of development of big cities, and
3) Supply of portable water and provision of sanitation

For supply of potable water and provision of sanitation, in the bigger cities, Municipal Corporation and City Development Authority/Water and Sanitation Agency (WASA) were mainly responsible water supply, sewerage and drainage e.g. Lahore. The Lahore Development Authority (LDA) is the statutory body under the HUD&PHED and the WASA is the wing of the LDA for water supply, sewerage and drainage as shown in **Figure 4.1**.

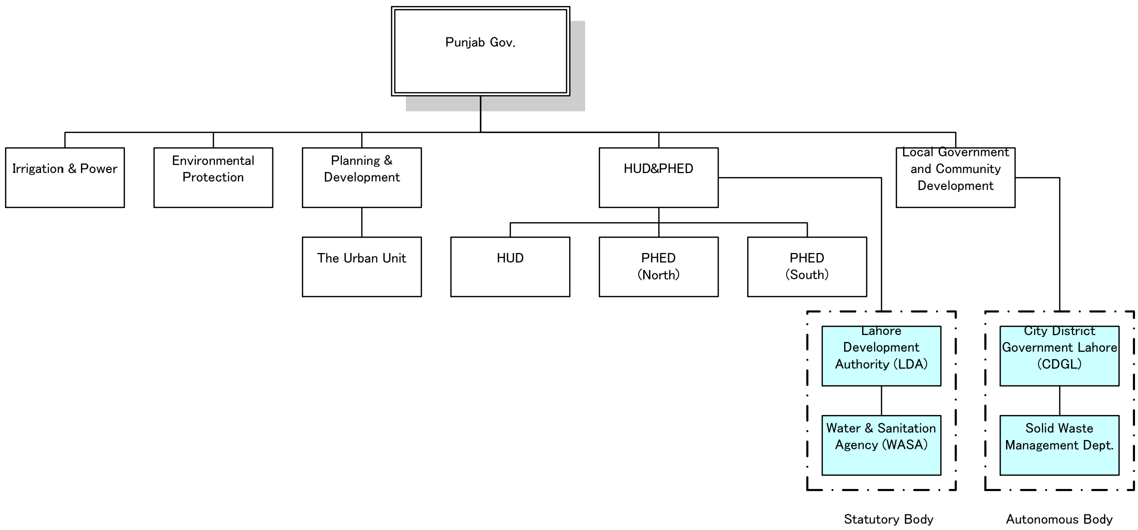


Figure 4.1 Organizations Concerned with Water Supply, Sewerage and Drainage in Lahore

Small community-based rural water supply and sanitation schemes are planned and constructed by the PHED under institutionalization of community participation. Responsibilities of Communities and the Provincial Government under institutionalization of community participation are as follows:

Provincial Government's responsibility:

1) Facilitate the community participation process, and provide essential training and health and hygiene education
2) Oversee activities of community and women's organizations
3) Site selection for water supply and/or wastewater treatment in coordination with the community
4) Construction of the scheme
5) Operator's training and transfer of schemes to the communities.

Communities' responsibility:

1) Formation of community and women's organizations
2) Bank account, collection of fee, and health and hygiene education
3) Maintaining records of meetings and health and hygiene practice
4) procurement of land free of charge
5) Provide in-kind labour and material contributions (including operators)
6) Own the scheme and carry out O&M and collect fees regularly

Source: M.A. Memon, Pakistan/Japan, "Institutionalization of community participation in rural water supply, Pakistan", 30th WEDC International Conference, Vientiane, Lao PDR, 2004

(2) P&D

The Planning and Development Department (P&D), the Provincial Government of Punjab is responsible for implementation for matters relating to development and administration in respect of foreign assisted/funded project in the province, coordination of external capital assistance including foreign training, approval, monitoring and implementation of development projects, etc. Even rural water supply project gets the administrative approval from P&D.

The Urban Unit placed in the Planning and Development Department is responsible for the infrastructure development including water supply and sewerage and city planning and implementation for five major cities (Lahore, Faisalabad, Rawalpindi, Multan and Gjuranwala) and four middle cities (Sialkot, Sargodha, DG Khan and Pahawalpur).

(3) Water Supply, Sewerage and Drainage Service in the CDGL jurisdiction

By the legislative enactment around 1974, the Provincial Government has been responsible for water supply, sewerage and drainage services and thereafter the WASA forming one wing of the LDA has been undertaking such services in Lahore. The supervisory department of the LDA is the HUD&PHED, while the City District Government of Lahore (CDGL) established in 2001 is under control of the Local Government and Community Development Department, although the

Zila Nazim (city mayor) is selected through election. Therefore, there is no dependent relationship between the LDA and CDGL, except that the Zila Nazim is the Chairman of the Lahore Development Authority also.

The Director General of LDA and the Managing Director of WASA are appointed by the Secretary of the HUD&PHED and there is somewhat personnel exchange among the HUD&PHED, LDA and WASA, but never between the WASA and CDGL.

The capital for infrastructure development of WASA has been almost provided by the Provincial Government and the fund from CDGL has been, if any, very limited up to now. In addition, the deficit of the tariff revenue below the operation and maintenance expenses has been also compensated by the subsidy from the Provincial Government.

By the amendment of the Local Government Ordinance in 2001, that the municipal services include water supply, sewerage and drainage was clarified but that WASA being under direct control of CDGL has never happened.

The LDA consists of the Zila Nazim of CDGL, DG of LDA, Town Nazims of all the Towns of Lahore City District, District Coordination Officer of Lahore City District, Representatives of the Provincial Government from the Planning and Development Board (P&D Board), the Finance Department, the Housing Urban Development and Public Health Engineering Department (HUD&PHED), the Local Government and Community Development Department (LG&CDD), the Heads of the Agencies established by the LDA (MD WASA and MD TEPA) and is chaired by the Zila Nazim of CDGL. The coordination among HUD&PHED, LDA, WASA, CDGL and Towns are actually done by those members.

It should be noted that the CDGL are empowered for tariff revision.

Their functional difference is shown in **Figure 4.2**. The LDA is mainly responsible for construction, operation and maintenance of social infrastructures in the metropolitan area of Lahore. The solid waste disposal is currently undertaken by the CDGL.

Under the LDA, the WASA provides services of water supply, sewerage and drainage in the core urban area of the CDGL jurisdiction formed by the whole or part of the nine towns (Shalimar Town and Gulberg Towns are wholly involved in the WASA jurisdiction).

Departments of CDGL

- Agriculture
- Community Development (CD)
- Education
- Enterprise & Investment
- Finance & Planning
- Health
- Information Technology
- Literacy
- Revenue
- Transport
- Law
- Public Funds CCBS
- Gender Support Unit (GSU)

LDA

- Housing
- Industrial development
- Traffic
- Transportation
- Health
- Education
- Water supply
- Sewerage
- Drainage
- Solid waste disposal
- Matters connected therewith

Source: LDA Act

Figure 4.2 Areas to be covered by the CDGL and LDA

The water supply, sewerage and drainage facilities services in the Study Area are being provided, operated and maintained by some agencies such as Lahore and Walton Cantonment Boards, Pakistan Railways, Defense Housing Authority (DHA) and Town Municipal Administration (TMA) other than WASA. The jurisdiction area of each agency is shown in **Figure 4.3** with their basic data are in **Table 4.1**.

Table 4.2 shows the organizations responsible for construction and O&M of water supply, sewerage and drainage within the CDGL jurisdiction. The sewage rate outside the WASA jurisdiction is presented in **Appendix 4.2**.

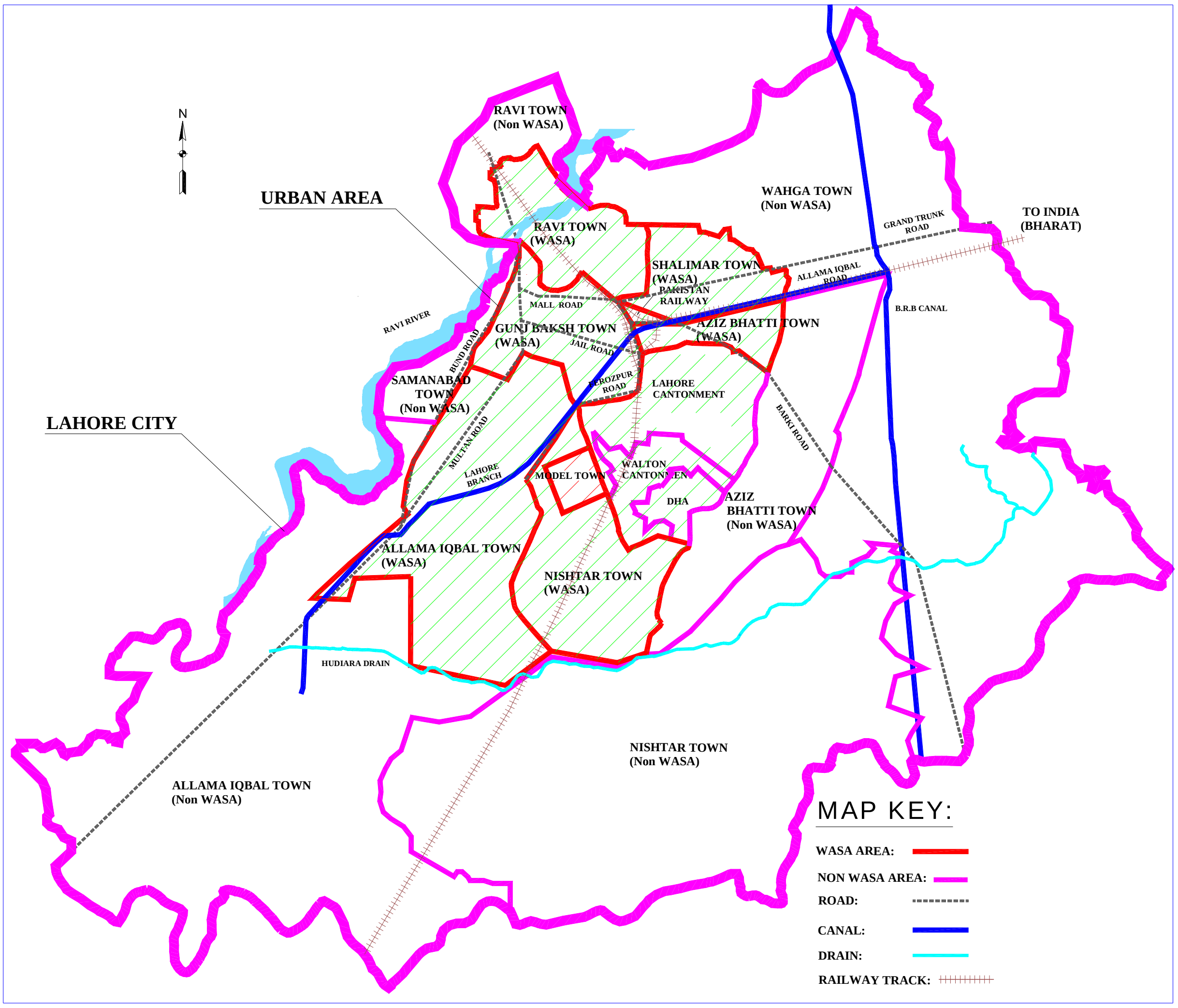


Figure 4.3 Jurisdiction of Each Agency/Town in the Study Area

Table 4.1 Basic Date for Each Jurisdiction

No.	**Name of Area**	**Area (km^2)**	**Population (million)*1**	**Remark**
1	WASA	350	5.67	
2	Cantonment	95	0.76	
3	Iqbal Town	400	0.25	
4	Nishtar Town	380	0.24	
5	Aziz Bhatti Town	75	0.05	
6	Wahga Town	430	0.27	
7	Ravi Town	10	0.01	
8	Data Gunji Bakhsh Town	5	0.01	
9	Samanabad Town	20	0.01	
	Total	**1,770**	**7.27**	

Source: Inventory Study, JICA Study Team 2009

Note: *1: Projected population is based on Census 1998. Population of each town is estimated except the common land with WASA Service Area.

Table 4.2 Organizations Responsible for Water Supply, Sewerage and Drainage within the CDGL Jurisdiction

	WASA Area	Non-WASA Area						
		Lahore Cantonment Board	Walton Cantonment Board	Defense Housing Authority	Model Town Society	Pakistan Railways	Private Developers	TMAs
Area (km^2)	1,772	58.7	19.6	15.2				
Population (2009)		275,000	288,000	192,000	55,000	40,853		
Construction of Facilities	WASA	Lahore Cantt. B.	Walton Cantt. B.	DHA	Model T. Soc.	Pakistan Railways	Private Developers	PHED
O&M of Facilities	WASA	Lahore Cantt. B.	Walton Cantt. B.	DHA	Model T. Soc.	Pakistan Railways	Private Developers	User Committee
Collection of water rate	WASA	Lahore Cantt. B. (Based on house size)	Walton Cantt. B. (Based on house size)	DHA (Based on house size)	Model T. Soc. (Based on house size)	Pakistan Railways (flat rate)		User Committee (flat Rate)
Collection of sewage rate	WASA	Lahore Cantt. B. (Based on ARV)	Walton Cantt. B. (Based on ARV)	DHA (Based on ARV)	Model T. Soc. (flat rate)	Pakistan Railways (no charge)		User Committee (no charge)
Water quality monitoring	WASA	None	None	None	None	Univ. of E&T	None	None
Permission of tube-well installation	WASA	PHED	PHED	PHED	PHED	PHED	PHED	PHED
Remarks	Most of Gulberg T. Entire Shalimar T. Part of Iqubal T., Nishtar T., Aziz Bhatti T., Wahga T., Ravi T., D.G. Baksh T., & Samanabad T.				Included in Gulberg T.	Included in Gulberg T.		Most of Iqubal T., Nishtar T., Aziz Bhatti T., Wahga T. Part of Ravi T., D.G. Baksh T., & Samanabad T.

Catt. B.: Cantonment Board DHA: Defense Housing Authority T. Soc.: Town Society Univ. of E&T: University of Engineering & Technology ARV: Annual Rental Value

CHAPTER 5 CURRENT CONDITIONS OF WATER SOURCE, WATER SUPPLY, SEWERAGE AND DRAINIGE

5.1 Water Source (Groundwater)

5.1.1 Legislation

The Canal and Drainage Act enacted in 1873 in the British Colonial times first used the word of “tube-wells” concerned with groundwater in Pakistan in the law. Even though the meaning of "canal" includes tube-wells, the law says very little about the use or control of groundwater.

3. Interpretation clause, The Canal & Drainage Act, 1873

> *"Canal" includes, all canals, channels, tube-wells and reservoirs constructed, maintained, or controlled by the Provincial Government for the supply or storage of water.*

Although the objective of the Punjab Soil Reclamation Act enacted in 1952 was also to accelerate reclamation and improvement of waterlogged and saline lands, the Act gives control of all groundwater uses except in house connection and livestock to the Punjab Soil Reclamation Board. It provides the basis for licensing the installation of tube-wells and authorizes the Board to close down tube-wells, either temporarily or permanently, if they negatively affect the existing use of water. Under the Act, the Board issued elaborate rules for licensing the tube-well, inspection of licenses and penalties for using tube-wells without a license.

The institutional structure of the Salinity Control and Reclamation Projects (SCARPs) and staffing was done exercising the powers under this Act. The Board went through several organizational structures, and in 1973, with the transfer of SCARPs to provinces, the Irrigation and Power Department was appointed as its administrator for executing O&M of the project, while, planning and development functions were transferred to the Punjab Planning and Development Board.

While groundwater use other than irrigational use came under the management of the Public Health Engineering Department (PHED) or presently Housing, Urban Development and Public Health Engineering Department (HUD&PHED), the permission authority of tube-well installation was given to the Development Authorities of Lahore, Faisalabad, Rawalpindi, Gujuranwala and Multan established by the statutory laws.

For the installation of tube-wells, Lahore Development Authority Act 1975 defines as follows:

Clause 29, LDA Act

(1) The Authority shall have the exclusive right to use ground water resources within the

area.

(2) No person shall, without the permission of the Authority, install a tube-well at such places within the Area as may be notified from time to time in the official Gazette by the Authority.

5.1.2 Relevant Agencies

Authority of permission for tube-well installation in the Lahore Metropolitan Area is vested in WASA. The application for the tube-well installation is first checked by the Director for Hydrology who passes it to Managing Director with recommendation for final decision. WASA, therefore, actually manages the private tube-well installation within its jurisdiction, but there are many unofficial tube-well installations by industries, establishments and personnel without any permission. WASA's DMD for finance has a policy to collect the sewerage and drainage charge from 4,047 private tube-wells as of April 1, 2009 once they are found. The Director for Hydrology gives its cooperation in the assessment of tube-well pumpage

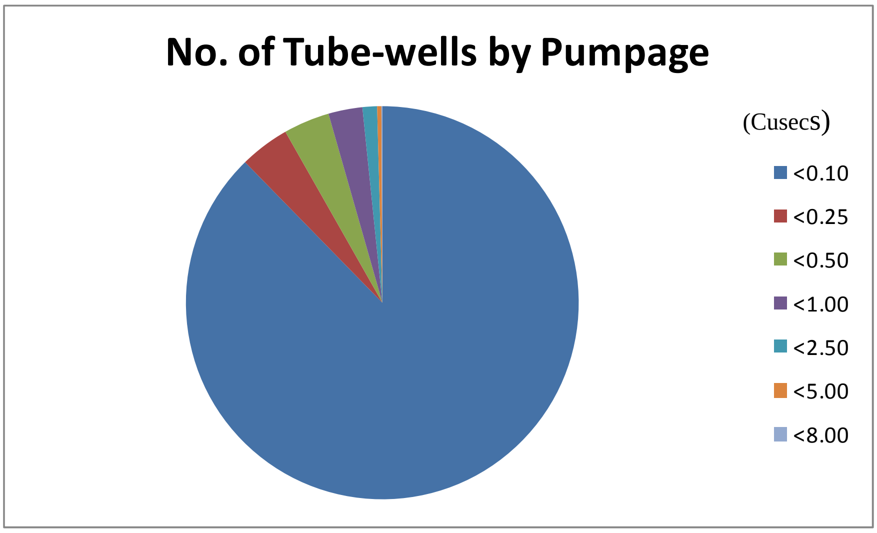
The charge for private tube-wells was called as "Sewerage and Aquifer Charges for Private Tube-wells" in the water tariff effective on January 1, 1998, but revised as "Sewerage/Drainage for Private Tube-wells" in the water tariff effective on April 4, 2004 due to the decision of the Supreme Court that the charge for water intake from the aquifer is not valid but the sewerage charges only is law full, based on the reason that groundwater taken from the aquifer is finally discharged into sewerage/drainage system of WASA.

5.1.3 Situation of Groundwater Control and Regulation

At present, the permission of the tube-well installation is dealt by relevant agencies such as WASA, HUD&PHED and the Irrigation and Power Department but they are approved as long as there is no effect on exiting tube-wells. There is no end to illegal tube-well installations in WASA's jurisdiction.

Within its jurisdiction, WASA is using 417 tube-wells and collects the sewerage/drainage charge from 4,045 private tube-wells as of February 2009. The groundwater abstraction from the latter is estimated at 450,000 m3/day based on the nominal or assessed pumpage and an operation time of eight hours (see

Figure 5.1). The 69 new tube-wells are expected to enter into operation this year. Although they are installed to replace the old ones of which the pumping capacity has halved, it will bring undoubtedly to augment the total pumping capacity of WASA.



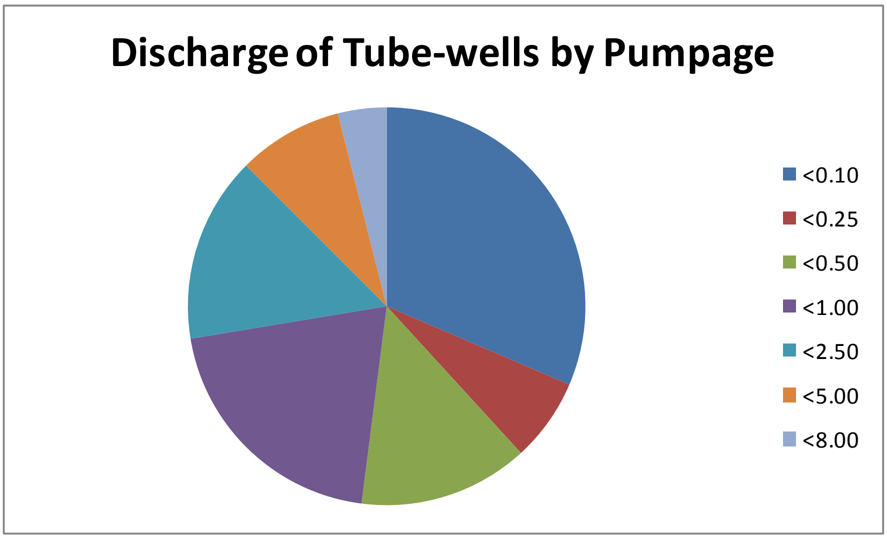


Figure 5.1 Private Tube-wells in Lahore

Under the Lahore and Walton Cantonment Boards, Model Town Society and Pakistan Railway, a total amount of 779,234 m^3/day groundwater is pumped from 173 tube-wells for water supply.

In the eastern rural area of Lahore, HUD & PHED has constructed 16 schemes for rural water supply, although their groundwater abstraction is unknown

It should be noted that the groundwater abstraction is not limited to the above. There are tube-wells used for irrigational purpose outside the WASA jurisdiction.

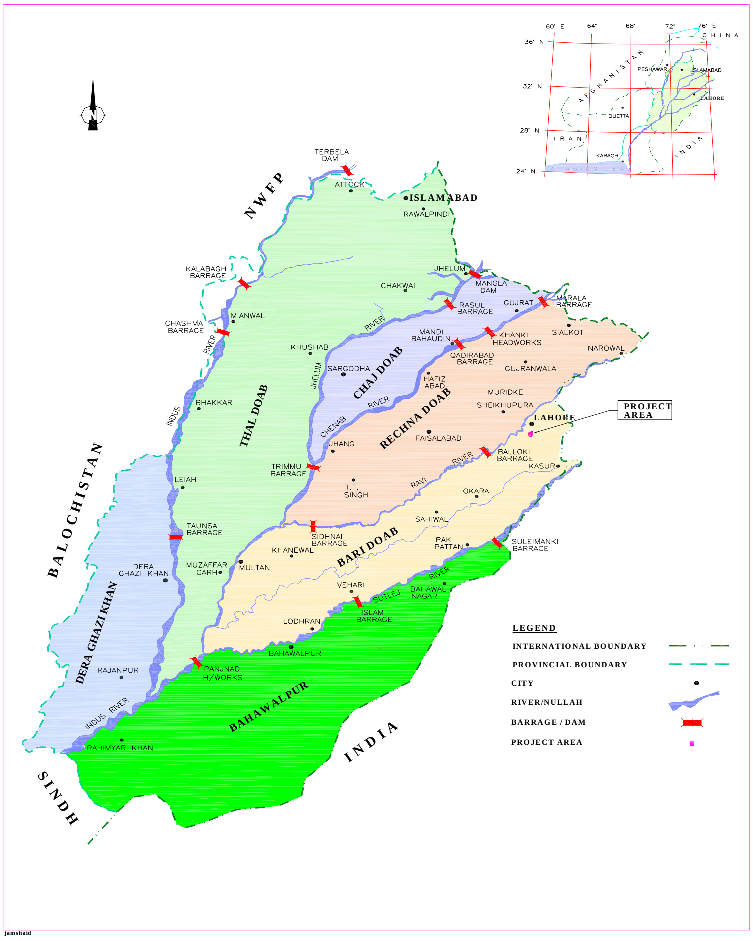


Figure 5.2 Doabs in Indus River System

In Pakistan, the areas sandwiched by rivers are called “doab” as shown in **Figure 5.2**, where a giant groundwater basin is formed. Lahore is located on the Bari Doab surrounded by the Ravi River, Sutlej River and the BRB Canal. According to the Agricultural Machinery Census in 2004 in “Punjab Development Statistics 2008” prepared by the Bureau of Statistics of the Government of the Punjab, there are 5,829 tube-wells in Lahore District, 194,158 tube-wells in the Bari Doab and 669 pumping stations for irrigation (see **Figure 5.3)**. In addition, the number of tube-wells has been increasing year by year. (There were 132 units in Lahore District and 7,194 tube-wells in the Bari Doab in 2003).

The “Groundwater Resources Evaluation and Study of Aquifer under Lahore” in 1991 estimated the total capacity of tube-wells at 1.36 m^3/s (25.85 MGD) , under the assumption of a pumpage of 0.014 m^3/s and an operation rate of 0.14 for approximately 700 irrigation tube-wells in Lahore. When these assumptions are applied to the above conditions, the groundwater abstraction is estimated at 32.9million m^3/day (7,233 MGD) for the Bari Doab. That of 669 pumping stations are not included in this calculation. Considering that WASA abstracted groundwater at 1,610,000 m^3/day (354 MGD) for the month of February 2009, the magnitude of groundwater abstraction for irrigation is outstanding.

Lahore District: $0.014\ m^3/s \times 5{,}829 \times 86{,}400\ sec/day \times 0.14 = 987{,}106\ m^3/day$

Bari Doab Groundwater Basin:

$0.014\ m^3/s \times 194{,}158 \times 86{,}400\ sec/day \times 0.14 = 32{,}879{,}492\ m^3/day$

Besides this, the Multan Development Authority also exists in Multan on the Bari Doab similar to Lahore, but its actual status of groundwater abstraction by WASA is unknown.

With such a high groundwater abstraction from existing tube-wells coupled with the continuous increase of new tube-wells and a decrease of groundwater recharge attributed to a reduction of River discharge and resultant water surface area of the Ravi River has probably caused the collapse of the water balance in the aquifer and accelerated the groundwater drawdown.

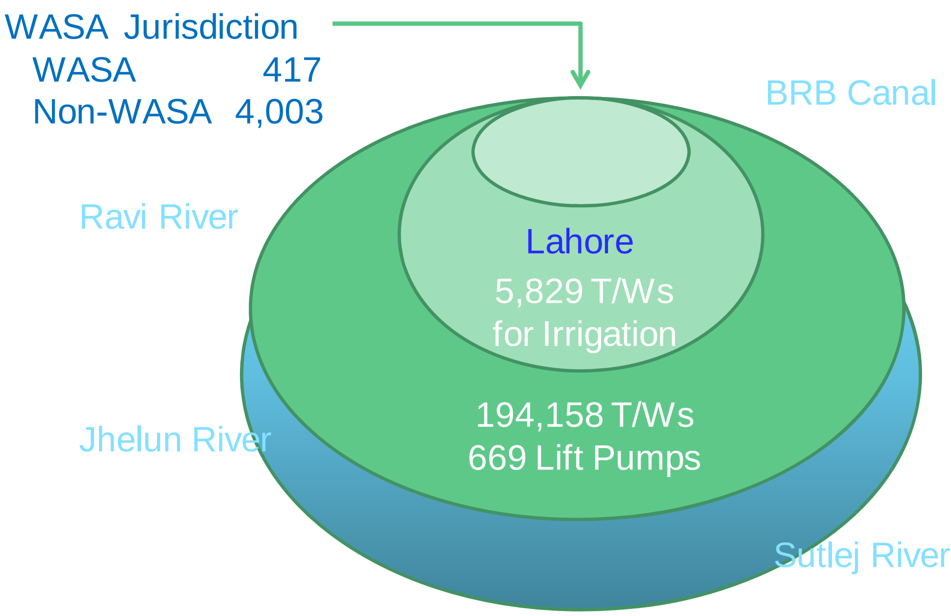


Figure 5.3 Image of the Bari Doab

In Punjab Province, The use of irrigational tube-wells is deeply concerned with industrial development especially economic development in the field of agriculture. The number of such tube-wells is huge and has been increasing by this moment. It is doubtful whether the endeavor to minimize the groundwater abstraction in the water supply sector is effective, but it is not appropriate to ignore such endeavor as a water supply service provider. Tackling this matter in an organized manor’s is required.

5.1.4 Problem Analysis

(1) Groundwater Potential

The bedrock of the giant groundwater basin formed in Bari Doab is reportedly located 1,300 ft below from the ground surface (GE +650 ft). This is based on the 1975 CDM report which described that the drilling data at the bore hole completed 2 miles southeast of Niaz Baig confirmed the bedrock at a depth of 1,250 to 1,274 ft and that this is the only one drilling to have reached the bedrock in Lahore area. However, the configuration of the giant groundwater basin has not yet been confirmed and the groundwater potential is unknown.

(2) Water Level

The drawdown of groundwater which seems to be unending is a potential threat to WASA which fully relies on groundwater for the water source.

The 1975 CDM report estimated the maximum drawdown of groundwater at 45 ft near Shadman Colony for the period of 1955 to 1974 or an annual drawdown rate of 2.25 ft/yr (0.68 m/yr).

"Integrated Master Plan for Lahore – Volume 1 (2002)" says that an annual average drawdown rate of groundwater is 2.03 ft/yr (0.62 m/yr) for the period of 1987 to 2000.

Table 5.1 shows the drawdown of groundwater at representative WASA tube-wells in the respective sub-divisions for 2005 to 2008. The drawdown occurs at 20 points out of 22 points and annual average drawdown is 0.92 m, say 1 m for three years, which is faster than afore -mentioned estimates.

(3) Ground Subsidence

There is no agency that has monitored the ground subsidence in Lahore including WASA and the case of significant ground subsidence has not been reported.

(4) Water Quality

The Pakistan Council for Research in Water Resources (PCRWR) of the Ministry of Science and Technology, Government of Pakistan has conducted water quality survey of tube-wells at the representative points dividing the urban area of Lahore into 16 squares for 2002 to 2006. Among others, the variation of arsenic concentration is notable. The drinking water standards for arsenic concentration are 10 ppb in WHO and 50 ppb in Pakistan (tentatively). The points that exceeded the WHO standard were 11 out of 16 points in 2002, but all in 2003. Two points with As of 55 ppb and 52 ppb exceeded the Pakistani standard in 2004 and one point showed an As concentration of 71.6 ppb in 2006. As a whole, the arsenic concentration is in the ascending trend obviously. This trend has been also confirmed in the JICA study in 2009 as shown in **Figure 5.4**.

Table 5.1 Drawdown of Groundwater at WASA Tube-wells (2005-2008)

Sr. No	Name of Sub Division	Static Water Level (SWL)				Difference			
		FEB./05 (m)	FEB./06 (m)	FEB./07 (m)	FEB./08 (m)	05/06 (m)	06/07 (m)	07/08 (m)	05/08 (m)
1	Shahdara	10.97	12.14	11.93	13.12	-1.17	0.21	-1.19	-2.15
2	City	25.15	26.07	26.99	27.34	-0.92	-0.92	-0.35	-2.19
3	Data Nagar	20.16	21.77	23.12	25.33	-1.61	-1.35	-2.21	-5.17
4	Misri Shah	25.70	26.43	27.69	28.42	-0.73	-1.26	-0.73	-2.72
5	Baghban Pura	25.45	26.94	27.75	29.03	-1.49	-0.81	-1.28	-3.58
6	Mughal Pura	28.45	30.41	31.33	32.01	-1.96	-0.92	-0.68	-3.56
7	Mustafabad	32.67	33.63	33.95	35.43	-0.96	-0.32	-1.48	-2.76
8	Taj Pura	28.95	29.14	28.53	31.94	-0.19	0.61	-3.41	-2.99
9	Ravi Road	23.65	23.68	23.55	23.35	-0.03	0.13	0.20	0.30
10	Islam Pura	23.94	24.59	23.84	23.72	-0.65	0.75	0.12	0.22
ll	Shimla Hill	30.72	32.06	33.12	33.87	-1.34	-1.06	-0.75	-3.15
12	Mozang	33.04	35.33	35.72	36.61	-2.29	-0.39	-0.89	-3.57
13	Gulberg	32.85	34.29	35.11	36.65	-1.44	-0.82	-1.54	-3.80
14	Samanabad	24.95	26.27	27.27	27.25	-1.32	-1.00	0.02	-2.30
15	Allama Iqbal Town	25.24	24.89	25.14	25.33	0.35	-0.25	-0.19	-0.09
16	Ichhra	32.82	34.33	35.02	35.02	-1.51	-0.69	0.00	-2.20
17	LA.Johar Town	24.08	25.20	25.65	25.80	-1.12	-0.45	-0.15	-1.72
18	Garden Town	30.09	31.49	33.10	34.18	-1.40	-1.61	-1.08	-4.09
19	Industrial Area	25.95	27.59	29.55	30.21	-1.64	-1.96	-0.66	-4.26
20	Town Ship	29.77	31.58	33.11	34.96	-1.81	-1.53	-1.85	-5.19
21	Green Town	22.01	23.36	24.61	26.45	-1.35	-1.25	-1.84	-4.44
22	M.E.S. Tubewells	26.25	26.59	27.67	27.67	-0.34	-1.08	0.00	-1.42
					Average	-1.13	-0.73	-0.91	-2.77
					Interval (yr)	1	1	1	3

Source: Prepared by JICA Study Team based on "Monthly Progress Report of February March", Hydology Division, WASA

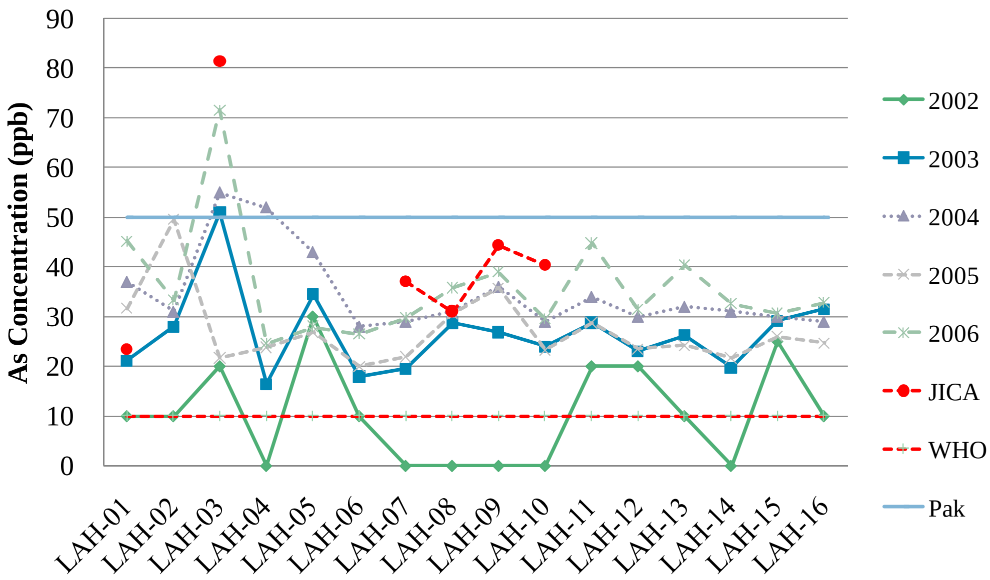


Figure 5.4 Movement of Arsenic concentration of groundwater (2002-2006)

"Pakistan's Waters at Risk" prepared by WWF in February 2007 rings an alarm bell for major cities in the Province of Punjab as follows:

A recent study of eleven cities of Punjab shows an excess of arsenic and fluoride concentrations in water supply systems of six cities; Multan, Bhawalpur, Shaikhupura, Kasur, Gujranwala, and Lahore (PCRWR 2004). UNICEF has also conducted studies and concluded that the population of Punjab in the main cities is exposed to high arsenic concentrations. A similar study by Environmental Protection Agency (EPA) on quality of sub-soil water in 14 districts of Punjab *revealed that 85% of samples tested were unfit for human consumption. Alarmingly, over two million people are drinking unsafe water, some with high arsenic concentration (WBCWRAS Paper 8, 2005)*

Considering the current situation of drawdown and water quality of groundwater on which WASA relies fully for a drinking water source, development of a surface water resource is the biggest issue.

5.1.5 Possibility of Surface Water Resource Development

(1) 1975 CDM Report

”Lahore Water Supply, Sewerage and Drainage Project” prepared by Camp, Dresser and Mckee, US consultants in 1975 has not only given the basis of what Water Supply, Sewerage and Drainage systems should be in Lahore, but also suggested a very important decision that the drinking water source should be groundwater from now onwards.

The CDM report has made a comparative study of the following five alternatives for drinking water source (see **Figure 5.5**).

Alternative 1	Intake of surface water from the Ravi River
Alternative 2	Intake of surface water from the BRB Canal
Alternative 3	Introduction of Ravi River water to the BRB Canal near Ravi Syphon (the crossing point with the BR Canal) and intake of surface water from the Lahore Branch of the BRB Canal
Alternative 4-1	Intake of surface water from the Lahore Branch of the BRB Canal near Mugal Pura and supply of treated wastewater to the BRB Canal downstream of a branching point to the Lahore Branch
Alternative 4-2	Intake of surface water from the Lahore Branch of the BRB Canal near Mugal Pura and payment of water rate
Alternative 5	Groundwater abstraction

These alternatives are considered to be still effective, even though some modifications are necessary corresponding to the situational change thereafter.

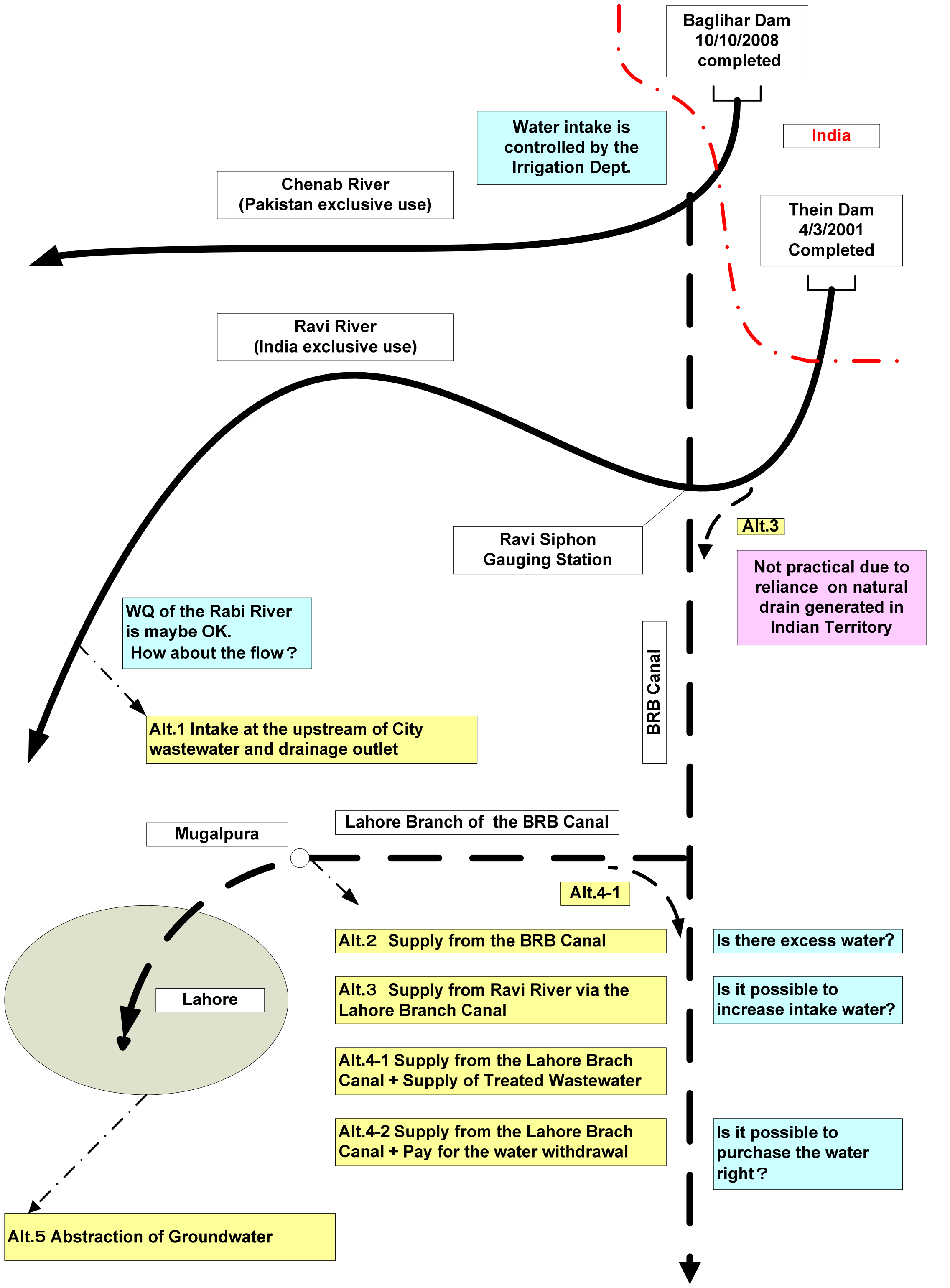


Figure 5.5 Possible Surface Water Resources

(2) Possible Surface Water Resources

The possible surface water resources are the Ravi River flowing on the west side of Lahore and the BRB Canal running on the eastern side. They have experienced a big change in the respective basins since 1975 as stated below.

In the Indus Water Treaty signed on September 19, 1960, the Indus System of Rivers comprises three Western Rivers the Indus, the Jhelum and Chenab and three Eastern Rivers - the Sutlej, the Beas and the Ravi; and with minor exceptions, the treaty gives India exclusive use of all of the waters of the Eastern Rivers and their tributaries before the point where the rivers enter Pakistan. Similarly, Pakistan has exclusive use of the Western Rivers. Pakistan also received one-time financial compensation for the loss of water from the Eastern rivers.
Source: “Indus Waters Treaty”, Wikipedia

In the Territory of India upstream of the Ravi River of which India’s exclusive use is allowed. The Ranjitsagar Dam, which is also called as the Thein Dam commissioned its operation on March 4, 2001, The Ranjitsagar Dam was constructed for the purposes of power generation and irrigation along with the second largest hydro-power generation station in India, these resulting in the strongest control of Indian over the discharge of the Ravi River.

India also started the Baglihar Dam along with a 450MW hydro-power station which was put into operation on October 10, 2008 in the Indian Territory upstream of the Chenab River which reduced water to the BRB Canal. It is now the point of a big political conflict between the two countries, whereas India has reportedly a plan to construct 12 more dams at the upstream of the Chenab River. If the Baglihar Dam was constructed only for power generation, all the flow should return to the river. The dam control will greatly affect the natural discharge pattern of the Chenab River and resultantly that of the BRB Canal.

At the point of the BRB Canal across the Ravi River, it flows under the Ravi River by a siphon which is called as the Ravi Syphon and two gauging stations are established for the BRB Canal and the Ravi River. This is the only gauging station immediately upstream of Lahore and at 1.5 km upstream of Ravi siphon starts the Territory of India.

In Pakistan, the discharge records of the river have not been properly arranged but just kept at the Irrigation and Power Department of the Provincial Government of Punjab in Lahore. The JICA Study Team has arranged the discharge records since 1991 of the BRB Canal and the Ravi River at Ravi Syphon for analysis with the cooperation of the department

Figure 5.6 and **Figure 5.7** show the monthly discharge pattern of the Ravi River for the two periods of 1991-2000 and 2001-2009. In the latter period, almost similar patterns are depicted and show “well-controlled”. The Thein Dam officially entered into operation on March 2001, but it was almost completed around October 1999 when the article of ”Completion of Thein dam soon” was found, and supposedly had started water storage in 2000. The influence of the dam construction is clearly shown in the average, maximum and minimum discharge pattern of the Ravi River through the comparison of two discharges before and after the dam construction (see **Figure 5.8**), which corroborates the significant reduction of the Ravi River discharge caused by the dam construction. The average daily discharge is lowest as 1,030-1,232 cusec during November to January since July 2000, but 285 to 549 cusec for five months from November 2008 to March 2009, when watching by sole year (see **Figure 5.9**). 186～331 cusec is recorded for six months from November 2000 to April 2001 but omitted since it might be caused by water storage accompanied with the dam completion. These discharges, however, are mainly attributed to the discharge of the Malara Canal, which gets water from the Chenab River similar to the BRB Canal and pours into the Ravi River upstream of the Ravi Syphon. The Ravi River has a role to convey and distribute water to two downstream canals near Balokki

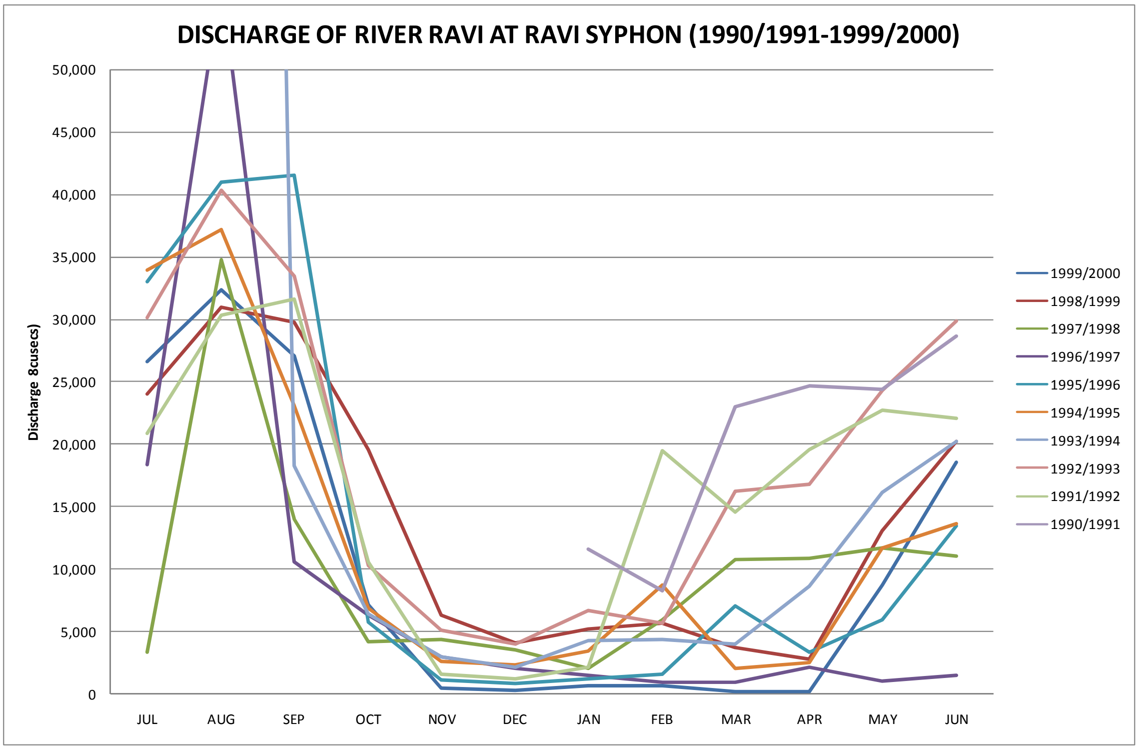


Figure 5.6 Average Daily Discharge Pattern of the Ravi River at the Ravi Syphon (1991～2000)

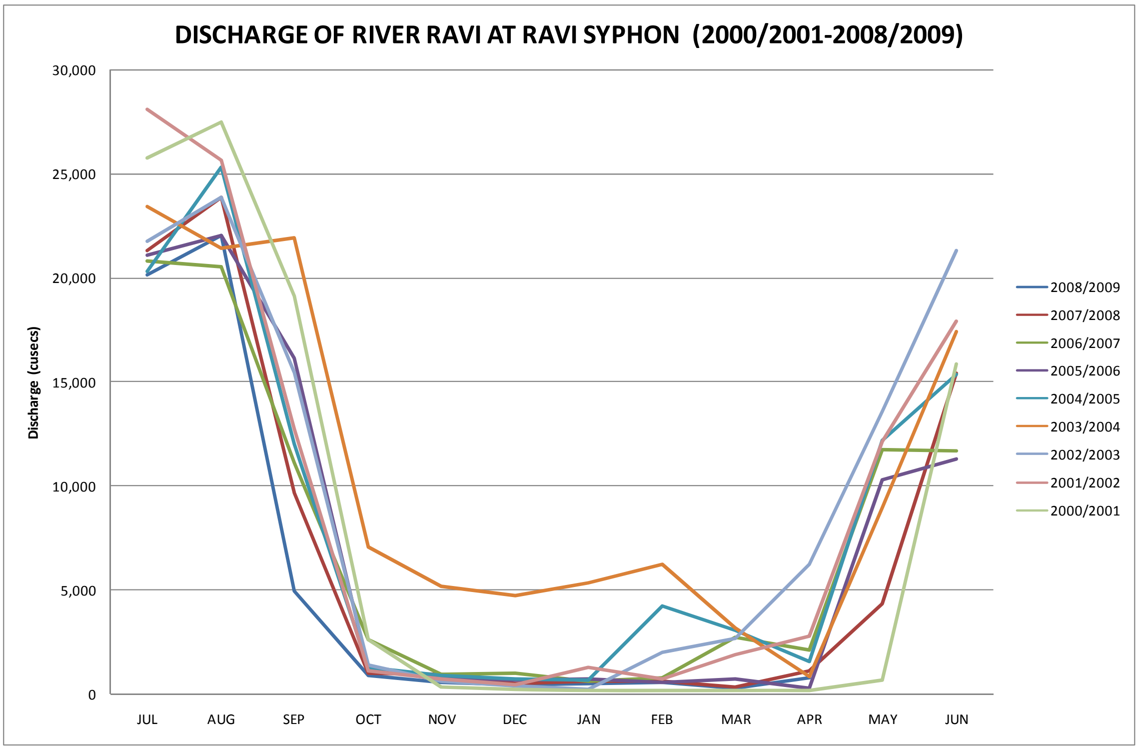


Figure 5.7 Average Daily Discharge Pattern of the Ravi River at the Ravi Syphon (2001～2009)

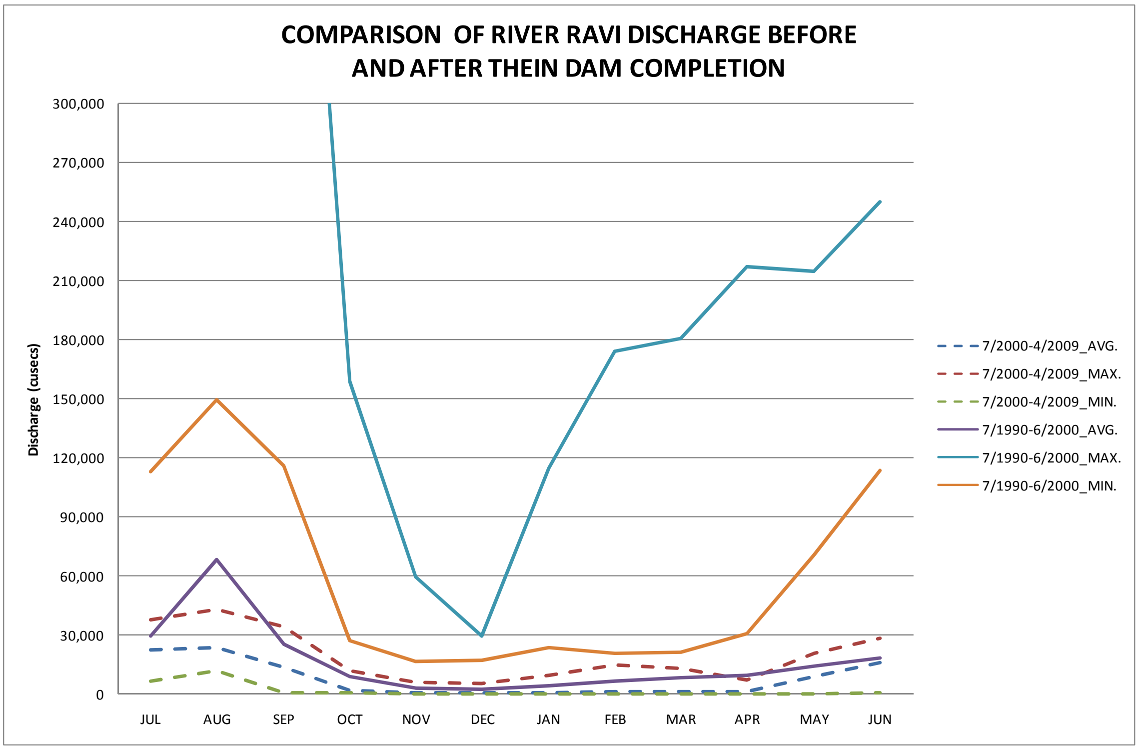


Figure 5.8 Change of Average, Maximum and Minimum Daily Discharge of the Ravi River before and after Thein Dam Construction

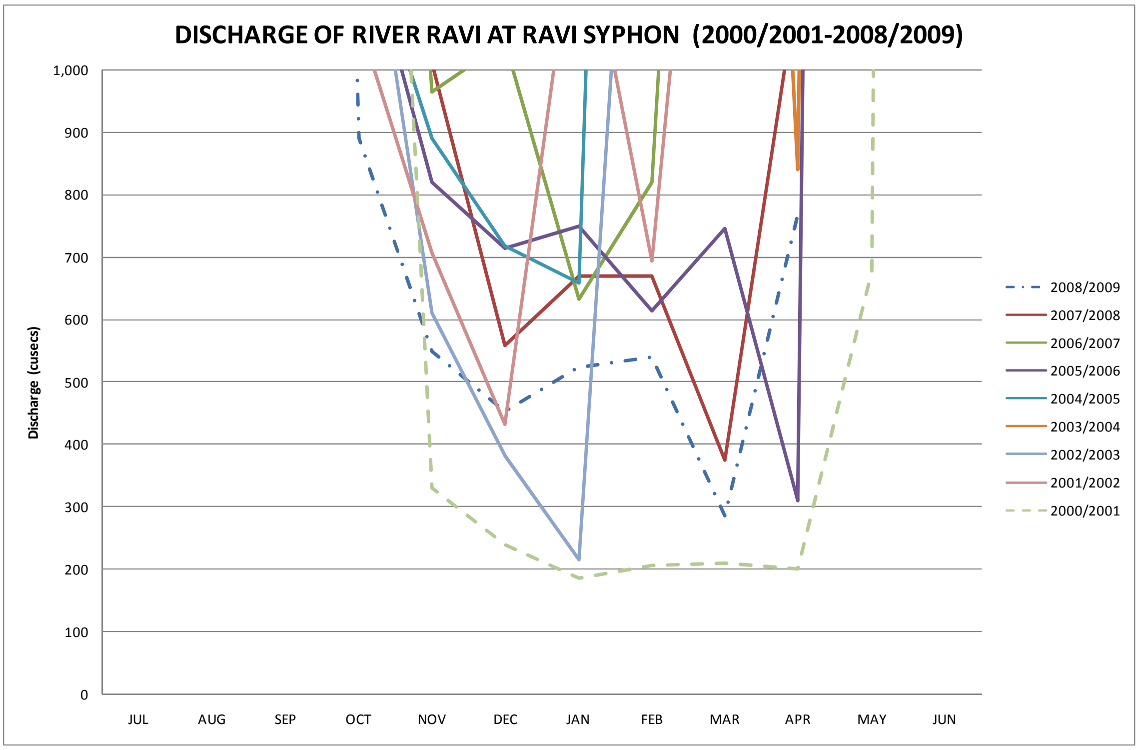


Figure 5.9 Average Daily Discharge Fluctuation by Year of the Ravi River

At the upstream of the Ravi River away from the urban area of Lahore, the agricultural land is extended and there is no fear of inflow of domestic and industrial wastewater. The information is almost unknown on the Indian Territory beyond the Ravi Syphon and available water quality data of the Ravi River is very limited as shown in **Table 5.2**.

Table 5.2 Water Quality of the Ravi River at the Ravi Syphon

Date of Collection	Temp. (ºC)	DO (mg/L)	pH	Q (cusec)	BOD (mg/L)	COD (mg/L)	TDS (mg/L)
MPL *[1]			6.5~8.5				1000
04/11/08	22.6	6.3	8.5	594 *[2]	2.5	8	160
TSS (mg/L)	**Cl (mg/L)**	**Sulfate (mg/L)**	**Sulfide (mg/L)**	**F (mg/L)**	**CN (mg/L)**	**Mn (mg/L)**	**Cu (mg/L)**
	250	250		1.50		0.10	1.0
90	5	41	0	0.588	0	0.071	0.057
Cd (mg/L)	**Cr (mg/L)**	**Zn (mg/L)**	**Fe (mg/L)**	**Ni (mg/L)**	**BOD load (ton/day)**		
0.003	0.050	3.0	0.30	0.020			
0.008	0.33	0.047	0.938	0.207	3.633 *[3]		

Source: Environmental Protection Department, Punjab Province
*[1] MPL: Maximum Permissible Limits by WHO Guideline
*[2] Ravi Syphon Gauging Station, Irrigation and Power Department, Punjab Province
*[3] Calculated by JICA study team (1 cusec = 2,446.5 m^3/day)

The results of the water quality survey conducted by the JICA Study Team at the same point is shown in **Table 5.3**.

Table 5.3 Water Quality of the Ravi River at the Ravi Syphon

Date of Collection	Temp. (ºC)	DO (mg/L)	pH	Total Hardness (mg/L)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)
MPL	>=3	NGVS	6.0-9.0	NGVS	80	150	200
5/16/09	24.2	1.50	7.66	80	3.2	7	81
NO_2 (mg/L)	NO_3 (mg/L)	NH_4 (mg/L)	Fe (mg/L)	Mn (mg/L)	Mg (mg/L)	As (μg/L)	F (mg/L)
NGVS	NGVS	40	8	2	NGVS	1000	10
0.003	0.771	0.08	1.86	BDL	2.40	3.42	BDL
Ca (mg/L)	Cl (mg/L)	SO_4 (mg/L)	Fecal Coli. (MPN/100mL)	Total Coli. (MPN/100mL)			
NGVS	NGVS	600	Nil	Nil			
28	9.8	13	>=240	>=240			

The water of the Ravi River currently becomes a valuable dilution source of wastewater discharged from almost urban area of Lahore. Even though available, water intake from the Ravi River makes the river environment deteriorated and the Ravi River becomes the drain completely a sullage carrier during the dry season.

Although the Irrigation and Power Department of the Provincial Government of Punjab has a plan to construct barrage for recreation and groundwater recharge at the upstream of the Ravi River, it is still in the stage of idea due to the various problems such as barrage construction, bund reinforcement

The Irrigation and Power Department takes the negative stance for the project relying on the discharge of the Ravi River due to its uncertain discharge resulted from the fact that the immediate upstream is the Indian Territory.

The BRB Canal is the great irrigational canal constructed under the grand scale and the part passing through Lahore is a very little span in its total length. Whether the surface water intake from the canal could be included in the canal distribution scheme cannot be foreseen. **Photo 5.1** shows the Ravi Syphon and **Figure 5.10** present the BRB Link Canal Line Diagram around Lahore.

Figure 5.11 and **Figure 5.12** presents the average daily discharge fluctuation of the BRB Canal for two periods of 1991-2000 and 2001-2009. There is obvious difference in the low discharge period between them. The discharge fluctuation of 1991-2000 is different by year, while that of

2001-2009 shows that the BRB Canal is operated with almost similar patterns and well controlled. The Canal was sometimes operated with the discharge exceeding a design flow of 4,850 cusecs at the Ravi Syphon in the former, but controlled so as to be a design flow at the maximum in the latter.

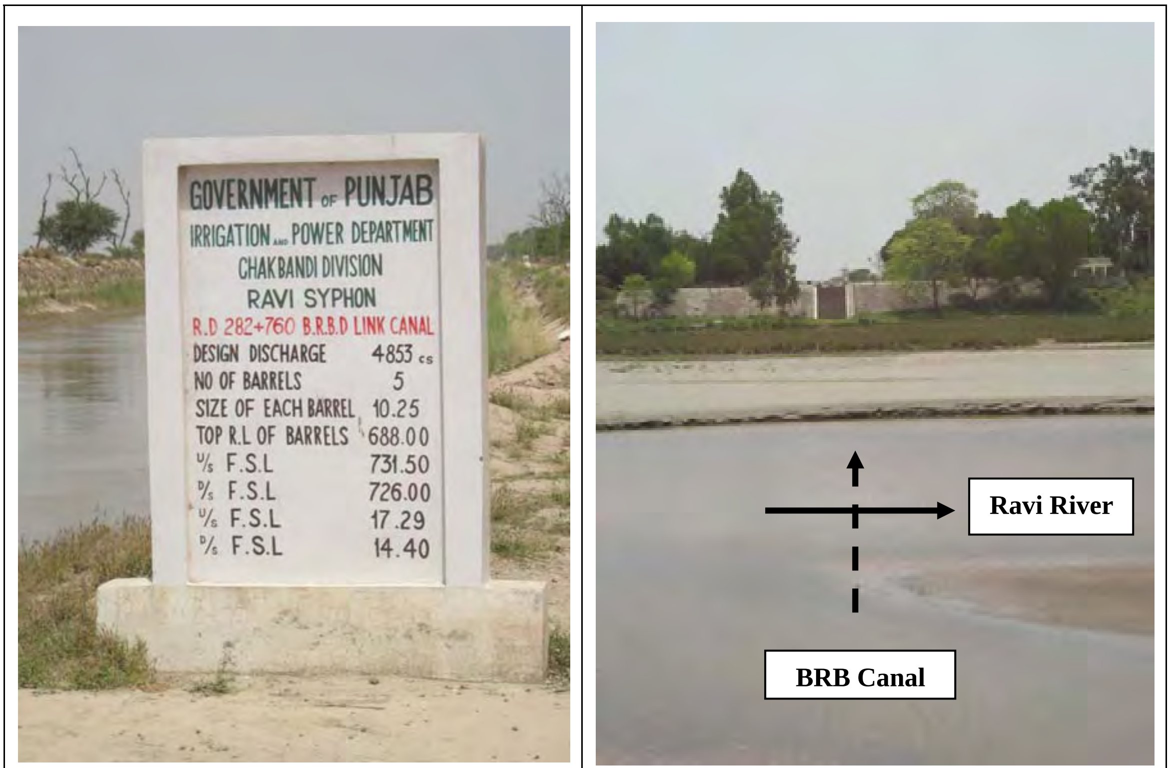


Photo 5.1 Ravi Syphon

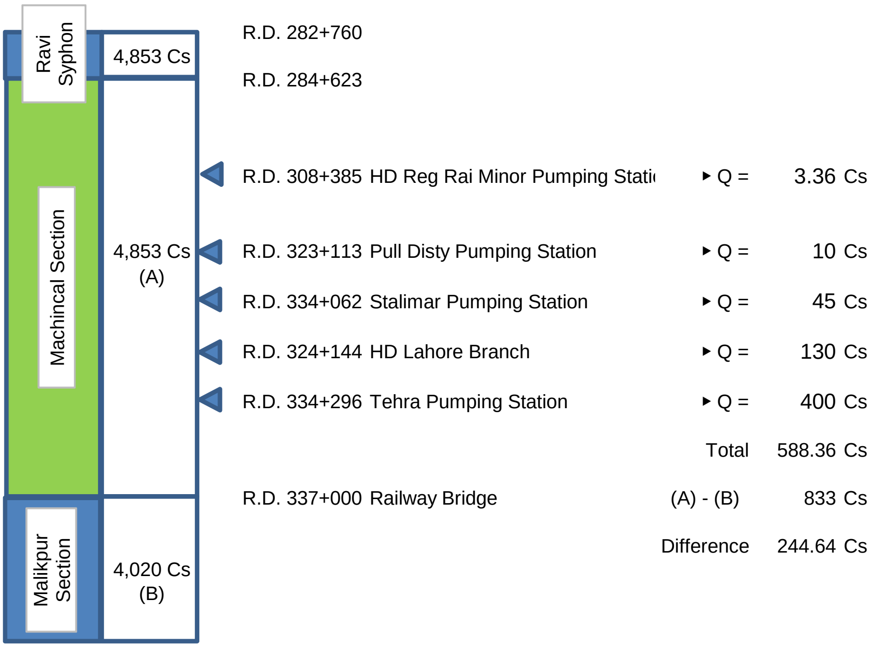


Figure 5.10 BRB Link Canal Line Diagram

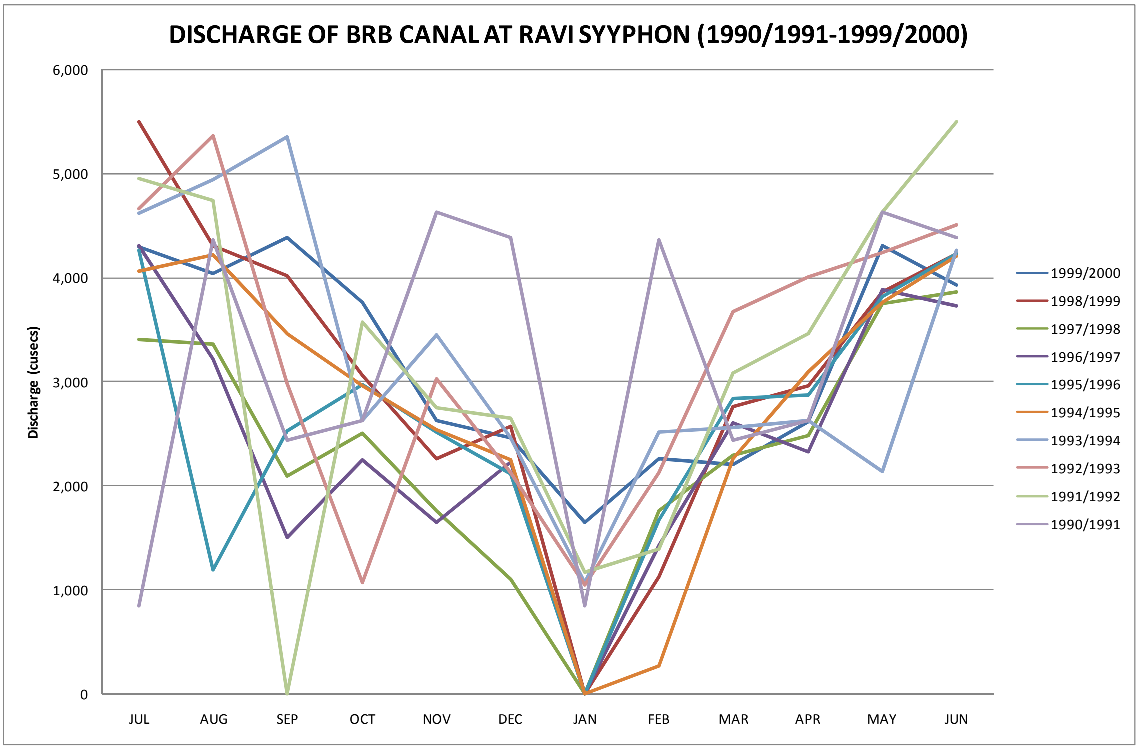


Figure 5.11 Average Monthly Discharge of the BRB Canal at the Ravi Syphon (1991～2000)

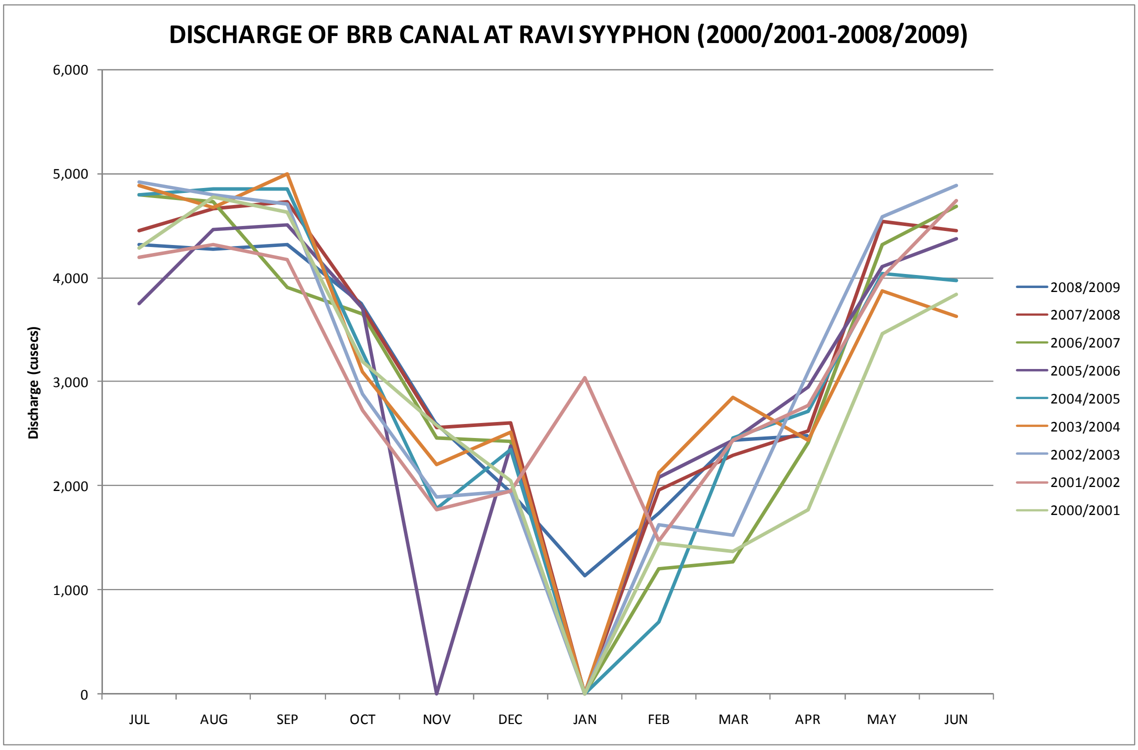


Figure 5.12 Average Monthly Discharge of the BRB Canal at the Ravi Syphon (2001-2009)

January is the month for cleaning and maintenance of the Canal and water distribution from the Chenab River is suspended. The minimum discharge during the period of 2001-2009 is 200 cusecs (489,000 m^3/day) in December 1994 and December 1997 except for the month where it was expressed that the discharge is "nil". Since the Baglihar Dam mentioned-above has just entered into operation, it is necessary to watch carefully what influence will appear from now on. However, as long as watching the minimum average discharge, adequate flow cannot be expected.

For the BRB Canal, the findings are as follows:

- A rice-wheat-cropping system is now popular in the Province of Punjab and the BRB Canal is used for rice irrigation during the period of mid-May to mid-October and for wheat irrigation during the remaining period of the year. For this reason, the Irrigation and Power Department has no concept of non-irrigational season.
- The works for repair and cleaning of the BRB Canal, stopping the flow in the BRB Canal, is indispensable every year.
- The BRB Canal was originally constructed for exclusively irrigational use. If there will be the request from WASA for water intake from the BRB Canal, it will be the issue at the political level.
- The influence of the Baglihar Dam operation on discharge pattern of the BRB Canal is unknown at present.
- The application of the new water right for the canal is the matter of the Indus River System Authority (IRSA) of the Federal Government.

In case that surface water is taken from the Canal, the water rate will be collected. In the revision of the water tariff on July 10, 2003, the policy has largely changed from the charge based on crop area cum crop type to the flat rate based on crop area. Charges were generally higher for high water consuming crops such as rice, and low for less water consuming crops such as wheat (for example, the per hectare crop-based-water-charges in the previous tariff, were Rs37 for fodder, Rs148 for wheat, Rs222 for cotton, Rs297 for rice, Rs432 for sugarcane). Under the new flat rate system, per hectare water charges are to be fixed for Rabi and Kharif seasons, regardless of the type of crops grown in each season (new rate per hectare are Rs124 for Rabi (winter crop period from January 10 to March 31) and Rs210 for Kharif (summer crop period from May 15 to September 30) crops, regardless of the type of crops grown). The BRB Canal was originally constructed for exclusively irrigational use but not assumed for city water use. The setting of water rate will be another big issue, when WASA will make a request for it.

The decease of Ravi River discharge caused by Thein Dam operation is assumed to affect the groundwater resource as a consequential reduction in the flowing surface area of the river, a decrease of groundwater recharge and increased of drawdown of groundwater but their exact relationships are unknown.

The detailed survey on groundwater resource has not been conducted by WASA since 1991 when NESPAK undertook ”Ground Water Resources Evaluation and Study of Aquifer under Lahore”. In the survey, the aquifer’s mathematical model was developed and delivered to WASA but it has been no longer used.

5.1.6 Direction to Be Taken for Water Source Problem

”Integrated Master Plan for Lahore – Volume 1” in 2002 proposed the following measures:

a) Proper control on wastage of water
b) Use of surface water
c) Control of expansion of Lahore City
d) Recharge of aquifer
e) Intermittent supply hour

It is difficult to control the expansion of Lahore City as the actual problem.

Groundwater recharge is worth studying. The problem is what would be the source of recharge. Treated wastewater or excess water of the Ravi River will be possible options. As the water requirement of Lahore is very huge, substantially extensive recharge area will be required.

The intermittent water supply leads to the deterioration of service quality and, as a water supply service provider, it is better to avoid such situation if possible. It may result in negative pressure in distribution system leading to water quality problems. It may also cause an increase of tube-well installation without permission.

Therefore, it is now high time to sincerely consider a) proper control on wastage of water and b) resort to use of surface water.

Directions to be taken for water source problem include, taking into consideration a) the groundwater drawdown and b) ascending trend of arsenic concentration in groundwater:

(1) Monitoring of Arsenic Concentration in Groundwater
It is important to reduce dependence on groundwater through the acquisition of surface water source, but groundwater use will never disappear in future. For this reason, it is necessary to monitor the arsenic concentration in groundwater continuously. At least five-year monitoring should be done at representative points in Lahore divided into squares as PCRWR has conducted.
(2) Acquisition of surface water source
Complete shifting of the water source from groundwater to surface water is difficult because (a) limited availability of surface water source, (b) constant water intake throughout the year and the existence of a no-flow month in the BRB Canal for cleaning and maintenance. However,

even though such problems exist, the acquisition of surface water source is indispensable for dilution of groundwater, and all the energies must be directed to finding a solution to the problem.

The following steps should be taken to undertake a study on this matter:

1) To commence the discussion with the agencies concerned on surface water intake as early as possible and get their consent.
2) Based on the results of 1) above, to conduct the review of the master plan for water supply facilities including the study on the utilization of treated wastewater (refer **5.1.7**)

Keeping in view the fact that it may take considerable time to acquire the surface water source, it is imperative to start the process quickly and at the same time stop any increase of groundwater abstraction. It is also important that this restriction must be applied to not only WASA tube-wells but also to private tube-wells. Furthermore, the control and regulation of private groundwater use, water recycle in the factories and utilization of treated wastewater should be given due consideration.

In addition to above, focusing on the control of wastage of water is all the more essential, hence all kinds of measures to be taken in this regard should be mobilized as shown below.

a) Promotion of installation individual water meters
b) Leakage detection and necessary repair and replacement of deteriorated pipes
c) Strengthening of progressive metered-rate
d) Control of per capita water consumption
e) Public enlightenment and improvement of water-saving awareness

5.1.7 Utilization of Treated Wastewater

As mentioned earlier, the acquisition of surface water source involve crucial problems and utilization of treated wastewater could be an important factor in the acquisition of surface water source. There are four options in the utilization of treated wastewater as shown in **Figure 5.13** and for (2) to (4) a separate detailed study will be required:

(1) Discharge into the Ravi River

This option is to discharge treated wastewater into Ravi River (that has been so far discharged without treatment) and to contribute to the improvement in water pollution in the River. The Irrigation Department would welcome it but may have a feeling at length which makes a trade difficult. Unless the Irrigation and Power Department aggress to increase the discharge of the Malara Canal, the intake from the Ravi River is quite limited.

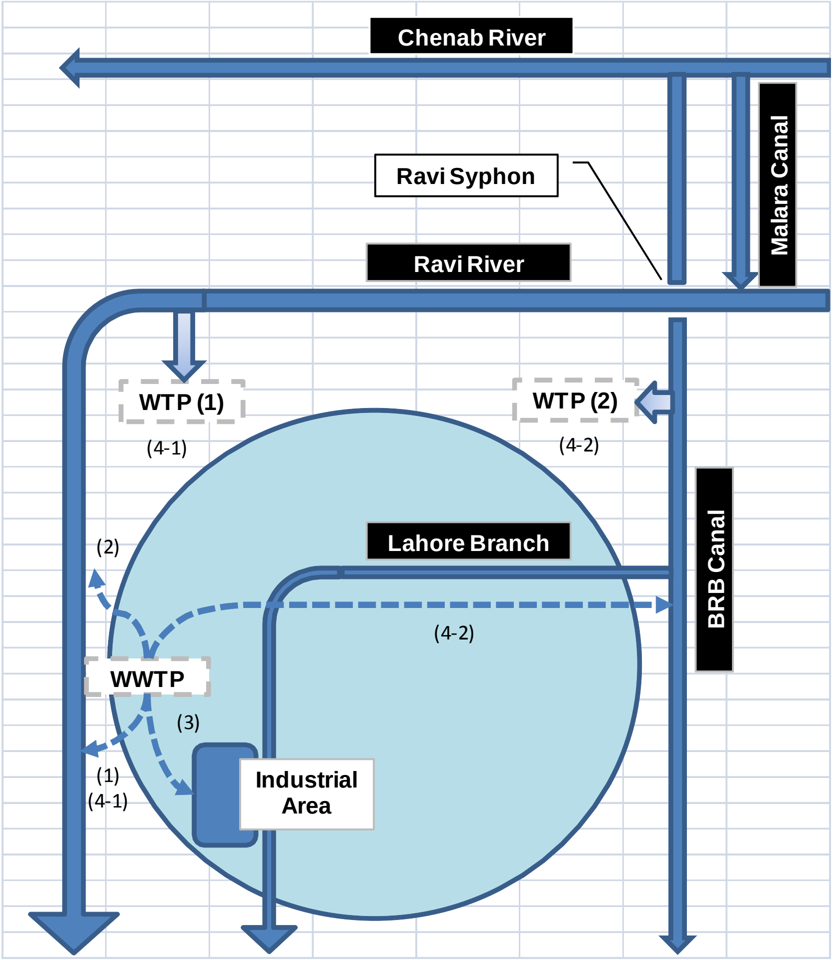


Figure 5.13 Treated Wastewater Utilization Options

(2) Groundwater Recharge

This option is to recharge the aquifer through infiltration at a recharge reservoir to store the treated wastewater. At the Bari Doab groundwater basin, groundwater is separated into two layerys by the unpermeable layer. The upper layer is mainly used for shallow wells of private developers, while the lower for tube-wells of WASA. For the lower layer recharge, a recharge well is used. But if its control fails, it becomes a water path through which polluted water enters. Therefore, elaborate care has always to be taken for the operation of recharge wells. Since the required number of wells is decided by the infiltration capacity, many recharge wells may be required. It is necessary to check the effect of recharge well by using a pilot well.

(3) Trade-off with Industrial water

This option is to substitute treated wastewater in place of groundwater used as industrial water. At present, 4005 private tube-wells are recorded by WASA with an estimated at discharge of 480,000 m3/day based on their nominal or assessed capacity and operation time. Since these tube-wells belong commerce concerns and individuals, actual use of industrial water is unknown because few factories have measuring arrangements for amount of water use as to

indicate a water balance. Rough estimation is that two-thirds of industrial water can be replaced by treated wastewater. But although it is within WASA's discretion, its impact is limited
To improve the accuracy of industrial water estimation, WASA's record should be categorized into the commerce, factory and individual at least, when WASA employees distribute the bills to the customers

(4) Trade-off with Irrigational Water

In consideration of quantity and quality of water, the trade-off of treated wastewater with irrigational water is ideal. However, when water as per WASA requirement is added to the present discharge of the BRB Canal, a study will be needed as to whether the canals is structurally safe. in this regard, the application of the water right to Indus River System Authority (IRSA) will be necessary. But in case that a certain amount of water is taken from the BRB Canal for water supply and the same amount of treated wastewater is returned to the BRB Canal, there is a possibility that the above structural problem and water right problem have to be cleared at the same time. While the construction of water intake facilities, water introduction pipes, water treatment plant, water transmission pipes and so on is essentials for surface water treatment, the most difficult problem is the construction of water transmission facilities from the wastewater treatment plant to the BRB Canal.

An alternative is the Malara Canal which delivers water into the Ravi River upstream of the Ravi Syphon. The present discharge of the Ravi River, especially during the period of November to April, is so small that it is necessary to increase the discharge of the Malara Canal. If the tradeoff that such water is taken from the Ravi River for water treatment and treated wastewater is instead discharged into the Ravi River is established, it is the best solution since the construction of water transmission facilities is not required. It should be noted that the study on whether the canal is structurally safe and on resolution of cost sharing issue will be necessary.

It will be of interest to note that in Japan, the test of treated wastewater utilization to paddy field cultivation was conducted for five years (2001-2005) at Nagisa Wastewater Treatment Plant, Eastern Regional Sewerage System, Osaka Prefecture in cooperation with the local agricultural association. The paddy field is established in the land of plant site earmarked for future expansion. The treated wastewater has a higher total nitrogen concentration than that in irrigational water and there is a fear that rice grows too much and fall down halfway. The test was conducted at the following five fields with different test conditions but there were reportedly no significant difference among those test runs in terms of stalk length and harvest as indicated in **Table 5.4**.

1) Treated wastewater + fertilized nitrogen (normal)
2) Treated wastewater + fertilized nitrogen (half)

3) Treated wastewater + fertilized nitrogen (none)
4) Irrigational water + fertilized nitrogen (normal)
5) Mixture of treated wastewater and Irrigational water + fertilized nitrogen (normal)

Table 5.4 Rice Harvest (kg/acre)

Test conditions			Harvest (kg/100m^2)				
Field	Water	Fertilization	FY2005	FY 2004	FY 2003	FY 2002	FY 2001
No.1	Treated wastewater	Normal	45.4	47.4	52.9	56.8	54.0
No.2	Treated wastewater	Half	47.1	49.5	42.4	48.1	46.9
No.3	Treated wastewater	None	44.8	43.2	29.8	47.2	-
No.4	Irrigational water	Normal	48.3	48.3	50.2	53.7	51.9
No.5	Mixture	Normal	45.9	43.4	50.2	50.9	-

Source: Journal of Japan Sewage Works Association, Vol.43、No.525、2006/07

5.2 Water Supply System

5.2.1 General

Source: WASA, 2009

Figure 5.14 illustrates the jurisdiction of Lahore city and WASA.

According to 1998 Population and Housing Census, which is the latest statistical report in terms of population by the government of Punjab, total population of Lahore district is 6,319 thousands persons. Percentage break-up of the urban and rural population is 82% and 18% respectively given in **Table 5.5**. The population is concentrated on urban area.

Table 5.5 Urban and rural population in Lahore city

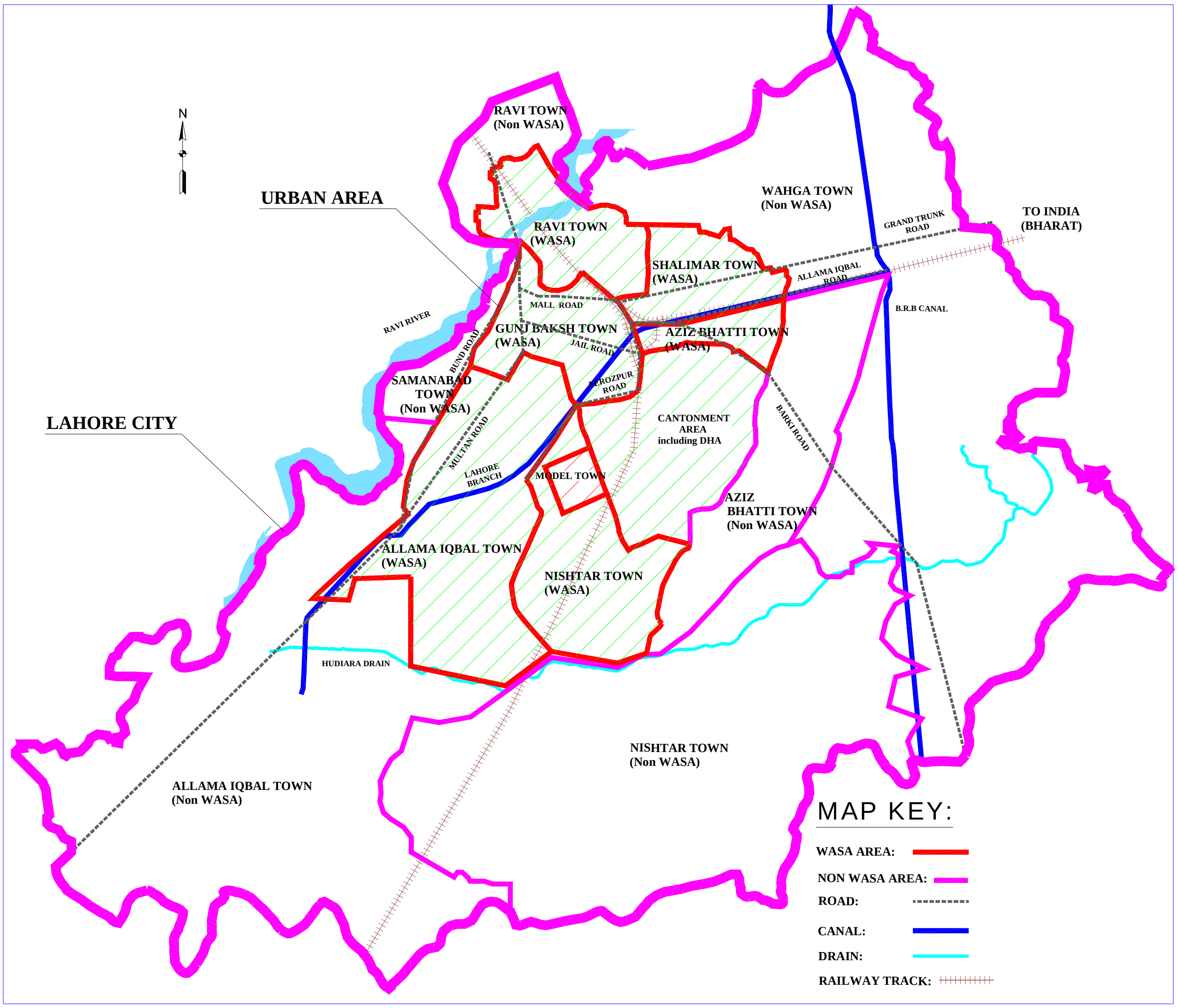
	Urban	Rural	Total
Lahore Cantonment Tesil	3,128	650	3,778
Lahore City Tesil	2,081	460	2,541
Total	5,209	1,110	6,319
Percentage	82%	18%	100%

Source: Punjab gateway, Government of the Punjab

WASA is responsible for water supply to most of the urban area in Lahore city. Rest of the urban area is served by others such as Lahore Cantonment Board, Walton Cantonment Board, Defense Housing Authority, Model Town Society, Pakistan Railways and other private developers.

In rural area, PHED (Public Health Engineering Department) is responsible for installation of water supply facilities, however none of public institutions take care of operation and maintenance of the systems. Residents have to operate systems by themselves.

Lahore city
- Urban area: WASA and others are responsible for water supply such as Lahore Cantonment, Walton Cantonment, Defense Housing Authority, Model Town, Pakistan Railways, etc.
- Rural area: PHED installs water supply facilities, but they are not responsible for operation and maintenance. Residents are responsible for it.



Source: WASA, 2009

Figure 5.14 Jurisdiction of Lahore City and WASA for Water Supply

5.2.2 WASA service area

WASA's jurisdiction comprises of following six towns in terms of water supply;

- Ravi Town
- Shalimar Town
- Data Gunj Buksh Town
- Aziz Bhatti Town
- Iqbal Town
- Nishter Town.

These towns are divided into totally 25 zones, which are called sub-divisions. The sub-division wise details of above facts are given in **Table 5.6**.

5.819 millions live within the jurisdiction of WASA who has provided 570,000 numbers of water supply connections. 5.015 millions are served, which is 87% of the total population in WASA area.

Rest of 13% population have either no WASA supply connection such as private developers or have their own arrangements or illegal connections.

In these six towns, Aziz Bhatti Town is smaller than any other towns thus total population is least. Ravi Town, Shalimar Town and Gunj Buksh town have the similar population each other such as 1.2 millions to 1.4 millions. Lahore city is particularly expanding to the south where Iqbal Town is located so that Iqbal town has been developed very much recently. It has the most population in six towns.

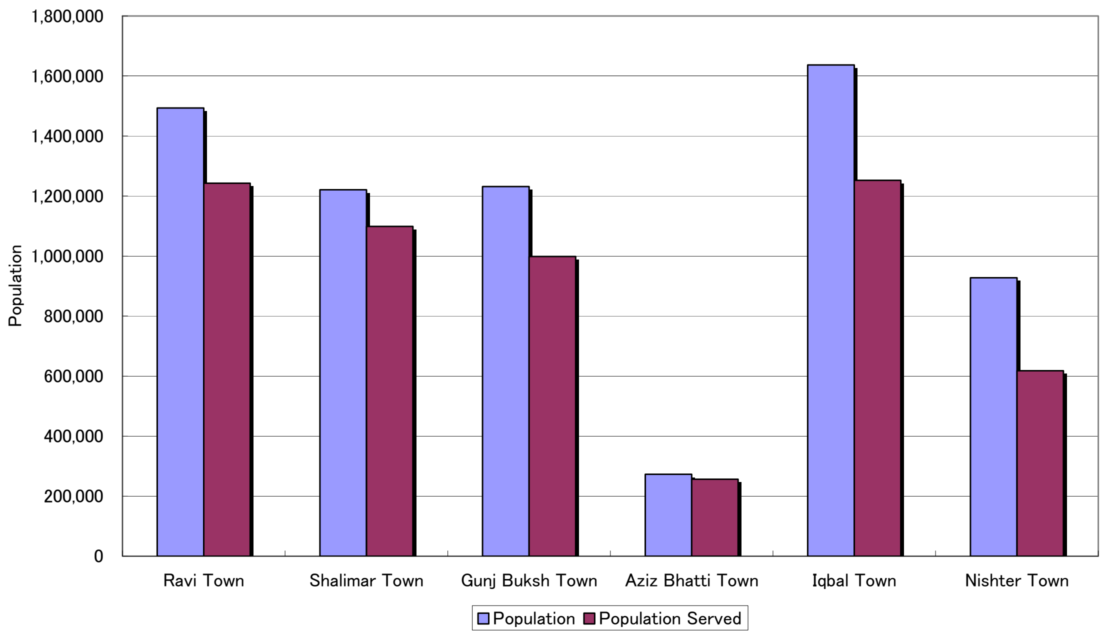


Figure 5.15 Population and served population in WASA in 2009

Source: WASA, 2009

Table 5.6 Population in WASA's area in 2009

Sr. No.	Description of Area	Population	No. of WASA Connections	Population Served	% of Population Served
RAVI TOWN					
1	City	240,908	26,866	219,034	90.92%
2	Shahdra including Farakhabad	486,774	32,487	428,264	87.98%
3	Data Nagar	197,302	19,213	171,653	87.00%
4	Misri Shah including Shadbag	630,083	58,772	579,046	91.90%
	Sub Total of Ravi Town	1,555,067	137,338	1,397,996	89.45%
SHALIMAR TOWN					
1	Mughal Pura	477,168	40,783	396,049	83.00%
2	Baghban Pura	405,333	41,429	336,345	82.98%
	Sub Total of Shalimar Town	882,501	82,212	732,395	85.14%
DATA GUNJ BUKSH TOWN					
1	Krishan Nagar	437,617	47,696	336,878	76.98%
2	Ravi Road	408,866	21,832	326,766	79.92%
3	Mozang	166,608	22,076	149,881	89.96%
4	Gulberg	202,735	20,535	178,914	88.25%
5	Shimla Hill including Anarkali	271,589	29,445	247,581	91.16%
	Sub Total of Data Gung Buksh	1,487,415	141,584	1,240,018	87.32%
AZIZ BHATTI TOWN					
1	Mustafabad	89,348	7959	82,191	91.99%
2	Tajpura	270,419	20024	243,296	89.97%
	Sub Total of Aziz Bhatti Town	359,767	27,983	325,487	89.76%
ALLAMA IQBAL TOWN					
1	Iqbal Town including Sabzazar	264,754	30942	243,362	91.92%
2	Samanabad	228,205	29333	207,461	90.91%
3	Ichra	202,668	20,076	159,034	78.47%
4	Johar Town	104,166	18,029	88,020	84.50%
	Sub Total of Allama Iqbal	799,793	98,380	697,877	86.45%
NISHTAR TOWN					
1	Industrial Area	223,554	28,557	163,083	72.95%
2	Green Town	200,476	15,469	180,288	89.93%
3	Garden Town	113,342	18,906	101,962	89.96%
4	Town Ship	197,355	19,583	175,528	88.94%
	Sub Total of Nishtar Town	734,727	82,515	620,861	85.45%
	Grand Total	**5,819,270**	**570,012**	**5,014,634**	**87.26%**

Source: WASA, 2009

(1) Water Sources (Tube-wells) in WASA

Water supply of Lahore city has always been based on the abstraction of groundwater.

According to “Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan.& Feb. 2009”,WASA is supplying water to the citizen from 417 tube-wells of different capacities, installed at a depth varying from 150m to 200m. The number of tube-wells and design capacity is shown in **Table 5.7.**

Total water production of these tube-wells is estimated to be 1,608,000 m^3/day (353.7 MGD) in January and February in 2009 given in **Table 5.7**, based on the reading of bulk flow meter installed on the outlet line of the some tube-wells.

Water production history of WASA in 2008 is shown in **Figure 5.16**. The peak production appears in May and June during summer season. When the rainy season comes in July, August and September, the water production decreases.
WASA is monitoring the static ground water level on a regular basis and average decline in ground water level comes to be 0.9 m (3 ft) approximately. The current situation of ground water is described in further details in **5.2**.

Table 5.7 Tube-wells in WASA

Sr. No.	Name of Town	Capacity of Tubewells						Total Nos of Tubewells	Total Production (mgd)	Total Production (m3/d)
		4 cusec		2 cusec		1 cusec				
		No. of T/W	Prod.	No. of T/W	Prod.	No. of T/W	Prod.			
1	Ravi Town	53	56.7	33	20.5	2	0.6	88	77.8	354,000
2	Shalimar Town	25	26.8	19	11.8	2	0.6	46	39.2	178,000
3	Gunj Bukhsh Town	72	77.0	46	28.5	8	2.5	126	108.0	491,000
4	Aziz Bhatti Town	8	8.6	14	8.7	0	0.0	22	17.2	78,000
5	Iqbal Town	39	41.7	29	18.0	2	0.6	70	60.3	274,000
6	Nishtar Town	33	35.3	24	14.9	3	0.9	60	51.1	232,000
	Total	**230**	**246.1**	**165**	**102.3**	**17**	**5.3**	**412**	**353.7**	**1,608,000**

Source: Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan.& Feb. 2009, WASA

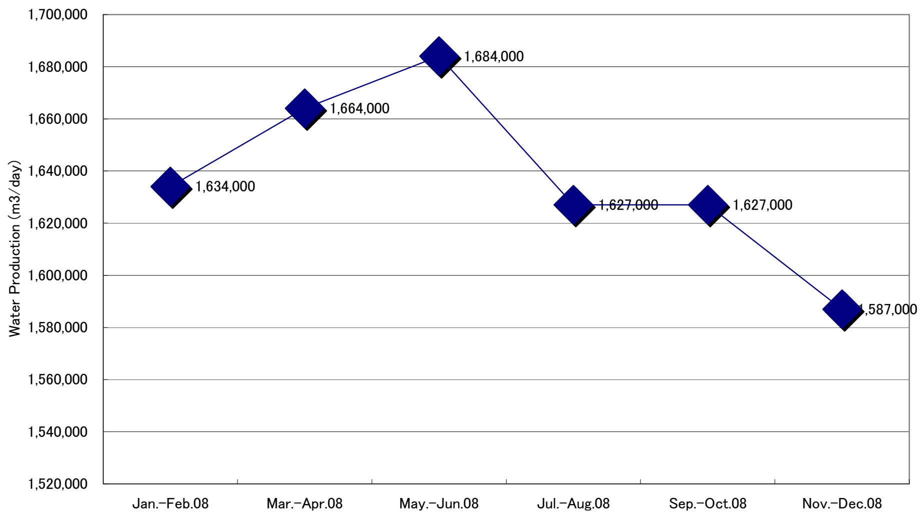


Figure 5.16 Water productions in WASA in 2008

Table 5.8 and **Figure 5.17** shows the between with water production, accounted for water and per capita demand.
Average per capita production is 294L/day in WASA. Maximum per capita demand is 492L/day in Gunj Buksh Town, whereas minimum is 161L/day in Shalimar Town.

Figure 5.18 shows the percentage of accounted for water in WASA. All the towns exceed 70% of accounted for water except for Gunj Buksh Town which has only 55%.

Considering the accounted for water, average per capita demand is 198L/day in WASA whereas average per capita production is 294L/day. That means 96L/capita/day is unaccounted for water on average. Gunj Baksh Town of high per capita production of 492L/day turns out the 264L/day per capita demand. That indicates that lots of leakage or illegal connections of 224L/capita/day can take place in Gunj Baksh Town.

The counterparts in Gunj Buksh Town and peoples form Union Council said that Ravi river bed area is mostly not included in WASA's jurisdiction. People in river bed have their individual shallow wells and manage to get water. They would use hand pumps, but now they started installing mechanical pumps, as ground water level is rapidly declining. Water quality from shallow wells is so poor that they often have stomach problems or some disease. One part of the river bed area is served by WASA, however water quality is still not so good due to deteriorated pipelines and contamination of sewerage water sucked by individual pumps. Deteriorated pipelines can cause leaks and there might be illegal connections in the river bed area to get water. That can result in high unaccounted for water in Gunj Baksh Town.

In order to improve the unaccounted for water and living environment of river bed area, water supply systems should be replaced and installed.

Table 5.8 Water production, accounted for water and per capita demand

No.	Towns	Water Production		Served Population	Per Capita Production	Accounted for water		% of Accounted for water	Per Capita Demand
		MGD	m3/d		L/Capita/d	MGD	m3/d	%	L/Capita/d
1	Ravi Town	78	355,000	1,242,892	286	59	268,000	76%	216
2	Shalimar Town	39	177,000	1,098,594	161	30	136,000	77%	124
3	Gunj Bukhsh Town	108	491,000	998,431	492	59	268,000	55%	268
4	Aziz Bhatti Town	17	77,000	256,564	300	12	55,000	71%	214
5	Iqbal Town	60	273,000	1,252,094	218	42	191,000	70%	153
6	Nishtar Town	51	232,000	617,900	375	36	164,000	71%	265
Total		353	1,605,000	5,466,475	294	238	1,082,000	67%	198

Source: Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan.& Feb. 2009, WASA

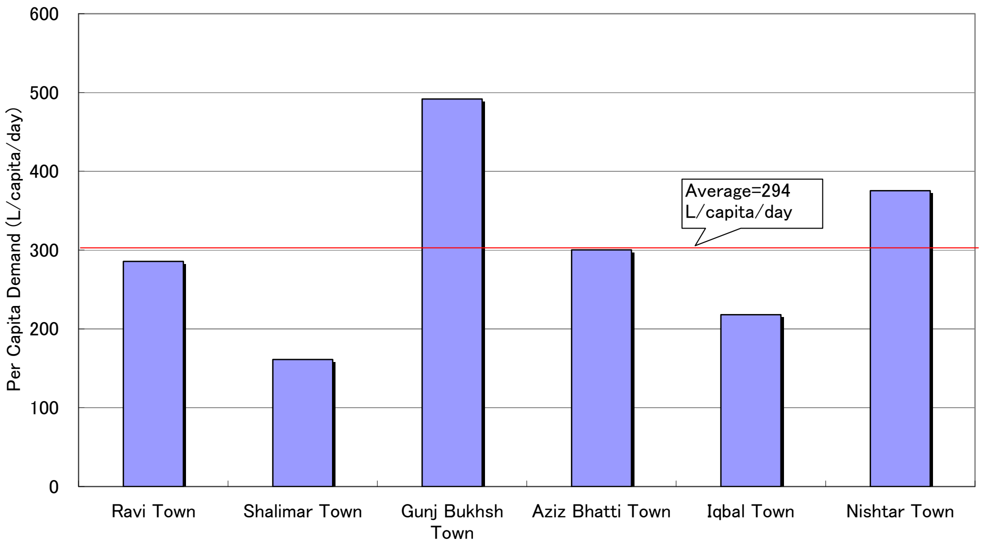


Figure 5.17 Per capita productions

Source: Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan.& Feb. 2009, WASA

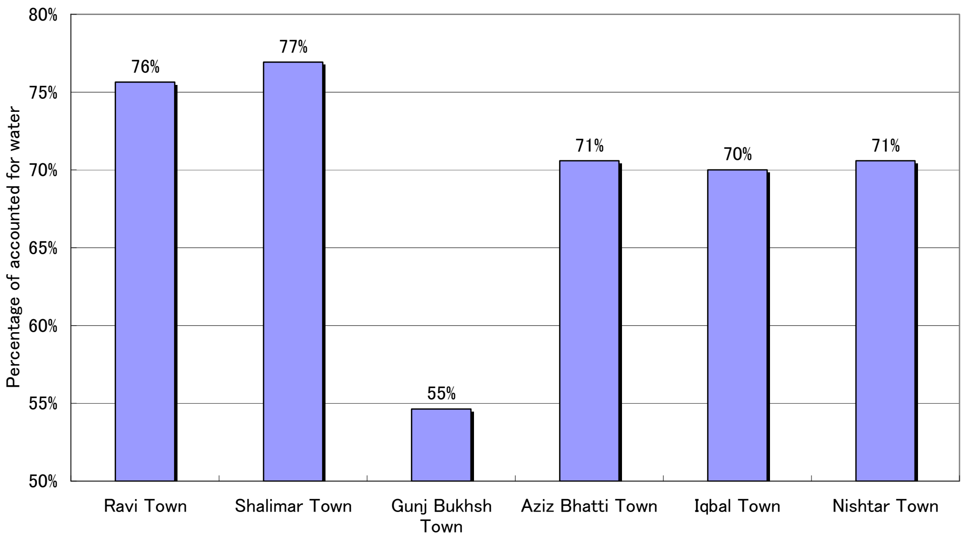


Figure 5.18 Percentage of accounted for water

Source: Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan.& Feb. 2009, WASA

(2) Pump Equipments in WASA

There are 412 working tube-wells in WASA given in **Table 5.7**. These tube-wells include 230 numbers of 112 lps (4 cusecs) capacity, 165 numbers of 56 lps (2 cusecs) capacity and 17 numbers of 28 lps (1 cusec) capacity.

On average the tube-wells work for 14-18 hours per day. In summer season, pumps work for around 20 hours to meet the demand. In either way, water is supplied intermittently due to no use of overhead reservoirs.

It is said that any reduction in pumping hours will substantially reduce the consumption of water and leakage.

Most of the pump head is 64m (210ft) regardless of how ground water level is going down significantly. According to the interview with Director of Shalimar Town, ground water level was observed to be around 6m (20ft) below ground in 1981 when the Director started to work for WASA; however it is currently 34m (110ft) below ground in 2009, 28m further down from 1981. In addition, dynamic water level, when the pump is running, indicates 43m (140ft) below ground level in 2009. Thus, the pressure head above the ground is calculated to be 21m (70ft) (=64- 43m), (= 210- 140ft) because the pump head is 64m. It is often insufficient to deliver water to the customers.

When buying and installing new pumps to tube-wells from now on, WASA should take the decline of ground water into consideration and determine the necessary pump head.

The pumps are all vertical line shaft type sited at ground level and electrically driven. It is said that the pumps typically remain in operation for around 15 years.

Tube-wells are manned continuously with all operational adjustments being undertaken manually on site. Instructions to stop or start pumps are given verbally by the SDO. There in no remote monitoring or SCADA.

These tube-wells inject water directly into the main water supply system. Due to the direct pumping, when the tube-wells are stopped, negative pressure is developed in pipelines which suck in the sewage and other deleterious materials thereby causing water quality problems.

(3) Water Distribution Network in WASA

The water distribution network in WASA area comprises a total pipe length of 4,982 km of which 2,308 km is above 4 inch diameter and 2,674 km is less than 4 inch diameter shown in **Table 5.9**.

The asbestos cement pipe has been mainly laid since the 1970s and is still the preferred material due to its moderation in price. Asbestos pipes are manufactured in Pakistan.

Prior to 1970 cast iron pipe was used although much of it has now been replaced. Ductile iron pipe is now used for some greater pipelines such as 18’’ trunk main line.

The entire network is integrated beyond borderlines of six towns. There are no distribution zones at all so that scattered tube-wells can back up to supply water each other when a certain tube-well is down, however it is difficult to understand the extent of the impact of a given tube-well or tank. No distribution zones results in that water accidents can affect a lot of areas and it is difficult to control the extent of the accidents.

Staff members of WASA said that it has been 30 years approximately since most of the pipelines were placed.

Table 5.9 Pipelines

	Ravi Town	Shalimar Town	Gunj Buksh Town	Aziz Bhatti Town	Allama Iqbal Town	Nishter Town	Total
Above 4" in km	266	259	485	97	410	792	2,308
Less than 4" in km	700	352	639	28	525	430	2,674
Total length of pipelines	966	610	1,124	125	935	1,222	4,982

Source: Monthly Progress Report, April 2009, WASA

Photo 5.2 AC pipelines being laid in WASA

(4) Overhead Reservoirs in WASA

There are 52 overhead reservoirs listed at **Table 5.10** having a total capacity of about 20,000 cu.m (4.4 million gallons) and a height from ground to the bottom water level ranging between 18m to 21m (60ft to 70ft). Depth of a reservoir is 3m (10ft). None of reservoirs, except the 4,500 cu.m (one million gallon) reservoir at Langey Mandi, is in operation due to insufficient capacity

Total capacity of 52 reservoirs is calculated to be 20,000 cu.m (4.4 MG) whereas water production of tube-wells is 1,608,000 cu.m (353.7 MG) in January and February in 2009. Thus, capacity of the reservoirs is only 1.3% of the average day supply. That means that reservoirs get empty in 18 minutes after tube-wells are shut down.

There are no standards in Pakistan for sizing reservoirs, however storage facilities require at least the volume of a few hours of average day supply for the following reasons;

- Equalizing supply and demand
- Increasing operating convenience
- Leveling out pumping requirements
- Providing water during source or pump failure
- Providing water to meet fire demands
- Blending water sources

If WASA install overhead reservoirs with the volume of a few hours of average day supply (1,608,000cu.m), it will require the volume of 201,000cu.m. Assuming that one reservoir has the capacity of 2,000cu.m, WASA will need approximately the number of 100 reservoirs. These reservoirs should be properly laid out in the service area to supply water to customers equally. When considering the arrangement of reservoirs, service areas and distribution zone of each reservoir has to be determined. It requires hydraulic modeling of existing distribution network. That means that location and diameter of existing pipelines should be identified, and then a water supply plan should be developed.

Consequently, there is no advantage to use existing overhead reservoirs at present because the capacity is too small to store water.
However, these reservoirs might be useful in the future as mixing tanks with alternative water source, not storage tanks. Details are described in **9.2**.

Photo 5.3 Overhead reservoir in WASA

Table 5.10 Overhead Tanks in WASA

Sr. No.	DESCRIPTION	SUB DIVISION	CAPACITY (GALLONS)	CAPACITY (m3)
1	Langey Mandi (Pani Wala Talab)	City	1,000,000	4,546
2	Chowk Na-Khuda, Misri Shah	Misri Shah	50,000	227
3	ShadBagh	Misri Shah	50,000	227
4	Wassan Pura	Misri Shah	50,000	227
5	Gujjar Pura	Misri Shah	50,000	227
6	Baghbanpura SDO Office	Baghbanpura	50,000	227
7	Mustafabad SDO Office	Muslafabad	50,000	227
8	Upper Mall Scheme, XEN East Office	Muslafabad	50,000	227
9	Ghari Shahu	Muslafabad	50,000	227
10	Qila-.Muhammadi (Qila Lachman Singh)	Ravi Road	50,000	227
11	Timber Market	Ravi Road	50,000	227
12	Fruit market	Ravi Road	50,000	227
13	Rewaz Garden	Islampura	50,000	227
14	Krishan Nagar SDO Office	Islampura	50,000	227
15	Sham Naaar	Islampura	50,000	227
16	Main market, Samamabad	Samanabad	50,000	227
17	Doongi Ground near Musjid Khizra	Samanabad	50,000	227
18	Sodiwal	Samanabad	50,000	227
19	Chenab Block	Allama Iqbal Town	100,000	455
20	Ravi Block	Allama Iqbal Town	100,000	455
21	F & V Market	Allama Iqbal Town	100,000	455
22	H- Block, Sabzazar	Allama Iqbal Town	100,000	455
23	F - Block, Sabzazar	Allama Iqbal Town	100,000	455
24	Mohlanwal	Allama Iqbal Town	30,000	136
25	Shah Jamai	Ichra	50,000	227
26	Rehmanpura	Ichra	50,000	227
27	Main Bazar, Ichra	Ichra	50,000	227
28	Shadman-l	Ichra	100,000	455
29	Shadman-ll	Ichra	100,000	455
30	A-Block Muslim Town	Ichra	100,000	455
31	Zafar Ali Road	Gulberg	50,000	227
32	Main Gulberg	Gulberg	50,000	227
33	B- Block Gulberg 11	Gulberg	30,000	136
34	T- Block Gulberg	Gulberg	50,000	227
35	A- Block Gulberg ill	Gulberg	50,000	227
36	C- Block Gulberg ill	Gulberg	50,000	227
37	D- Block Gulberg HI	Gulberg	50,000	227
38	E- Block Gulberg HI	Gulberg	50,000	227
39	B- Block Gulberg II	Gulberg	50,000	227
40	FCC Block Gulberg	Gulberg	50,000	227
41	IMP Block Gulberg III	Gulberg	50,000	227
42	Nishtar Colony	Gulberg	50,000	227
43	A- Block M.A. Johar Town	Garden Town	100,000	455
44	Block G-4 M.A. Johar Town	Garden Town	100,000	455
45	F- Block M.A. Johar Town	Garden Town	100,000	455
46	Block R-3 MA Johar Town	Garden Town	100,000	455
47	Trade Center MA Johar Town	Garden Town	100,000	455
48	Tanki No.1 Pindi Stop Industrial Area	Garden Town	50,000	227
49	Gawala Colony	Garden Town	30,000	136
50	Tanki No.2 Block No. P B-1 Township	Township	50,000	227
51	Tanki No.3 Block No. P B-1 Township	Township	150,000	682
52	Tanki No.4 Sector 0-1	Green Town	250,000	1,137
	Total Reservoir Capacity		4,440,000	20,184

Source: WASA, 2009

It is reported that a big housing scheme called "LDA Avenue-1" is being developed in Iqbal Town.

Total area of the project is 8,300,000m2 approximately. It includes 12,000 residential plots, 140km length of roads, 160km length of water supply lines of AC from 3" to 12" diameter, 160km length of sewer lines from 9" to 90" and 16 numbers of tube-wells.

WASA will be responsible for water supply and sewerage system in this scheme.

It is noted that nine overhead reservoirs are planned to be installed and used to feed customers in the scheme. In spite of disuse of other existing reservoirs in WASA, the reason to install new reservoirs is, the scheme is so isolated that they need storage facilities.

The reservoir has a capacity of 450 cu. m (100,000 gallon) each. It is designed to be 25% of average day supply.

16 tube-wells are planned to be installed. They are not designed to be operated for 24 hours, but water will be supplied for 24hours to customers by using the function of reservoirs such as equalizing supply and demand.

Table 5.11 Details of LDA Avenue-1 project

Total area of project	16,320 Kanals (8,300,000m^2)
Residential plots	11,862 nos.
Overhead reservoirs	9 nos. (100,000 gallon capacity each)
Tube-wells	16 nos. (2 cusecs capacity each)
Water supply lines (AC pipes)	Approximately 160km length of all sizes from 3" to 12"
Sewer lines	Approximately 160km length of all sizes from 9" to 90"
Sewage disposal station	1 No.
Storm water drain	Approximately 20km length of all sizes from 3" to 11.5 width

Lahore city is expanding to the south in Iqbal town and Nishter Town so that this kind of scheme will be more developed.

(5) Flow Meters in WASA

Around 40% of tube-wells have bulk flow meters to determine the volume into supply, but most of them do not work. Only 21 flow meters (5% of tube-wells) are working properly given in **Table 5.12** and **Figure 5.19**.

There are no flow meters installed to the outlet line of the overhead tanks.

Results of reading of bulk flow meters in January and February 2009 are shown in **Table 5.13** and **Table 5.14**. 4cusec and 2 cusec tube-wells produce 4,800m3/day (1.07MGD) and 2,800m3/day (0.62MGD) on average respectively. Comparing with the design capacity, it is found that the pump efficiency is going down or accuracy of bulk flow meters is losing. The design capacity of 4cusec and 2 cusec pumps are supposed to be 9,800m3/day (2.15MGD) and 4,900m3/day (1.08MGD) respectively while the observed capacity is 4,800m3/day and 2,800m3/day. Production of tube-wells is decreasing by 40% to 50%.

Total production of tube-wells is estimated by multiplying the duty of the pump by the hours in operation given in **Table 5.7**.

Table 5.12 Bulk Flow Meters in WASA

	Ravi Town	Shalimar Town	Gunj Buksh Town	Aziz Bhatti Town	Allama Iqbal Town	Nishter Town	Total
Total no. of tube-wells	88	46	126	22	70	60	412
Total no. of BFMs	31	26	56	10	28	16	167
Out of order BFM	23	18	43	9	21	12	126
BFM in low reading	4	5	6	0	4	1	20
Working order BFM	4	3	7	1	3	3	21
Not installed	57	20	70	12	42	44	245

Source: Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan. & Feb. 2009, WASA

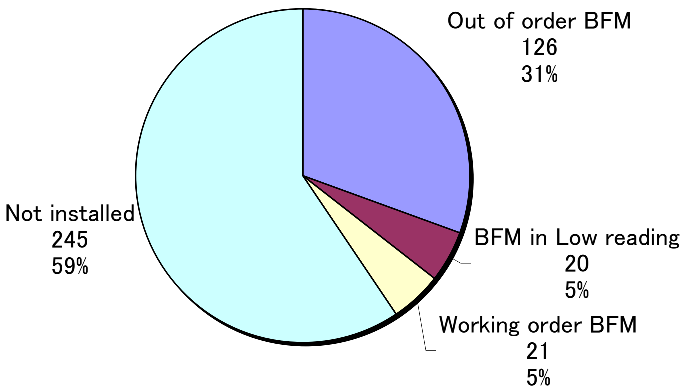


Figure 5.19 Bulk Flow Meters in WASA

Table 5.13 Results of bulk flow meter reading of 4 cusec tube-wells

Town	Location of Tubewell	Capacity		Installation Year	Working hr / day	1st Reading (m3)	Dated	2nd Reading (m3)	Dated	Difference of reading	Difference of Days	MGD	m3/day
		Design	At present										
RAVI TOWN	Lakkar Mandi / Timber Market (City Sub Division)	4 Cfs	3 Cfs	1986	17	1,538,217	2009/1/3	1,760,746	2009/3/2	222,529	58	0.85	3,837
	Latif Chowk (Farkhabad Sub Division)	4 Cfs	4 Cfs	1995	16	8,561,046	2009/1/3	8,895,400	2009/3/2	334,354	58	1.27	5,765
	Shahdra Town (Shahdra Sub Division)	4 Cfs	4 Cfs	2003	16	2,948,612	2009/1/3	3,206,721	2009/3/4	258,109	60	0.95	4,302
SHALIMAR TOWN	Pir Kotli Abdul Rehman (Mughal Pura Sub Division)	4 Cfs	4 Cfs	2000	17	3,238,286	2009/1/2	3,519,172	2009/3/3	280,886	60	1.03	4,681
	Muslim Abad (Mughal Pura Sub Division)	4 Cfs	4 Cfs	2001	16	8,517,885	2009/1/1	8,844,045	2009/3/4	326,160	62	1.16	5,261
GUNJ BUKHSH TOWN	Bagh Munshi Ladha (Ravi Road Sub Division)	4 Cfs	4 Cfs	1986	16	9,744,073	2009/1/10	9,899,496	2009/3/4	155,423	53	0.65	2,933
	E-Block Gulshan-e-Ravi (Islampura Sub Division)	4 Cfs	4 Cfs	2003	16	9,408,903	2008/12/31	9,819,693	2009/3/7	410,790	66	1.37	6,224
	Sodiwal Quarter (Islampura Sub Division)	4 Cfs	4 Cfs	1993	16	1,033,713	2008/12/31	1,312,166	2009/3/2	278,453	61	1.01	4,565
AZIZ BHATTI TOWN	Al-Faisal Town C Block (Tajpura Sub Division)	4 Cfs	4 Cfs	2003	16	7,751,983	2009/1/6	8,072,233	2009/3/9	320,250	62	1.14	5,165
ALLAMA IQBAL TOWN	A Block RehmanPura (Ichhra Sub Division)	4 Cfs	4 Cfs	2003	16	4,840,244	2009/1/1	5,139,730	2009/3/3	299,486	61	1.08	4,910
NISHTAR TOWN	3 D II (Green Town Sub Division)	4 Cfs	4 Cfs	2002	16	3,361,490	2008/12/31	3,709,235	2009/3/3	347,745	62	1.24	5,609
											Average	**1.07**	**4,841**

Source: Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan. & Feb. 2009, WASA

Table 5.14 Results of bulk flow meter reading of 2 cusec tube-wells

Town	Location of Tubewell	Capacity		Installation Year	Working hr / day	1st Reading (m3)	Dated	2nd Reading (m3)	Dated	Difference of reading	Difference of Days	MGD	m3/day
		Design	At present										
SHALIMAR TOWN	Baja Line (Mughal Pura Sub Division)	2 Cfs	2 Cfs	2006	16	1,809,838	2009/1/2	1,955,409	2009/3/2	145,571	59	0.54	2,467
NISHTAR TOWN	Nishtar Colony No.1 (Industrial Area Sub Division)	2 Cfs	2 Cfs	2001	17	1,652,878	2009/1/1	1,854,678	2009/3/7	201,800	65	0.68	3,105
RAVI TOWN	Takkia Khusra Wala (Shadra Town Sub Division)	2 Cfs	2 Cfs	1989	16	2,062,530	2009/1/3	2,223,189	2009/3/2	160,659	58	0.61	2,770
GUNJ BUKHSH TOWN	Patiyala Ground (Anarkali Sub Division)	2 Cfs	2 Cfs	1999	17	3,577,254	2008/12/31	3,784,515	2009/3/2	207,261	61	0.75	3,398
	Dhobi Mandi (Anarkali Sub Division)	2 Cfs	2 Cfs	2005	17	978,232	2008/12/31	1,123,940	2009/3/4	145,708	63	0.51	2,313
												0.62	**2,810**

Source: Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan. & Feb. 2009, WASA

(6) Disinfection

It is reported that water is sometimes contaminated in pipelines due to suction of sewerage through deteriorated pipelines or some reasons. In particular, coliform bacteria, which are supposed to be killed by disinfection, are often positive in tap water so that WASA is working on disinfection at tube-wells.

Water is disinfected by following chlorination equipments.

- Hypochlorinator
- Dripping system
- Ultraviolet treatment

A summary of the WASA monthly progress report for April 2009 reveals the following indication of the state of disinfection at the tube-wells during the month in **Table 5.15** and **Figure 5.20**.

Hypochlorinators are installed in 68% of tube-wells but only half is working properly. Half of chlorinators are currently out of order. 32% of total tube-wells have no hypochlorinators. Those tube-wells which do not have proper hypochlorinators have basically dripping chlorine systems except for four to six tube-wells that have ultraviolet disinfection systems which the Government of Punjab installed.

A hypochlorinator and an UV system is common equipment for disinfection in water, but dripping systems are somewhat unique one to dose chlorine. The dripping system gives a drip of Sodium hypochlorite directly to interspaces between a casing of a tube-well and suction pipe of a tube-well pump.

20% sodium hypochlorite is dosed without dilution from a solution container via suction lines to the tube-well without any pumps. Injection volume of sodium hypochlorite is so small because is not diluted and there is no control system of dosing so that it is unclear how much effect this system has on disinfection, and how much mixed it is. In addition, it is concerned that it can cause a corrosion of suction pipe and casing due to its high oxidizing properties.

When using a dripping system currently, dose of chlorine is 2ppm, 10-12 drops in a minute as instructed by chemists from WASA.

Table 5.15 Chlorinators in WASA

	Ravi Town	Shalimar Town	Gunj Buksh Town	Aziz Bhatti Town	Allama Iqbal Town	Nishter Town	Total
Total chlorinators	43	44	107	20	46	49	309
Working order	13	21	79	13	18	12	156
Out of order	30	23	28	7	28	37	153
Not installed	50	13	34	4	25	17	143
Total no. of tube-wells	93	57	141	24	71	66	452

Source: Monthly Progress Report, April 2009, WASA

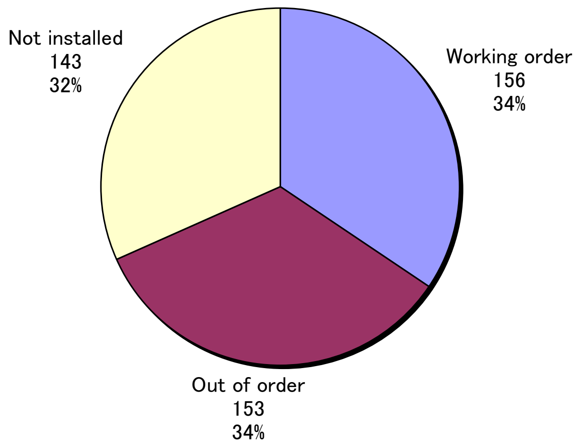


Figure 5.20 Chlorinators in WASA

Photo 5.4 Dripping system

Photo 5.5 Ultraviolet treatment

(7) House Connections

There are 557,000 housing connections in WASA approximately whereas 49% connections are un-metered given in **Table 5.16** and **Figure 5.21**. Even if it is metered, only 73,000 meters are working which is equivalent to 13% of the total connections. Most of the customers might keep their water taps open and sometimes even do not replace or repair faulty taps as they are not financially affected by wastage of water. This amount of wastage has severe implications on the WASA water supply system.

Customers are responsible for their service pipes and their meters. Customers often take the cheapest priced pipe which is of inferior quality. Until recently galvanized iron was the only material used for service pipe but now PVC is preferred. However, cheap, poor quality pipes are still being installed. A high number of customers (estimated to be in order of 50% to 60%) have installed pumps with suction directly from the WASA's water main. this results in inducing negative pressure in the water mains which can introduce contaminated water, particularly during flooding or in the vicinity of sewers or drains.

Table 5.16 Metered & un-metered connections in WASA

Metered, Working	Metered, not working	Unmetered	Total
72,865	212,578	271,447	556,890
13%	38%	49%	100%

Source: WASA Financial Department, 2009

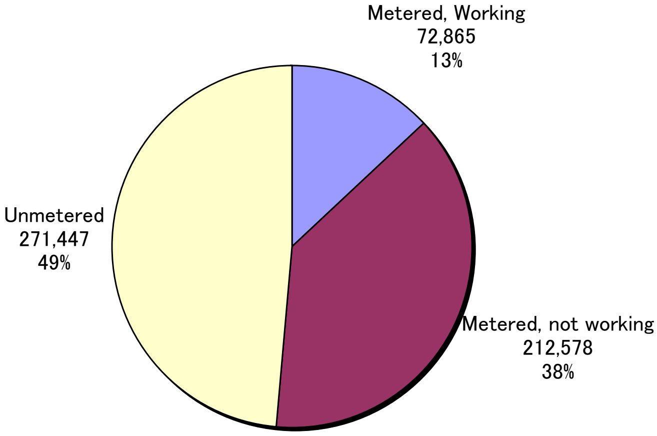


Figure 5.21 Metered & un-metered connections in WASA

It is not possible to list the exact number of illegal connections.

Under the project of "Identification Study of Water Supply and Sewerage Services in Lahore City" in 2007, a pilot area with 1,500 service connections and 30km of pipes was set up in a newly developed residential area of Johar Town. The objective of the pilot area in the project is to demonstrate the principles to assess and reduce the level of Unaccounted for Water. The report says that 3% of connections were found to be illegal and this figure is lower compared to the estimated number of illegal connections in the city more around 5% according WASA officials. This can be explained by the fact that the pilot area is recent, planned and housed by middle and upper income households.

There is no provision of group connection system in the tariff of WASA.

(8) Public stand posts in WASA

When the water supply system in Lahore was under the Lahore Municipal Corporation, public stand posts were sanctioned as free water supply points for an average of 50 houses per connection. Most of such connections exist in the older and thickly populated parts of Lahore. In the past, WASA has been making efforts to disconnect these connections but due to public resentment, these efforts were unsuccessful. WASA has prohibited installation of public stand posts any further and there is no provision of allowing any public stand posts in the future.

However, WASA has a plan to install water taps around tube-wells as “free of cost” drinking water to poor people livings in the areas deprived of clean drinking water.

Table 5.17 Public Stand Posts in WASA

	Ravi Town	Shalimar Town	Gunj Buksh Town	Aziz Bhatti Town	Allama Iqbal Town	Nishter Town	Total
No. of Public Stand Posts	357	3	203	0	18	0	581

Source: Monthly Progress Report, April 2009, WASA

(9) Tanker filling/ Lorry filling in WASA

There are a number of lorry filling points in WASA. These points are used for filling tankers of WASA as well as for filling lorries of Fire Department of City District Government Lahore. The tankers of WASA (total number 24, each of 7000 liters capacity) are used to meet emergency requirements in areas where acute water shortage is caused due to a major breakdown of electricity or of pumping machinery. Water Lorries of Fire Department of CDGL are used for fire fighting in the city. Water is provided free of cost in both cases.

Table 5.18 Tanker filling/ Lorry filling stands in WASA

	Ravi Town	Shalimar Town	Gunj Buksh Town	Aziz Bhatti Town	Allama Iqbal Town	Nishter Town	Total
No. of Lorry filling Stands	5	0	3	1	3	3	15

5.2.3 Urban area out of WASA jurisdiction

Most of the urban area is served by WASA and other areas are supplied by Lahore Cantonment Board, Walton Cantonment Board, Defense Housing Authority, Model Town Society, Pakistan Railway and other private developers. They have their own water supply network with tube-wells and reservoirs.

Table 5.19 shows the served population of these utilities.

Population of these served area is around 950,000 and 74% of them are supplied, which is equivalent to 706,000 people. Percentage of served population in Lahore Cantonment Board looks quite low, but the Lahore Cantonment has recently extended to rural Aziz Bhatti Town. In this area, no facilities like tube-wells or distribution system have been installed. People get water through hand pumps or electric pumps installed on small size bore holes which are drilled to a depth of about 200- 300 feet.

Walton Cantonment area has a large population but its water supply jurisdiction is limited. Its extended areas do not have tap water facilities and also, a large area of Walton Cantonment is in the jurisdiction of Defense Housing Authority which is quite independent and has its own water supply/revenue collection system (estimated no. of connection is 10,000).

Table 5.19 Population in urban area out of WASA area

Utilities	Population	No. of Consumer Connection	Population Served	% of Population Served	Total No. of Houses
Lahore Cantonment Board	268,785	14,516	134,393	50%	20,149
Walton Cantonment Board	541,320	29,610	433,056	80%	51,426
Defense Housing Authority	43,000	8,600	43,000	100%	8,600
Model Town Society	55,000	6,500	55,000	100%	3,600
Pakistan Railways	40,853	6,151	40,853	100%	5,950
Total	948,958	65,377	706,302	74%	89,725

shows that these utilities have 193 tube-wells with total capacity of 877,000m3/day (358.5 cusec feet per second) which on average are operated for 12 to 18 hours a day. They are between 150m (500ft) and 210m (700ft) deep.
Tube-wells have not been provided with any chlorination system and bulk flow meters except for Lahore Cantonment Board.

In Lahore Cantonment Board and Model Town Society, There is no regular monitoring of water quality and water samples are occasionally got tested through laboratory of PCSIR (Pakistan Council for Scientific & Industrial Research).
In Pakistan Railways, water was tested through the laboratory of University of Engineering & Technology only when a new Tube-well was installed and commissioned.

There are 70 overhead reservoirs in the area of these four utilities in **Table 5.22**.

Table 5.20 Pump equipments in urban area out of WASA area

S.NO	DESCRIPTION OF AREA	Number of Tubewells With Capacities								Total No. of Tubewells	Total Capacities Cfs	Total Capacities Cfd	Total Capacities m3/d
		4-Cfs	3.5-Cfs	3-Cfs	2.5-Cfs	2-Cfs	1.5- Cfs	1- Cfs	unknown				
1	Lahore Cantonment Board	0	0	0	0	43	3	6	1	53	98.5	8,510,400	240,988
2	Walton Cantonment Board	0	0	0	0	53	0	0	0	53	106.0	9,158,400	259,337
3	Defense Housing Authority	0	0	0	0	20	0	0	0	20	40.0	3,456,000	97,863
4	Model Town Society	1	0	0	0	14	0	0	0	15	32.0	2,764,800	78,290
5	Pakistan Railways	0	0	0	0	8	44	0	0	52	82.0	7,084,800	200,619
	Total	1	0	0	0	138	47	6	1	193	358.5	30,974,400	877,097

Table 5.21 Disinfection and metering equipments in urban area out of WASA area

		No. of tubewells	Chlorination		No. of Bulk Flow Meters
			Chlorinator	Dripping System	
1	Lahore Cantonment Board	53	53	0	53
2	Walton Cantonment Board	53	0	0	0
3	Defense Housing Authority	20	unknown	unknown	unknown
4	Model Town Society	15	0	0	0
5	Pakistan Railways	52	22	0	0
	Total	193	75	0	53

Table 5.22 Overhead reservoirs in urban area out of WASA area

		No. of reservoirs	Total capacities Gallons	Total capacities m3
1	Lahore Cantonment Board	6	240,000	1,091
2	Walton Cantonment Board	2	150,000	682
3	Defense Housing Authority	20	unknown	unknown
4	Model Town Society	2	20,000	91
5	Pakistan Railways	40	2,328,563	10,586
	Total	70	2,738,563	12,450

Residents of these utilities are not likely to agree to merge their water supply facility with WASA. The primary reason for not accepting to become a consumer of WASA is the difference in water tariff.

Table 5.23 shows the water tariff in these utilities. Consumers basically pay their water bills accordance with the size of the house except for Pakistan Railways. In Pakistan Railways, consumers are charged for water supply at flat rates ranging depending upon the pay scale of the employee getting water.

Table 5.23 Water tariff in urban area out of WASA area

No.	Description of area	Water tariff
1	Lahore Cantonment Board	House up to 10 Marla Area: 720 Rs Per Year House more than 10 Marla Area: 2,400 Rs Per Year
2	Walton Cantonment Board	House up to 10 Marla Area: 720 Rs Per Year House more than 10 Marla Area: 2,400 Rs Per Year
3	Defense Housing Authority	House up to 10 Marla Area: 720 Per Year House more than 10 Marla Area: 2400 Per Year
4	Model Town Society	House up to 1 Kanal area: 160 Rs Per Month House up to 2 Kanals area: 200 Rs Per Month House more than 2 Kanals: 400 Rs Per Month
5	Pakistan Railways	Up to BS-16: 20 Rs Per Month More than Bs-17: 40 Rs Per Month

Note: 1 Marla = 25m2, 1 Kanal = 505m2. Letters “BS” stands for Basic Scale i.e basic salary of a pay scale allowed to a category of employee. The number of basic pay scales (BPS or BS) starts from BS-1 and finish at BS-22 while

BS-1 is the lowest salary paid to an employee.

5.2.4 Rural Area

The latest Census in 1998 tells that there are 1,110,000 people living in rural area.
It is very difficult to describe the details of water supply schemes in rural area, because no public organizations manage them. In that manner, the biggest problem in rural area is absence of professional operators of the water supply system. Either TMA or PHED does not operate water systems at all. WASA also does not take after systems because it is out of jurisdiction. In fact, TDA does not do anything about water supply. PHED is responsible for just design and construction of facilities, not operation and maintenance. After a completion of facilities, PHED hands them over to a User Committees, which is organized of residents. The User Committee as a representative of citizens has to operate their water supply facilities, although they are amateur of operation and maintenance of water supply. Besides, water rate is cheap such as Rs100 per month per connection. User Committee cannot save for operation and maintenance of the system, while people use water whatever they want.

Table 5.24 shows disrupted water supply schemes in the eastern jurisdiction of PHED. 13 out of 16 schemes were disrupted due to nonpayment for electric bill, because people are poor and do not pay water bill. The total amount of construction cost of 16 disrupted schemes is 1,819 million Rs and served population is around 379,000.

Table 5.24 Disrupted water supply scheme offered by PHED

Sr. No.	Towns	Name of Village/Scheme	Completion Year	Completion Cost Rs. In Million	Population Served	Scheme remained Functional up to (Years)	Proposed Rehablitation Cost (Rs. In Million)	Reason for Non Functioning
1	Cantt.	Khana Nou	1996-97	64.5	2,987	10	2.00	Non Cooporation of Public
2	City LHR	Raiwaind	1976-77	16.1	273,313	28	1.00	Non Payment to WAPDA
3	City LHR	Maraka	1999-2000	7.3		7	0.50	Non Payment to WAPDA
4	Cantt.	Pandoke	1995-96	22.4	1,683	12	1.00	Non Cooporation of Public
5	Cantt.	Khana Nou	1996-97	64.5	2,987	10	2.00	Non Cooporation of Public
6	Cantt.	Christian Colony (Raiwind)	1996-97	18.4	10,382	10	0.35	Non Payment to WAPDA
7	Wahga Town	Jadhu Dheer	1997-98	1,425.0	6,759	8	0.35	Non Payment to WAPDA
8	Wahga Town	Dogrian Kalan	1993-94	29.1	11,823	7	5.00	Non Payment to WAPDA
9	Wahga Town	Attuki Awan	1992-93	26.9	11,823	14	5.50	Non Payment to WAPDA
10	Wahga Town	Rampura Jagir	1990-91	12.0	12,489	14	6.00	Non Payment to WAPDA
11	Wahga Town	Awan Dhaiwal	1993-94	18.2	5,290	14	5.50	Non Payment to WAPDA
12	Wahga Town	Dogacth	1996-97	14.7	3,471	10	6.00	Non Payment to WAPDA
13	Wahga Town	Baseen	1992-93	33.9	8,367	14	6.50	Non Payment to WAPDA Low Pressure Stolen of Machinery
14	Wahga Town	Jallo Pind	1992-93	28.4	21,297	14	6.50	Non Payment to WAPDA Low Pressure Stolen of Machinery
15	Wahga Town	Kohrian	1992-93	21.1	3,964	14	5.50	Non Payment to WAPDA
16	Azizz Bhatti Town	Padhri	1993-94	16.2	2,643	14	3.80	Non Payment to WAPDA Low Pressure
		Total		1,818.5	379,278		57.50	

Source: PHED, 2009

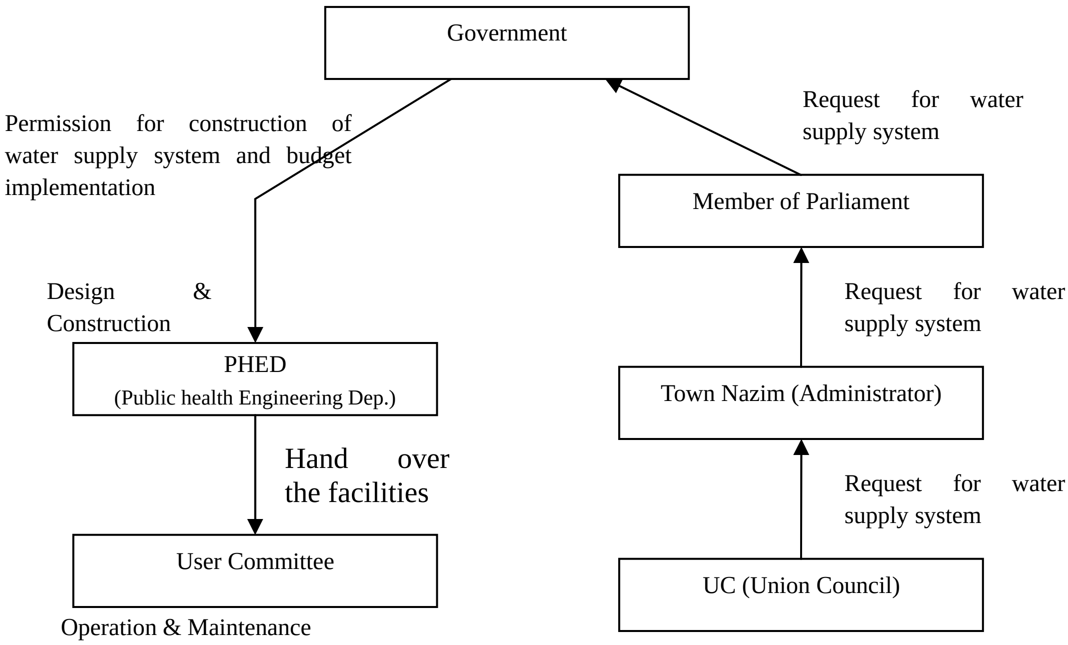


Figure 5.22 Diagram of management system for rural water supply scheme

Figure 5.22 illustrates the framework of management system for rural water supply scheme. UC (Union Council), who are representative of community in a certain rural area, requests to Town Nazim (administrator) for establishment of water supply scheme to their community. Town Nazim requests a member of Parliament for it. Government and Parliament give permission for construction of water supply system and implement budget. PHED execute an instruction and build facilities. Then, PHED hands over the facilities to the User Committee which comprises of residents out there. User Committee takes after the facilities. After handing over, PHED does not participate in management of the water supply scheme.

Directors of PHED, who are in charge of design and construction of rural water supply, told us the overview of water supply schemes in rural area.

- Most of the water supply scheme has one tube-well and one overhead reservoir.
- Capacity of an overhead reservoir is 9m3- 45m3 (2,000-10,000 gallon).
- Depth of tube-wells is around 150- 180m (500-600ft).
- Tube-wells are operated intermittently. In some part of rural area, tube-wells works at 4-8AM, 12-3PM and 6-10PM. It works for 11 hours a day. In some area, it runs only 6 hours a day.
- Tube-wells which were installed a long time ago are not disinfected at all. But recent tube-wells are disinfected.
- There are a lot of damaged pipelines. The government has allocated 620 million Rs for replacement of deteriorated pipelines.
- Material of the pipelines is AC.

- People who have no running water use a hand pump to get water.
- Samanabad Town is located on the river bed defined as flood area. It is not allowed to live there. People live without permission so that public agency cannot provide any facilities.

It is said that people are suffering from polluted water of tannery in Kasur located near the south boundary of Lahore city. They have a symptom such as twisting arms. The government prepared 150 million Rs for them recently.

shows that PHED’s schedule for implementation of water supply schemes in 2008-09. It involves six tube-wells, five overhead tanks and pipelines with the total length of around 77km. This table indicates that asbestos cement pipes are used for pipelines of 8’’ diameter or greater and PVC for less than 6’’ diameter. The size of tube-wells and overhead tanks looks smaller than WASA, tube-wells are mostly 1.0 cusec or 1.5 cusec and the capacity of overhead tanks ranges mainly from 91m3 (20,000 gallon) to 136m3 (30,000 gallon).

Table 5.25 PHED’s schedule for implementation of water supply schemes in 2008-09

Name of the Scheme	1	2	3	4	5	Total
	Dubai Town	Hanjarwal	Nawazish abad	Sultan Town	Raiwind	
Tubewell 1.0 cusec	1	2	1	0	0	4
Tubewell 1.5 cusec	0	0	0	1	1	2
Pumping Chamber	1	2	1	1	1	6
Pumping Machinary	1	2	1	1	1	6
Electric Connection	1	2	1	1	1	6
Pipelines						
3" PVC (ft)	9,430	24,975	9,890	5,745	119,934	169,974
4" PVC (ft)	1,175	6,084	2,500	1,664	23,140	34,563
6" AC (ft)	935	4,439	1,100	1,187	25,270	32,931
8" AC (ft)	305	1,225	1,230	447	8,280	11,487
10" AC (ft)	0	2,265	0	0	800	3,065
Overhead tank						
20,000 gallons	1	1	1	0	0	3
30,000 gallons	0	0	0	1	0	1
100,000 gallons	0	0	0	0	1	1

Source: Public Health Engineering Division Lahore Implementation of ADP Schemes 2008-09 Monthly Progress Report for the Month of 04/2009

5.3 Sewerage

5.3.1 WASA Service Area

The existing WASA Service Area of sewerage system is about 350 km^2. WASA Service Area is divided into six sewerage sub-catchment areas with its own proposed waste water treatment plant (WWTP) as shown in **Figure 5.23**. Sewerage sub-catchment boundaries have been determined primarily on basis of topographical features, existing sewer network and site investigations.

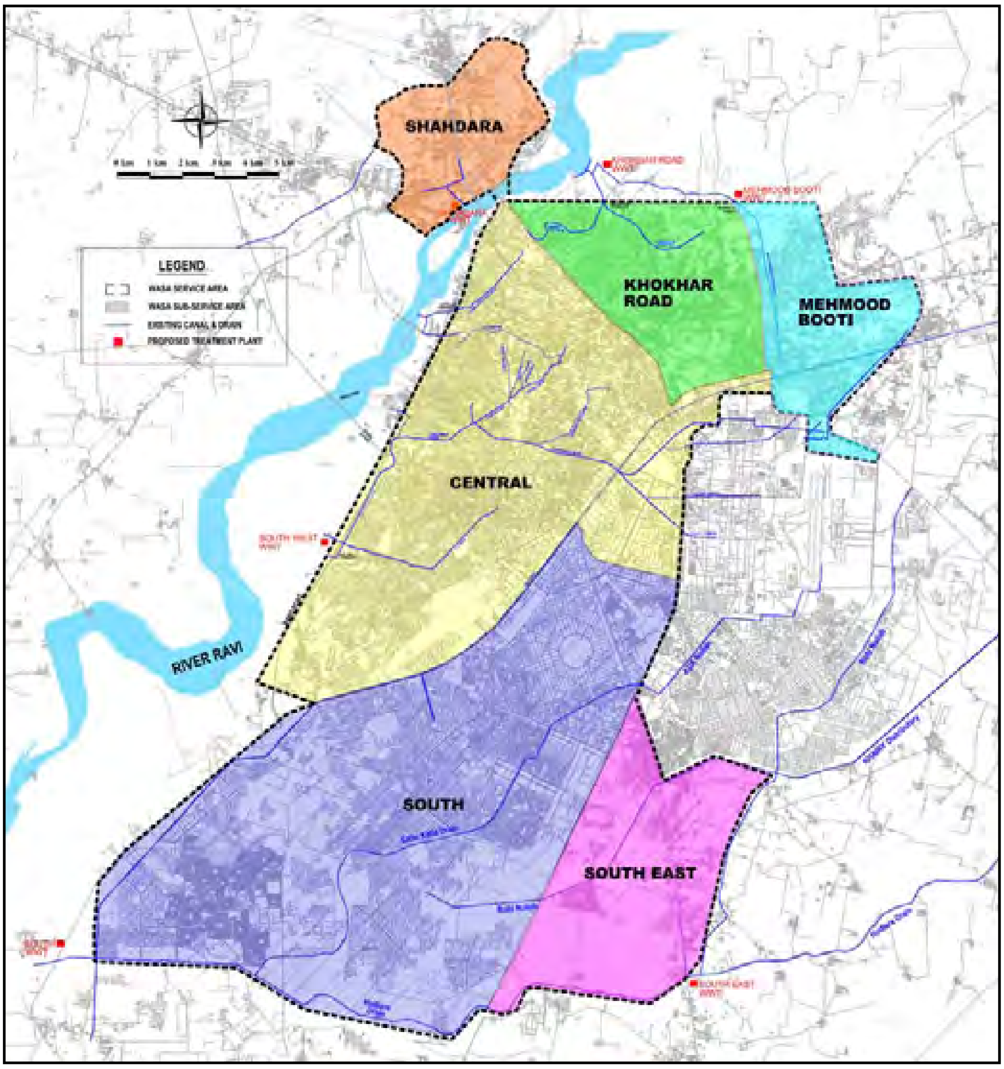


Figure 5.23 WASA Service Area and Sub-catchment Areas

The sewerage system consist of 582 km of trunk sewer and 2,926 km of lateral sewer, making a total length of 3,508 km, 12 major disposal pumping stations and 79 lift stations.

Whole wastewater is finally discharged into the River Ravi without any treatment. The summary of sewerage sub-catchment area are given in the following table.

Table 5.26 Data of Existing Sewer in WASA Service Area

Sub-catchment Area	Area	Length of Sewer (km)			Pipe Material		
		Total	Trunk	Lateral	Brick	RC Pipe	Box Culvert
Shahdara	Shahdara	262	29	233	0%	100%	0%
Mehmood Booti	Mughalpula	126	25	101	18%	82%	0%
Khokhar Road	Data Nagar	122	18	104	0%	100%	0%
	Misri Shar	182	21	161	21%	34%	45%
	Baghbanpura	222	31	191	14%	83%	3%
	Total	*526*	*70*	*456*			
Central	City	94	9	85	46%	54%	0%
	Taj Pura	32	9	23	0%	100%	0%
	Mustafabad	12	4	10	38%	62%	0%
	Ravi Road	179	23	156	29%	71%	0%
	Krishan Nagar	223	45	178	12%	78%	10%
	Sumla Hill	161	21	140	100%	0%	0%
	Mozang	172	17	155	59%	41%	0%
	Gulberg	161	25	136	0%	100%	0%
	Allama Iqbal Town	137	34	103	0%	97%	3%
	Samanabad	88	8	80	22%	78%	0%
	Ichhra	64	38	26	0%	100%	0%
	Total	*1,325*	*233*	*1,092*			
South	Johar Town	305	39	266	0%	100%	0%
	Green Town	131	7	124	0%	100%	0%
	Industrial Area	251	136	115	0%	99%	1%
	Township	223	23	200	0%	100%	0%
	Garden Town	197	8	189	0%	100%	0%
	Total	*1,107*	*213*	*894*			
South East	Makhoon Abad	162	12	150	0%	100%	0%
	Total	**3,508**	**582**	**2,926**			

Source: WASA, 2009

Table 5.27 Summary of Sewerage Sub-catchment Area

Sub-catchment Area	Area (km^2)	Number of Pumping Station		Length of Sewer (km)
		Major Disposal	Lift Station	
Shahdara	18.44	1	6	262
Mehmood Booti	22.79	1	10	126
Khokhar Road	29.19	2	18	526
Central	100.26	6	27	1,325
South	138.95	1	17	1,107
South East	39.65	1	1	162
Total	**340.28**	**12**	**79**	**3,508**

Source: WASA 2009, Inventory Study by JICA Study Team 2009

Correctly, the existing sewer system in Lahore City isn't either separate system or combined system. In the WASA (LDA) Design Criteria, it is recommended that sewer system should preferably be of the separate system; on the other hand, it is suggested that special allowance for some storm water flow be made when designing the sewers. And practically, existing sewers were designed to take storm water flows equal to half of the peak dry weather flow. However, this is not proper combined system because, in case of the combined system, design flow for sewers will be in the range of more than 10 times of the dry weather flow.

The existing sewers mainly consist of RC sewers while in some places egg-shaped brick masonry sewers are also present. The existing sewer networks are semi-combined system for a total length of 3,508 km. The diameter of sewer pipes ranges from 300 mm to 1,830 mm. The breakdown of sewer networks and pipe material is tabulated below:

Since the topography is flat in Lahore City, 79 lift stations are arranged by WASA and wastewater is finally discharged into the River Ravi through 12 major disposal stations, although some individually discharge into the river directly. The location of 12 major disposal stations, 79 lift stations are shown in **Figure 5.24**, and some of the relevant data on these disposal stations and lift stations are shown in **Table 5.28** and **Table 5.29**, respectively.

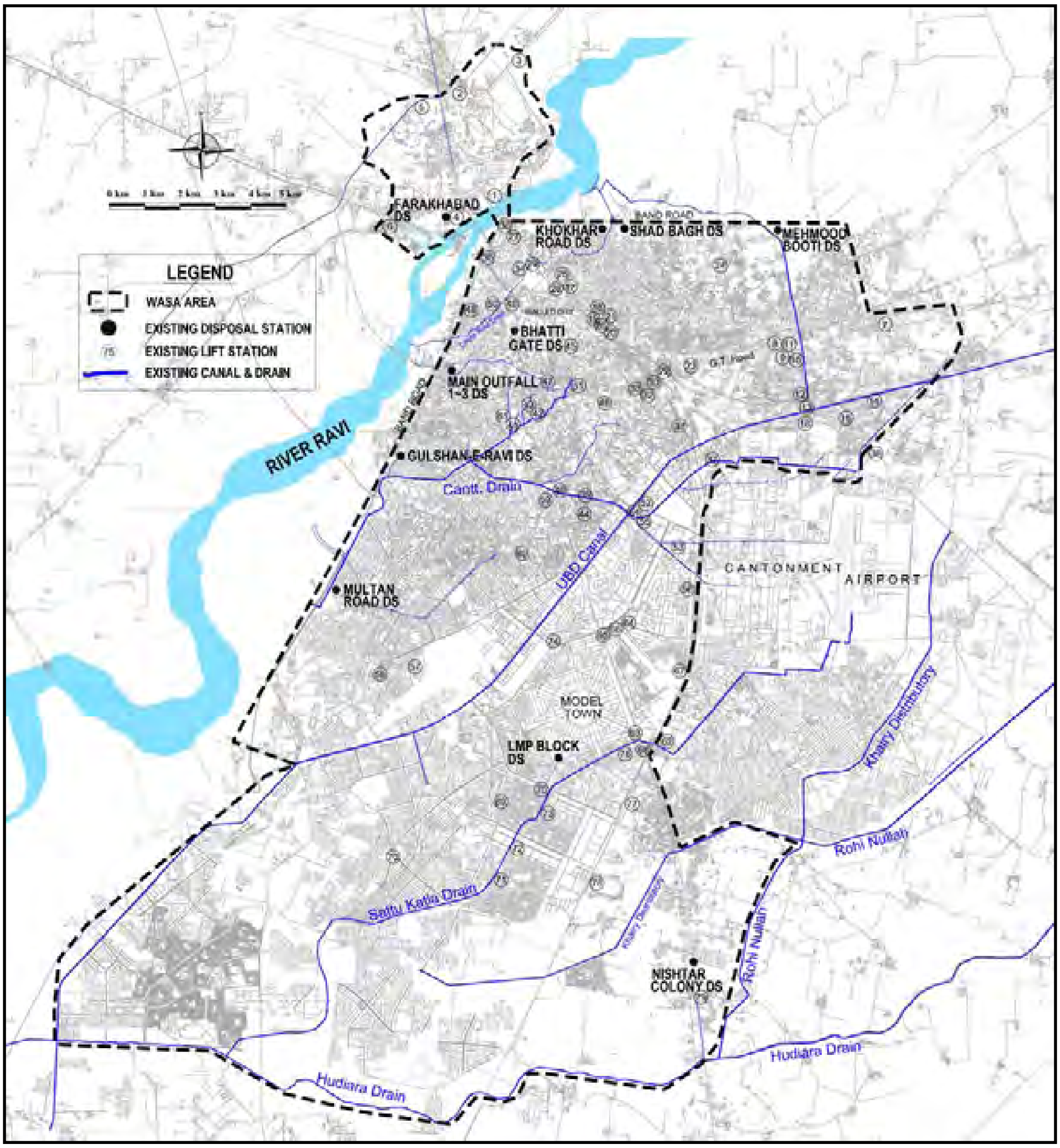


Figure 5.24 Plan of Existing Major Disposal Stations and Lift Stations

Table 5.28 TECHNICAL DATA THE EXISTING TWELVE (12) MAJOR DISPOSAL STATIONS

Sub-service area	SHAHDARA	MEHMOOD BOOTI	KHOKHAR ROAD		CENTRAL						SOUTH	SOUTH EAST
Item	FARARKHABAD	MEHMOOD BOOTI	SHAD BAGH	KHOKHAR ROAD	BHATTI GATE	MAIN OUTFALL-1	MAINOUTFALL-2	MAINOUTFALL-3	GULSHAN-E-RAVI	MULTAN ROAD	LMP BLOCK	NISHTAR COLONY
Location	Sheikhupura Road	Bund Road near Mehmood Booti	Bund Road	Bund Road near Shadbagh	Near Data Darbar.	Bund Road near Saggian Bridge Chowk.	Bund Road near Saggian Bridge Chowk.	Bund Road near Saggian Bridge Chowk.	G-Block, Gulshan-e-Ravi near Bund Road	Sabzazar Scheme, adjacent to Motorway Bypass.	Model Town Extension.	Main Feroze Pur Road near Nishter Colony.
Established Year	1982	1997	1982	1997	2000	1945	1977	1985	1992	1982	1985	1992
Donor *1	WB/DFID	WB/DFID	WB/DFID	WB/DFID	Govt. of Punjab	Govt. of Punjab	WB	Govt. of Punjab	WB	WB	Govt. of Punjab	Govt. of Punjab
Total Capacity	181 Cfs (5.13 m^3/s)	224 Cfs (6.36 m^3/s)	240 Cfs (6.78 m^3/s)	168 Cfs (4.77 m^3/s)	100 Cfs (2.84 m^3/s)	181 Cfs (5.13 m^3/s)	102 Cfs (2.90 m^3/s)	87 Cfs (2.47 m^3/s)	560 Cfs (15.86 m^3/s)	240 Cfs (6.78 m^3/s)	125 Cfs (3.55 m^3/s)	111 Cfs (3.15 m^3/s)
Total Number of Pump	10	4	6	3	4	10	4	5	14	6	6	8
Number and Capacity of Pumps [year installed, type of pump*2]	・3 x 20 Cfs (0.57 m^3/s) [1982, VAF] ・2 x 13 Cfs (0.37 m^3/s) [1995, HAF] ・1 x 25 Cfs (0.71 m^3/s) [1997, HAF] ・1 x 25 Cfs (0.71 m^3/s) [2004, HAF] ・3 x 15 Cfs (0.42 m^3/s) [2005, VAF]	・3 x 56 Cfs (1.59 m^3/s) [1997, VAF] ・1 x 56 Cfs (1.59 m^3/s) [2004, VAF]	・4 x 40 Cfs (1.13 m^3/s) [1982, VAF] ・2 x 40 Cfs (1.13 m^3/s) [2006, VAF]	・3 x 56 Cfs (1.59 m^3/s) [1997, VAF]	・4 x 25 Cfs (0.71 m^3/s) [2000, VAF]	・1 x 25 Cfs (0.71 m^3/s) [1983, HAF] ・1 x 25 Cfs (0.71 m^3/s) [1990, HAF] ・2 x 8 Cfs (0.23 m^3/s) [1999, SP] ・1 x 40 Cfs (1.13 m^3/s) [2000, VAF] ・3 x 15 Cfs (0.42 m^3/s) [2004, VAF] ・2 x 15 Cfs (0.42 m^3/s) [2006, VAF]	・2 x 25 Cfs (0.71 m^3/s) [1988, HAF] ・2 x 26 Cfs (0.74 m^3/s) [1990, SP]	・3 x 25 Cfs (0.71 m^3/s) [1985, HAF] ・2 x 6 Cfs (0.17 m^3/s) [1985, HAF]	・8 x 40 Cfs (1.13 m^3/s) [1982, VAF] ・4 x 40 Cfs (1.13 m^3/s) [2000, VAF] ・2 x 40 Cfs (1.13 m^3/s) [2006, VAF]	・4 x 40 Cfs (1.13 m^3/s) [1982, VAF] ・2 x 40 Cfs (1.13 m^3/s) [2006, VAF]	・2 x 25 Cfs (0.71 m^3/s) [1990, HAF] ・3 x 20 Cfs (0.57 m^3/s) [1999, VAF] ・1 x 15 Cfs (0.42 m^3/s) [2000, VAF]	・3 x 13 Cfs (0.37 m^3/s) [1992, HAF] ・1 x 25 Cfs (0.71 m^3/s) [1996, HAF] ・1 x 8 Cfs (0.23 m^3/s) [2000, SP] ・2 x 12 Cfs (0.34 m^3/s) [2006, HAF] ・1 x 15 Cfs (0.42 m^3/s) [2006, VAF]
Status of Pump	All pumps are in working condition	All pumps are in working condition	All pumps are in working condition	One pump is out of order	One pump is out of order	All pumps are in working condition	All pumps are in working condition	All pumps are in working condition	All pumps are in working condition	All pumps are in working condition	All pumps are in working condition	One pump [1992] is out of order
Number of Gates x Width(m) x Height(m)	2 Nos. x 1.22 m x 1.83 m	6 Nos. x 2.44 m x 2.44 m	2 Nos. x 1.83 m x 1.22 m	6 Nos. x 2.44 m x 2.44 m	1 No. x 1.83 m x 2.38 m 12 Nos. x 1.22 m x 1.83 m	2 Nos. x 2.44 m x 1.52 m 3 Nos. x 1.83 m x 1.52 m 2 Nos. x 1.22 m x 0.91 m 1 No. x 1.22 m x 1.52 m	1 No. x 2.44 m x 2.44 m	1No. x 1.98 m x 1.52 m	4 Nos. x 1.52 m x 2.44 m	3 Nos. x 1.83 m x 3.35 m	2 No. x 1.83 m x 1.83 m	1 No. x 2.44 m x 2.44 m
Size of Inflow Sewer	1 No. x 6 x 10 feet (3.05 x 1.83 m) 1 No. x 6 x 10 feet (3.05 x 1.83 m)	1 No. x 8 x 7 feet (2.44 x 2.13 m)	* 1 No. x ϕ 66 in. (1.68 m) * 1 No. x φ54 in. (1.37 m) * 2 No. x φ60 in. (1.52 m) * 1 No. x 14 x 8 feet (4.27 x 2.44 m)		2 Nos. x 10 x 6 feet (3.05 x 1.83 m)	* 1 No. x φ57 in. (1.45 m) * 1 No. x φ54 in. (1.37 m)	1 No. x φ66 in. (1.68m)	1 No. x 5 x 6 feet (1.52 x 1.83 m)	1 No. x 14 x 11 feet (4.27 x 3.35 m)	1 No. x 7 x 11 feet (2.13 x 3.35 m)	* 1 No. x ϕ 30 in. (0.76 m) * 1 No. x φ36 in. (0.91 m) * 2 No. x φ42 in. (1.07 m)	1 No. x 5 x 7 feet (1.52 x 2.13 m)
Photographs												

NOTE: 1. WB: World Bank
DFID: Department for International Development

Table 5.29 Technical Data for The Existing Lift Stations

No.	Name of Lift Station	Established Year	Pump Type*[1]	Number and Capacity of Pumps (nos.)		(Cfs)	(m^3/s)	Total Capacity (Cfs)	(m^3/s)	Status of Pump	Final Discharge Point
SHAHDARA AREA											
1	Maqbra More	1985	H	1	x	2	(0.06)	2	(0.06)	ok	River Ravi
2	Barkat Town	1989	H	1	x	4	(0.12)	7	(0.21)	ok	Farakhabad DS
			H	1	x	3	(0.09)				
3	Shahdara Town	1990	H	4	x	6	(0.17)	24	(0.68)	ok	River Ravi
4	Saeed Park	1995	H	1	x	4	(0.12)	7	(0.21)	ok	River Ravi
			H	1	x	2	(0.06)				
			H	1	x	1	(0.03)				
5	Faisal Park	1995	H	1	x	2	(0.06)	5	(0.15)	ok	Irrigation Distributary
			S	1	x	2	(0.06)				
			H	1	x	1	(0.03)				
6	Fazal Park	1996	H	2	x	6	(0.17)	18	(0.4)	ok	River Ravi
			S	1	x	4	(0.12)				
			S	1	x	2	(0.06)				
MEHMOOD BOOTI AREA											
7	Madina Chowk	2008	S	3	x	10	(0.29)	38	(1.11)	ok	Shalimar Escape Drain
			S	2	x	4	(0.12)				
8	Dars Baray Mian	1982	H	2	x	2	(0.06)	4	(0.12)	ok	Shalimar Escape Drain
9	Toheed Park	1992	H	2	x	2	(0.06)	4	(0.12)	ok	Shalimar Escape Drain
10	Shah Kamal	1992	H	2	x	2	(0.06)	4	(0.12)	ok	Shalimar Escape Drain
11	Shalimar Link	1984	H	3	x	6	(0.17)	18	(0.51)	ok	Shalimar Escape Drain
12	Lal Pul	1998	S	3	x	2	(0.06)	20	(0.47)	ok	Shalimar Escape Drain
			S	1	x	4	(0.12)				
			H	1	x	4	(0.12)				
			H	1	x	6	(0.17)				
13	Fayaz Park	2001	S	1	x	2	(0.06)	6	(0.12)	ok	Shalimar Escape Drain
			H	1	x	2	(0.06)				
			H	1	x	2	(0.06)				
14	Taj Bagh	2008	S	2	x	6	(0.17)	12	(0.34)	ok	Shalimar Escape Drain
15	B-Block Tajpure	2008	S	1	x	4	(0.12)	10	(0.29)	ok	Shalimar Escape Drain
			S	1	x	6	(0.17)				
16	Tajpura Main	1990	S	1	x	25	(0.71)	75	(2.13)	ok	Shalimar Escape Drain
			H	2	x	25	(0.71)				
KHOKHAR ROAD AREA											
17	Peco	1998	S	2	x	4	(0.12)	14	(0.41)	ok	Siddique Pura Drain
			H	1	x	6	(0.17)				
18	Ellahi Park	1993	H	2	x	6	(0.17)	12	(0.34)	ok	Railway Drain
19	Kachu Pura	1990	H	1	x	2	(0.06)	8	(0.23)	ok	Railway Drain
			H	1	x	6	(0.17)				
20	Do Moria Pul	1998	S	2	x	4	(0.12)	8	(0.24)	ok	Railway Drain
21	Chowk Nakhu	2006	H	1	x	6	(0.17)	6	(0.17)	ok	Railway Drain
22	Achant Garh-I	1992	H	1	x	4	(0.12)	10	(0.3)	ok	Railway Drain
			S	3	x	2	(0.06)				
23	Achant Garh-II		H	2	x	2	(0.06)	4	(0.12)	ok	Shad Bagh DS
24	Wheat Man Road	2008	S	2	x	4	(0.12)	10	(0.24)	ok	Upper Chotta Ravi Drain
			S	1	x	2	(0.06)				
25	Lari Adda	1998	H	2	x	4	(0.12)	10	(0.24)	ok	Siddique Pura Drain
			H	1	x	2	(0.06)				
26	Faiz Bagh	1988	H	1	x	4	(0.12)	6	(0.12)	ok	Railway Drain
			S	1	x	2	(0.06)				
27	Truck Stand	2003	H	2	x	4	(0.12)	12	(0.36)	ok	Siddique Pura Drain
			H	2	x	2	(0.06)				
28	General Bus Stand	2003	S	2	x	6	(0.17)	12	(0.34)	ok	Siddique Pura Drain

No.	Name of Lift Station	Established Year	Pump Type*[1]	Number and Capacity of Pumps				Total Capacity		Status of Pump	Final Discharge Point
				(nos.)		(Cfs)	(m^3/s)	(Cfs)	(m^3/s)		
29	F & V Market	1985	S	1	x	2	(0.06)	14	(0.42)	ok	Siddique Pura Drain
			S	3	x	4	(0.12)				
30	Baja Lane	1985	S	2	x	2	(0.06)	4	(0.12)	ok	Railway Drain
31	Larex Colony	1996	H	1	x	1	(0.03)	11	(0.32)	ok	Railway Drain
			H	1	x	4	(0.12)				
			S	1	x	6	(0.17)				
32	Ghazi Mohallah	1980	H	1	x	2	(0.06)	6	(0.06)	ok	Railway Drain
			H	1	x	4	(0.12)				
33	Muhammad Nagar	1979	H	1	x	2	(0.06)	12	(0.35)	ok	Railway Drain
			H	1	x	4	(0.12)				
			S	1	x	6	(0.17)				
34	Molana Ahmed	2007	H	2	x	4	(0.12)	10	(0.3)	ok	Siddique Pura Drain
			H	1	x	2	(0.06)				
CENTRAL AREA											
35	Forest Colony	1996	H	3	x	6	(0.17)	38	(1.09)	ok	River Ravi
			H	2	x	10	(0.29)				
36	Ali Pure	1980	H	1	x	6	(0.17)	12	(0.23)	ok	River Ravi
			H	1	x	4	(0.12)				
			H	1	x	2	(0.06)				
37	Infantory Road	1986	H	3	x	6	(0.17)	18	(0.51)	ok	Cantt. Drain
38	Bahar Shah Road	1985	H	2	x	6	(0.17)	12	(0.34)	ok	Cantt. Drain
39	Shadman Colony	2007	S	2	x	4	(0.12)	12	(0.36)	ok	Cantt. Drain
			S	2	x	2	(0.06)				
40	Shama Chowk	1999	S	2	x	2	(0.06)	5	(0.15)	ok	Cantt. Drain
			S	1	x	1	(0.03)				
41	Lake Road	2006	S	2	x	4	(0.12)	8	(0.24)	ok	Central Drain
42	Lytton Road No.1	1995	S	1	x	6	(0.17)	18	(0.53)	ok	Central Drain
			S	3	x	4	(0.12)				
43	Lytton Road No.2	1998	H	3	x	6	(0.17)	18	(0.51)	ok	Central Drain
44	Ahata Mool	1986	S	1	x	2	(0.06)	4	(0.06)	ok	Cantt. Drain
			H	1	x	2	(0.06)				
45	Mochi Gate	2004	S	1	x	2	(0.06)	31	(0.89)	ok	Lower Chotta Ravi Drain
			S	1	x	4	(0.12)				
			H	1	x	25	(0.71)				
46	Janki Davi	1987	H	2	x	2	(0.06)	4	(0.12)	ok	Main Outfall-1
47	Nappier Road	2006	H	1	x	25	(0.71)	25	(0.71)	ok	Central Drain
48	Kasurpura (Merzi	1997	H	1	x	6	(0.17)	12	(0.23)	ok	River Ravi
			S	1	x	4	(0.12)				
			S	1	x	2	(0.06)				
49	Bagh Munshi	1996	H	2	x	6	(0.17)	42	(1.08)	ok	Lower Chotta Ravi
			S	1	x	4	(0.12)				
			H	1	x	26	(0.74)				
50	Kali Wali Pulli	1998	S	1	x	1	(0.03)	5	(0.15)	ok	Lower Chotta Ravi Drain
			H	1	x	4	(0.12)				
51	Lakshmi Chowk	2003	H	2	x	25	(0.71)	50	(1.42)	ok	Central
52	Zafar Ali Road	2005	H	1	x	6	(0.17)	6	(0.17)	ok	Cantt. Drain
53	Q-Block	2007	H	1	x	25	(0.71)	41	(1.17)	ok	Cantt. Drain
			S	2	x	8	(0.23)				
54	Sharif Colony G-II	1995	S	2	x	1	(0.03)	8	(0.06)	ok	Cantt. Drain
			H	1	x	6	(0.17)				
55	Gulberg G-Block		H	3	x	25	(0.71)	116	(3.3)	ok	Cantt. Drain
			S	1	x	25	(0.71)				
			S	2	x	8	(0.23)				
56	A-I Block Gulburg	2007	S	2	x	15	(0.43)	55	(1.57)	ok	Cantt. Drain
			H	1	x	25	(0.71)				
57	Mustafa Town		S	3	x	4	(0.12)	12	(0.36)	ok	Multan Rd. DS

No.	Name of Lift Station	Established Year	Pump Type*1	Number and Capacity of Pumps (nos.)	(Cfs)	(m^3/s)	Total Capacity (Cfs)	(m^3/s)	Status of Pump	Final Discharge Point
58	Azam Garden	2007	H	1 x	2	(0.06)	2	(0.06)	ok	Multan Rd. DS
59	Rasool Park	1996	H	1 x	25	(0.71)	53	(1.51)	ok	Cantt. Drain
			H	1 x	10	(0.29)				
			H	3 x	6	(0.17)				
60	Shah Kamal	2003	S	1 x	10	(0.29)	22	(0.63)	ok	AIT Drain
			H	2 x	6	(0.17)				
61	PIA Planitanium	2007	S	2 x	10	(0.29)	26	(0.75)	ok	Central Drain
			S	1 x	6	(0.17)				
SOUTH AREA										
62	LDA Quarter	1986	H	2 x	6	(0.17)	12	(0.34)	ok	Sattu Katla Drain
63	I-T Park Gupal	2007	H	2 x	25	(0.71)	58	(1.65)	ok	Sattu Katla Drain
			S	1 x	8	(0.23)				
64	Center Point	1996	V	1 x	4	(0.12)	12	(0.36)	ok	Irrigation Distributary
			H	1 x	4	(0.12)				
			S	1 x	4	(0.12)				
65	L-Block G-III	1998	H	1 x	1	(0.03)	2	(0.06)	ok	Irrigation Distributary
			S	1 x	1	(0.03)				
66	Nursery Disposal	2007	S	2 x	1	(0.03)	2	(0.06)	ok	Irrigation Distributary
67	Makkah Colony	1993	H	1 x	20	(0.57)	32	(0.91)	ok	Sattu Katla Drain
			H	2 x	6	(0.17)				
68	Nawaz Sharif	2008	S	1 x	1	(0.03)	3	(0.09)	ok	Sattu Katla Drain
			S	1 x	2	(0.06)				
69	Block B-III	2002	H	2 x	4	(0.12)	9	(0.27)	ok	Sattu Katla Drain
			H	1 x	1	(0.03)				
70	Shoukat Khanum	2003	H	2 x	12	(0.34)	56	(1.6)	ok	Sattu Katla Drain
			H	4 x	8	(0.23)				
71	C-II Town Ship	1980	H	3 x	13	(0.37)	63	(1.79)	ok	Sattu Katla Drain
			H	4 x	6	(0.17)				
72	C-I Town Ship	1980	H	2 x	13	(0.37)	44	(1.25)	ok	Sattu Katla Drain
			H	3 x	6	(0.17)				
73	A-II D/S Sector	1980	H	1 x	4	(0.12)	10	(0.29)	ok	Sattu Katla Drain
			H	1 x	6	(0.17)				
74	Usman Block	1991	S	1 x	8	(0.23)	26	(0.75)		Sattu Katla Drain
			S	2 x	6	(0.17)			one is out	
			H	1 x	4	(0.12)			of order	
			S	1 x	2	(0.06)				
75	Satu Katla	1980	S	1 x	25	(0.71)	83	(2.36)	ok	Sattu Katla Drain
			H	2 x	25	(0.71)				
			S	1 x	8	(0.23)				
76	Bahar Colony	2008	H	1 x	6	(0.17)	6	(0.17)	ok	Sattu Katla Drain
77	Boston Colony	1990	S	1 x	4	(0.12)	8	(0.24)	ok	Sattu Katla Drain
			H	1 x	4	(0.12)				
78	Race Club	2007	S	2 x	2	(0.06)	4	(0.12)	ok	Sattu Katla Drain
SOUTH EAST AREA										
79	Youhana Abed	2004	S	1 x	6	(0.17)	10	(0.29)	ok	Hudiara Drain
			S	1 x	4	(0.12)				

Note: *1 V:Vertical Axial Flow Pump, H:Horizontal Axial Flow Pump, S:Submersible Pump
Source: Inventory Study by JICA Study Team, 2009

(1) Shahdara Area

The Shahdara Area covers the area of Jia Musa, Aziz Colony, Rajput Town, Shahdara, Siddiqia Colony. Total area and projected population in 2009 is about 18.44 km^2 and 755,000 persons, respectively. WASA has been provided the sewerage system in this area since 1970's. The existing sewerage system consist of 29 km of trunk sewer and 233 km of lateral sewer, making a total length of 262 km, 1 major disposal pumping station and 6 lift stations. Whole wastewater is finally discharged of into the River Ravi or irrigation channel with no treatment. The Railway Line is a barrier that has divided the Shahdara Area into east and west side. Both sides have following main pumping station.

- West side: Farakhabad Disposal Station
- East Side: Shahdara Town Lift Station

The waste water from Jia Musa, Aziz Colony and Rajput Town is discharged into the Farakhabad Disposal Station, whereas the Shahdara Town Lift Station caters for area of the Shahdara and Siddiqia Colony and finally the waste water is discharged into the River Ravi by means force main. The size of trunk sewers in the Shahdara Area varies from 0.61 m to 1.52 m diameter and trunk sewers were constructed in 1980's but majority of trunk sewers in this area are in good working condition. The existing sewerage system is shown in **Table 5.30** and the location of existing sewerage system in the Shahdara Area is shown in **Figure 5.25**.

Table 5.30 Existing Sewerage System in the Shahdara Area

Sub-Area	Size of Inflow Sewer (m)	Pumping Station					Final Discharge Point
West	ϕ 0.61	→	Faisal Park LS*1	→			Irrigation Channel
	ϕ 0.61	→	Saeed Park LS	→	Farakhabad DS*2	→	River Ravi
	ϕ 0.61	→	Fazal Park LS	→	Farakhabad DS	→	River Ravi
East	ϕ 0.38	→	Maqbra More LS	→	→	→	River Ravi
	ϕ 0.46 & ϕ 0.53	→	Barkat Town LS	→	Shahdara Town LS	→	River Ravi
	ϕ 0.76 & ϕ 0.91	→	Shahdara Town LS	→	→	→	River Ravi

Source: WASA, 2009 & Inventory Study JICA Study Team, 2009
Note: *1 LS: Lift Station, *2 DS: Disposal Station

The Farakhabad Disposal Station was constructed in 1982 and total number of pump is 10 pumps. Out of the 10 pumps, 2 pumps which were installed in 1982 do not function full capacity of pump due to aging.

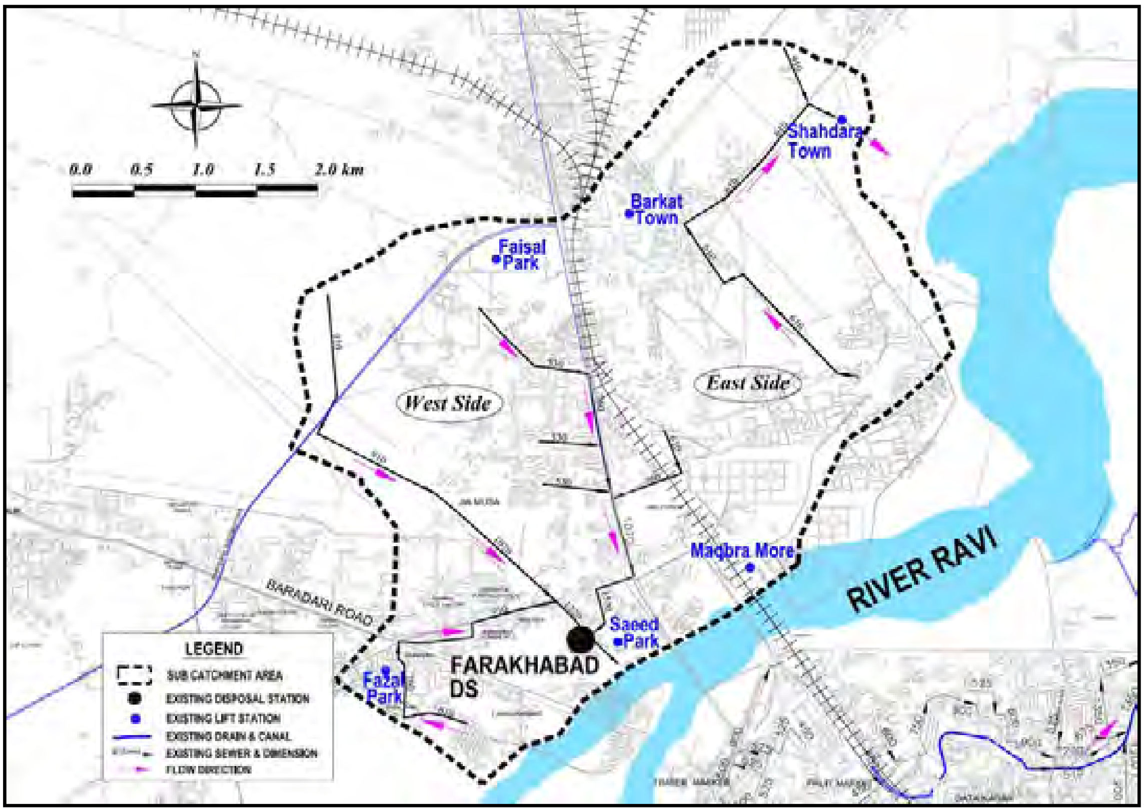


Figure 5.25 Existing Sewerage System in the Shahdara Area

(2) Mehmood Booti Area

Mehmood Booti Area is located in the northeast of WASA Service Area. WASA has provided the sewerage system in this area since 1970's. The existing sewerage system consists of 25 km of trunk sewer and 101 km of lateral sewer, making a total length of 126 km and Mehmood Booti Disposal Station. The size of trunk sewers varies from 0.69 m to 2.44 x 2.13 m (box culvert). The wastewater is collected at the Mehmood Booti Disposal Station through the sewers and untreated wastewater is pumped to the River Ravi directly. Majority of the sewers in this area are in good working condition, however, some of the sewers in southern part of this area are already settled and are not in proper working condition, and also the existing trunk sewers do not cover the requirement of all of this area. Therefore, sewers from a number of adjoining areas are connected to the Shalimar Escape Channel directly or through existing 10 lift stations.

The Mehmood Booti Drainage Pumping Station receives discharge from the Shalimar Escape Channel so the Mehmood Booti Drainage Pumping Station is utilized as a disposal station during dry weather. Whole wastewater from this pumping station finally flows to the River Ravi without any treatment. The location of existing sewerage system in the Mehmood Booti Area is shown in **Figure 5.26.**

The Mehmood Booti Disposal Station was constructed in 1997. There are 4 pumps and all pumps are in working condition. However, installed generator, 1,000 KVA, can operate only 3 pumps so it needs to provide additional generator. The present capacity of pumps will be inadequate to cater for the future sewage flows.

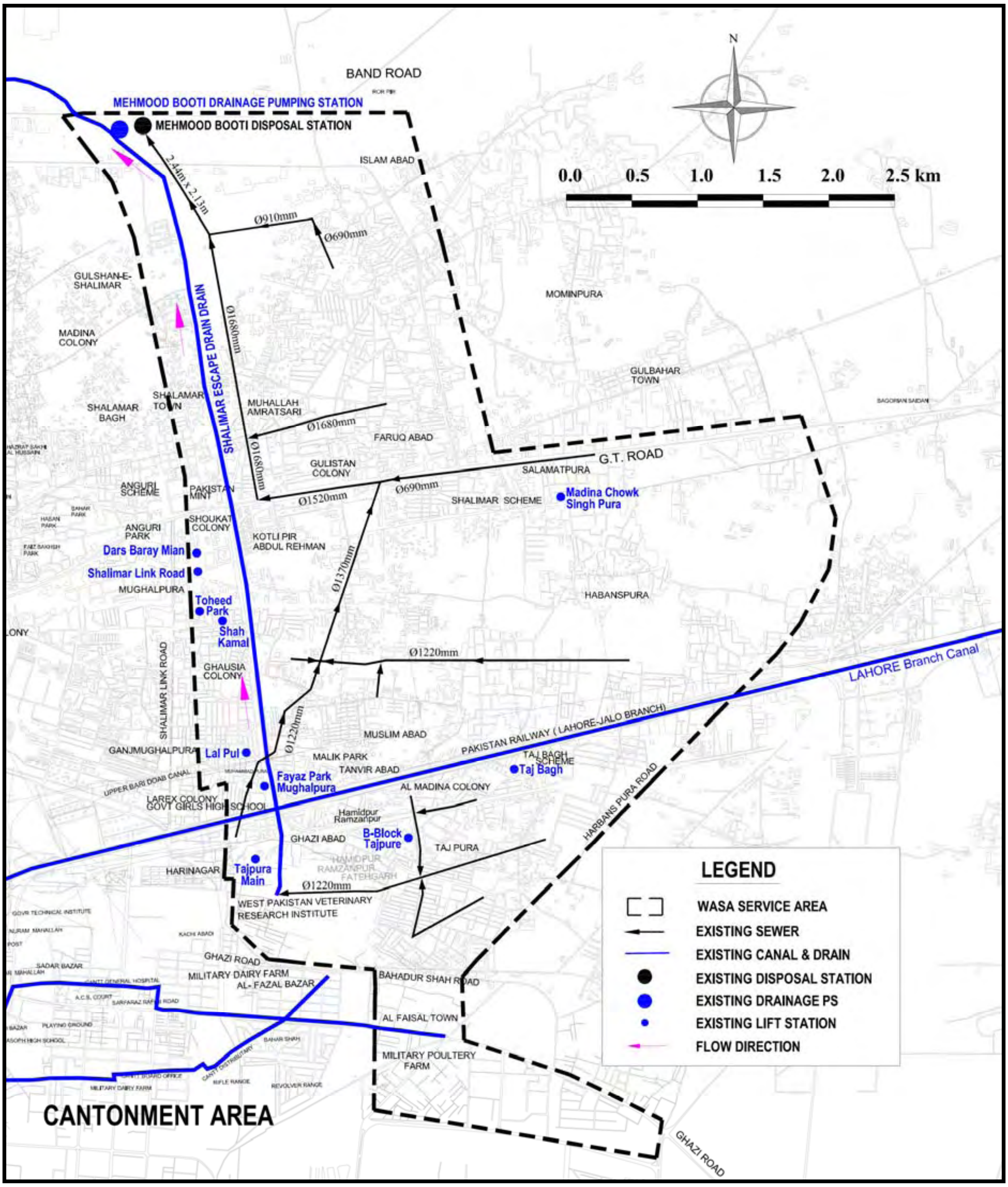


Figure 5.26 Existing Sewerage System in the Mehmood Booti Area

(3) Khokhar Road

The Khokhar Road Area for sewerage and drainage system includes the area delimited by Band Road in the north, Pakistan Railway Line in the southwest & southeast and boundary line of the Mehmood Booti Area in the east. Total area is about 29.19 km^2 and the WASA has provided the infrastructure in this area since 1970's. The existing sewerage & drainage system consists of 70 km of trunk sewer and 456 km of lateral sewer, making a total length of 526 km, 3 main drains, 2 major disposal pumping station, 1 drainage pumping station and 18 lift stations. All of wastewater from this area is collected at the Khokhar Road Disposal Station, Shad Bagh Disposal Station and Siddique Pura Drainage Pumping Station and inlets of these pumping stations meet at the same wet well. Whole wastewater is finally discharged of into the River Ravi without any treatment. The existing sewers mainly consist of RC sewers while in some places egg-shaped brick masonry sewers are also present. Most of the trunk sewers are in good working condition. The size of trunk sewers in this area varies from 0.50 m to 1.50 m diameter. The flow of wastewater in existing sewerage & drainage system is tabulated in **Table 5.31** and the location of existing sewerage system in the Khokhar Road Area is shown in **Figure 5.27.**

Table 5.31 Existing Sewerage System in the Khokhar Road Area

<table>
<tr><th>Lift Station or Trunk Sewer</th><th colspan="5">Main Drain</th><th>Final Discharge Point</th></tr>
<tr><td>Trunk Sewer (ϕ 1.35m)</td><td>→</td><td>→</td><td>→</td><td>→</td><td>→</td><td rowspan="4">Khokhar Road DS*2
& Shad Bagh DS &
Siddique Pura DPS*3
↓
River Ravi</td></tr>
<tr><td>1) Truck Stand LS*1
2) Molana Ahmed LS
3) F&V Market LS
4) General Bus Stand LS
5) Peco LS
6) Lari Adda LS</td><td>→</td><td>→</td><td>→</td><td>Siddique Pura Drain</td><td>→</td></tr>
<tr><td>1) Ellahi Park LS
2) Kachu Pura LS
3) Do Moria Pul LS
4) Chowk Nakhu LS
5) Achant Garh-I LS
6) Faiz Bagh LS
7) Baja Lane LS
8) Larechs LS
9) Ghazi Mohallah LS
10) Muhammad Nagar LS</td><td>→</td><td>Railway Drain</td><td>→</td><td>Siddique Pura Drain</td><td>→</td></tr>
<tr><td>1) Achant Garh-II LS
2) Wheat Man Road LS</td><td>→</td><td>→</td><td>→</td><td>Upper Chotta Ravi Drain</td><td>→</td></tr>
</table>

Source: WASA, 2009 & Inventory Study JICA Study Team, 2009

Note: *1 LS: Lift Station, *2 DS: Disposal Station, *3 DPS: Drainage Pumping Station

The Shad Bagh Disposal Station was constructed in 1982 and total number of pumps is 6. Out of the 6 pumps, 4 pumps which were installed in 1982 do not function the full capacity due to aging, so their will need replacement. The existing generator, 1,000 KVA, can operate only 4 pumps so it needs to provide additional generator. The present capacity of pumps will be inadequate to cater for the future sewage flows.

The Khokher Road Disposal Station has 4 pumps but one pump is out of order due to mechanical problem. And existing generator of 1,000 KVA also has mechanical problem so it needs replacement.

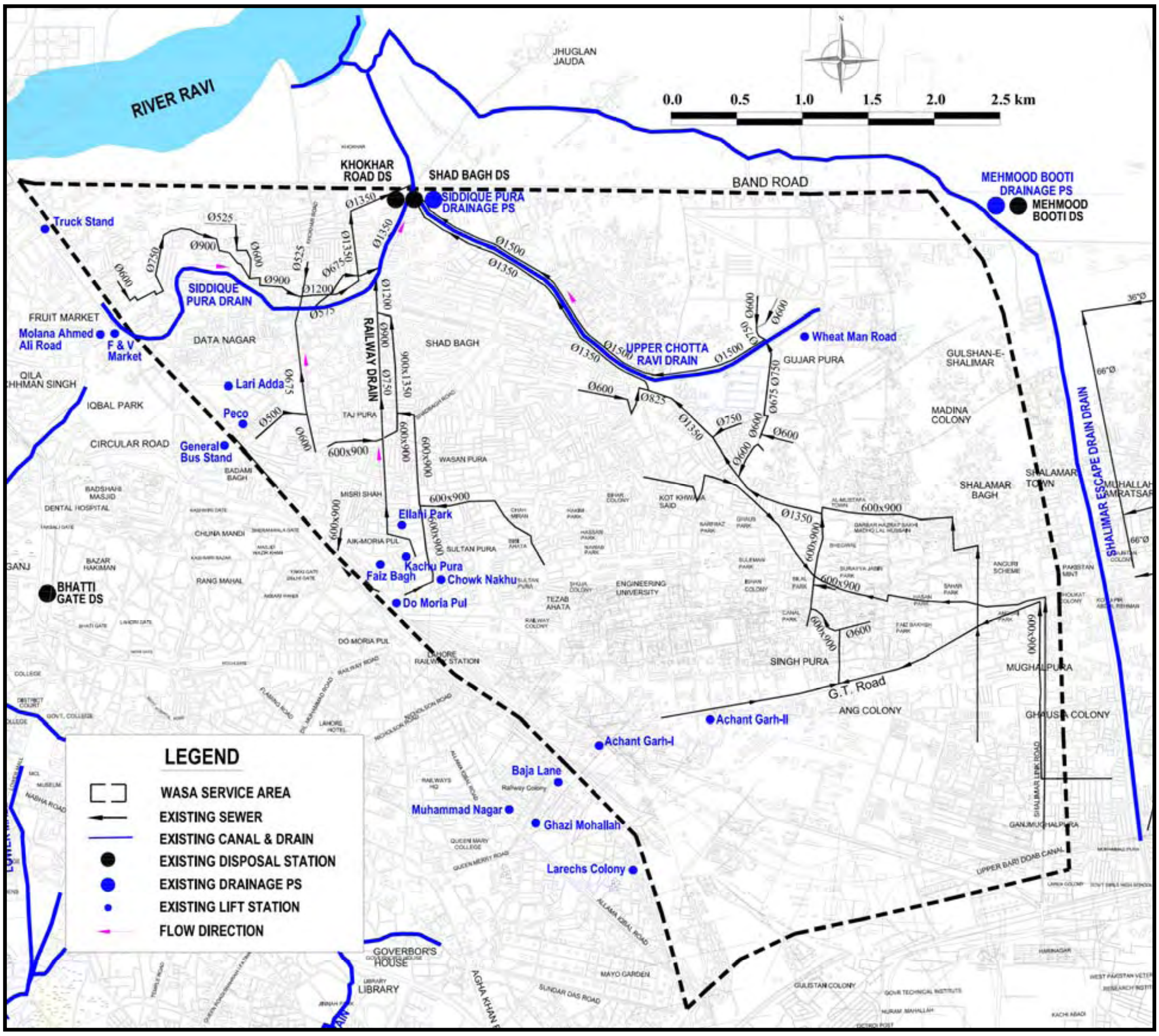


Figure 5.27 Existing Sewerage System in the Khokhar Road Area

(4) Central Area

This area is core of WASA service area and covers the old area located in North, which has been developed for long time and has an old sewerage system installed by WASA.

The existing sewerage system consists of 233 km of trunk sewer and 1,092 km of lateral sewer, making a total length of 1,325 km, 4 main drains, 6 major disposal pumping station, 2 drainage pumping stations and 27 lift stations. The existing sewers mainly consist of RC sewers while in some places egg-shaped brick masonry sewers are also present. The size of trunk sewers in this area varies from 0.50 m to 1.83 m diameter. The existing sewerage system of the Central Area was laid about 20 to 70 years back. During this period, there has been immense increase in population making the system inadequate for present population. Also, most of the sewers in the existing sewerage system has been badly silted up causing operation and maintenance problems. There are various industries in upper part of the Central Area such as moulding industry, carpet industry and flour mills. These industries discharge wastewater into the sewers without any treatment process thus resulting into the reduction of capacity of sewers due to sedimentation and choking. Basically, the waste water should not be discharged into the open drains, however, most of the waste water is discharged into the open drains via sewerage lift stations as mentioned in **Table 5.33**.

At present, the wastewater is directly discharged to the River Ravi from the following pumping stations without any treatment.

- Main Outfall No.1~3 Disposal Stations
- Gulshan-e-Ravi Disposal Station
- Multan Road Disposal Station
- Chotta Ravi Drainage Pumping Station
- Babu Sabu Drainage Pumping Station

Ideally, drainage pumping stations are constructed only for the purpose of storm water drain but in fact a number of sewers are connected to storm water drain so drainage pumping station is utilized as a disposal station during dry weather. The existing sewerage & drainage system is tabulated in **Table 5.32** and the location of existing sewerage system in the Central Area is shown in **Figure 5.28**.

Table 5.32 Existing Sewerage System in the Central Area

Lift Station	Main Drain or Trunk Sewer					Final Discharge Point
1) Forest Colony 2) Ali Pure 3) Kasurpura	→	→	→	→	→	River Ravi
1) Bagh Munshi 2) Kali Wali Pulli	→	→	→	Lower Chotta Ravi Drain	→	Chotta Ravi Drainage Pumping Station
1) Mochi Gate	→	Trunk sewer	→	Lower Chotta Ravi Drain	→	Chotta Ravi Drainage Pumping Station
1) Janki Davi	→	Trunk sewer	→	Trunk sewer	→	Main Outfall No.1 Disposal Station
1) Lake Road 2) Lytton Road No.1 3) Lytton Road No.2 4) Nappier Road 5) Lakshmi Chowk 6) PIA Planitanium	→	Central Drain	→	Cantonment Drain	→	Babu Sabu Drainage Pumping Station
1) Infantory Road 2) Bahar Shah Road 3) Shadman Colony 4) Shama Chowk 5) Ahata Mool 6) Zafar Ali Road 7) Q-Block 8) Sharif Colony G-II 9) G-Block Gulberg-II 10) A-I Block Gulburg 11) Rasool Park	→	→	→	Cantonment Drain	→	Babu Sabu Drainage Pumping Station
1) Shah Kamal	→	Trunk Sewer	→	AIT Drain	→	Multan Road Disposal Station
1) Mustafa Town 2) Azam Garden	→	Trunk Sewer	→	Trunk Sewer	→	Multan Road Disposal Station

Source: WASA, 2009 & Inventory Study JICA Study Team, 2009

Multan Road Disposal Station was constructed in 1982 and existing 6 pumps are in working condition. Out of the 6 pumps, 4 pump which were installed in 1982 need replacement due to aging of pumps. The present capacity of pumps will be inadequate to cater for the future sewage flows.

For Gulshan-e-Ravi Disposal station, there are 14 pumps and all of pumps are in working condition. However, 8 pumps are old which were installed in 1982 so that these pumps do not function to full capacity. The present capacity of pumps will be inadequate to cater for the future sewage flows.

Main Outfall No.1 Disposal Station was constructed in 1945 and their, this pumping station is the oldest one in Lahore. This disposal station has 10 pumps and all pumps are in working condition. However, 2 pumps which were installed in 1983 and 1990 need replacement due to aging. Main Outfall No.2 Disposal Station was constructed in 1977. This disposal station has 4 pumps and all pumps are in working condition. However, 2 pumps whivh were installed in 1988 need replacement due to aging.

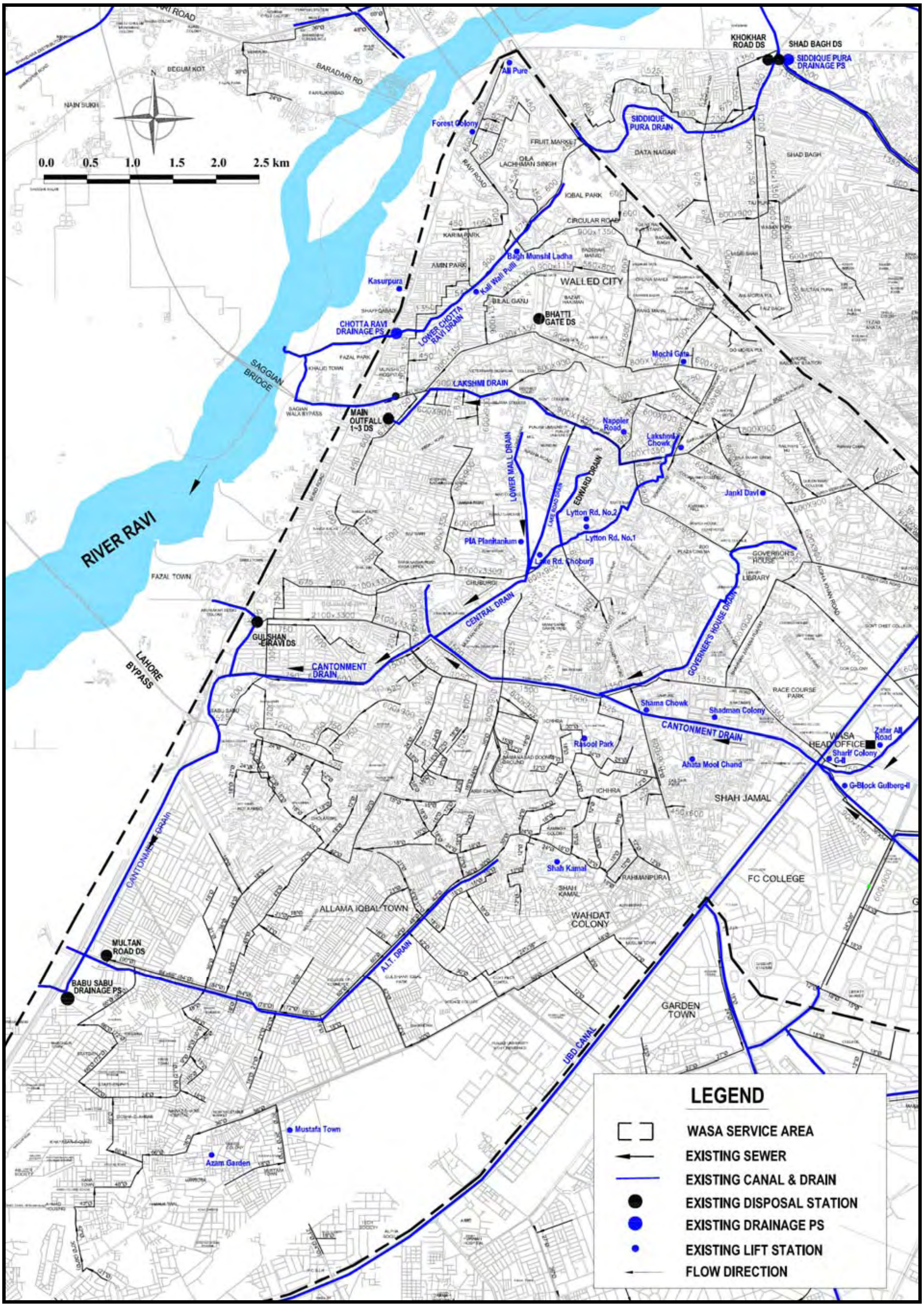


Figure 5.28 Existing Sewerage System in the Central Area

(5) South Area

The sewerage system of the South Area mainly consists of RC sewers along with a small proportion of egg-shaped brick masonry sewers and the related appurtenances. The age of old sewerage system in the upper part of the South Area, comprising of areas like Gulberg, Garden Town, Faisal Town, Model Town, Township and Green Town is about 20 to 40 years old, while sewers and their related appurtenance in the newly developed areas, in the lower part of the South Area, were constructed in the last 5 to 15 years.

The existing sewerage system consist of 213 km of trunk sewer and 894 km of lateral sewer, making a total length of 1,107 km, the LMP Block Disposal Station and 17 lift stations.

At present, lower part of the South Area is rapidly growing towards southwest and new housing schemes are being developed over vast contiguous or isolated areas. Developers of these housing schemes though have provided their internal sewerage systems but they do not have the facility of trunk sewers for interlinking different schemes for environment friendly ultimate disposal of sewage.

The existing sewers, in the upper part of South Lahore mainly consist of RC sewers while in some places egg-shaped brick masonry sewers are also present. Most of the trunk sewers in the existing system are inadequate to cater for the present and future sewage flows. Existing trunk sewers in most of the areas are in poor condition and have lived their lives and need to be replaced. This system has also been supplemented/ extended as part of development of a number of housing schemes in the private and government sector, through laying of additional sewer lines and temporary lift stations in the area. Presently, wastewater is discharged into irrigation distributaries or the Sattu Katla and Hudiara Drains as main carriers which ultimately fall into the River Ravi near Maraka. Out of the 17 lift stations, the following 3 lift stations discharge the wastewater to irrigation distributaries.

- Center Point Lift station
- L-Block G-III Lift Station
- Nursery Disposal Lift Station

In the lower part of South Area, mainly consisting of new developments, no trunk sewer facilities have been provided so far by WASA. In these areas wastewater is being pumped to the nearby storm water drains and where no storm water drains exist, wastewater is discharged to even in open fields, thus creating environmental nuisance.

The LMP Block Disposal Station was constructed in 1985 and existing 6 pumps are working condition however the present capacity of pumps will be inadequate to cater for the present and future sewage flow.

The location of existing sewerage system in the South Area is shown in **Figure 5.29.**

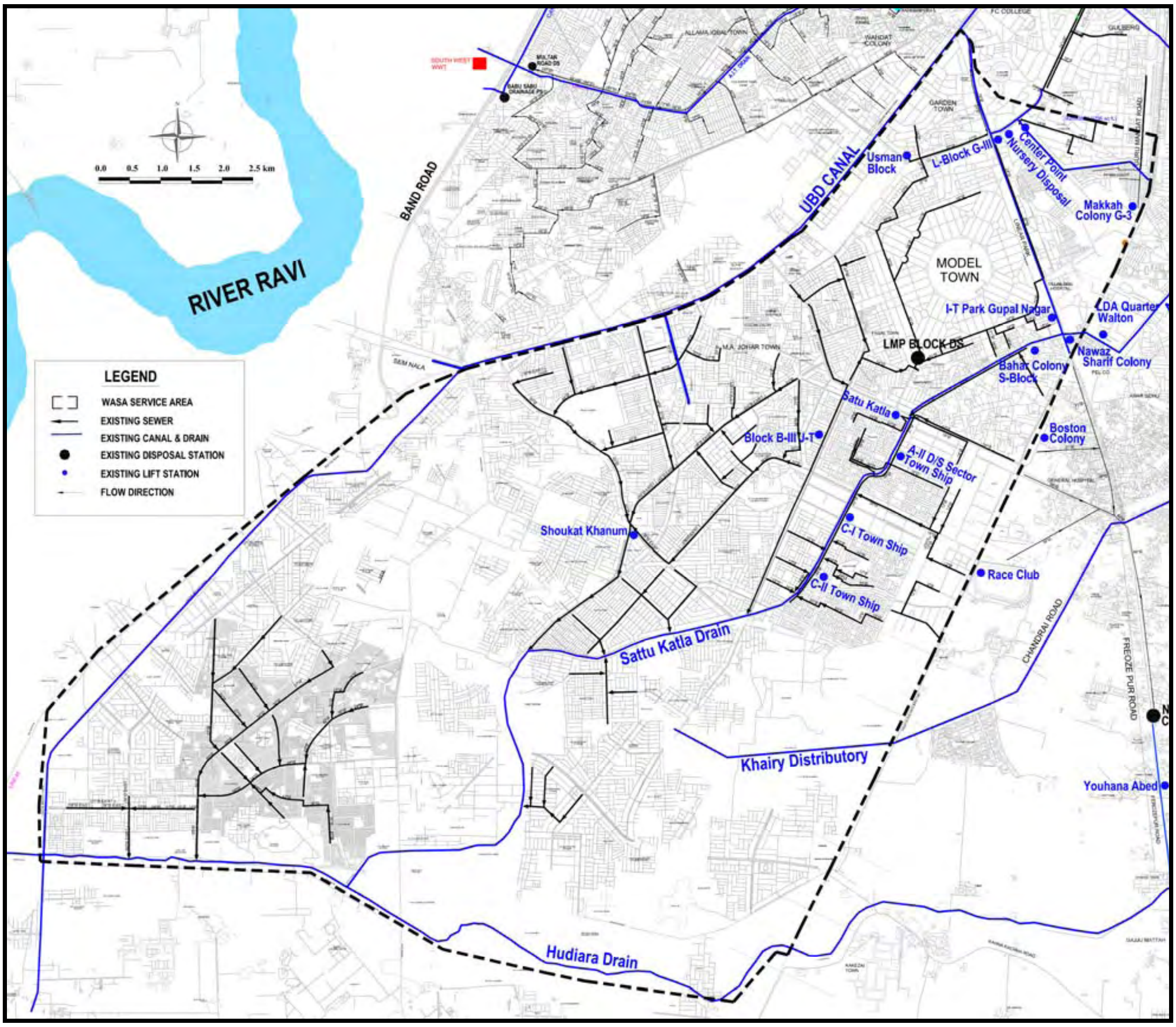


Figure 5.29 Existing Sewerage System in the South Area

(6) South East Area

The South East Area covers areas developed in recent past such as Saroba Town, Shadab Colony, Hamza Town, Asif Town and Gujar Colony and many other housing schemes under process of development. This area has been experiencing very fast urban growth rate, but trunk sewers have not been provided at the same rate along suitable routes. The existing sewerage system consist of 12 km of trunk sewer and 150 km of lateral sewer, making a total length of 162 km, 1 major disposal pumping station and 1 lift station. The size of trunk sewers in this area varies from 0.53 m diameter to 2.13 x 1.83 m (box culvert). The wastewater from the area along Freoze Pur Road is collected to the Nishtar Colony Disposal Station and finally is discharged into the Hudiara Drain without any treatment. The trunk sewer is in good working condition but majority of the branch sewers are already settled and are not in proper working condition.

However, most of the South East Area, mainly consisting of new developments, no trunk sewer facilities has been provided so far by WASA. In these area, wastewater is discharged into the nearby storm water drains and where no storm water drain exist, wastewater is discharged to even in open fields, thus creating environmental nuisance. The location of existing sewerage system in the Shahdara Area is shown in **Figure 5.30**.

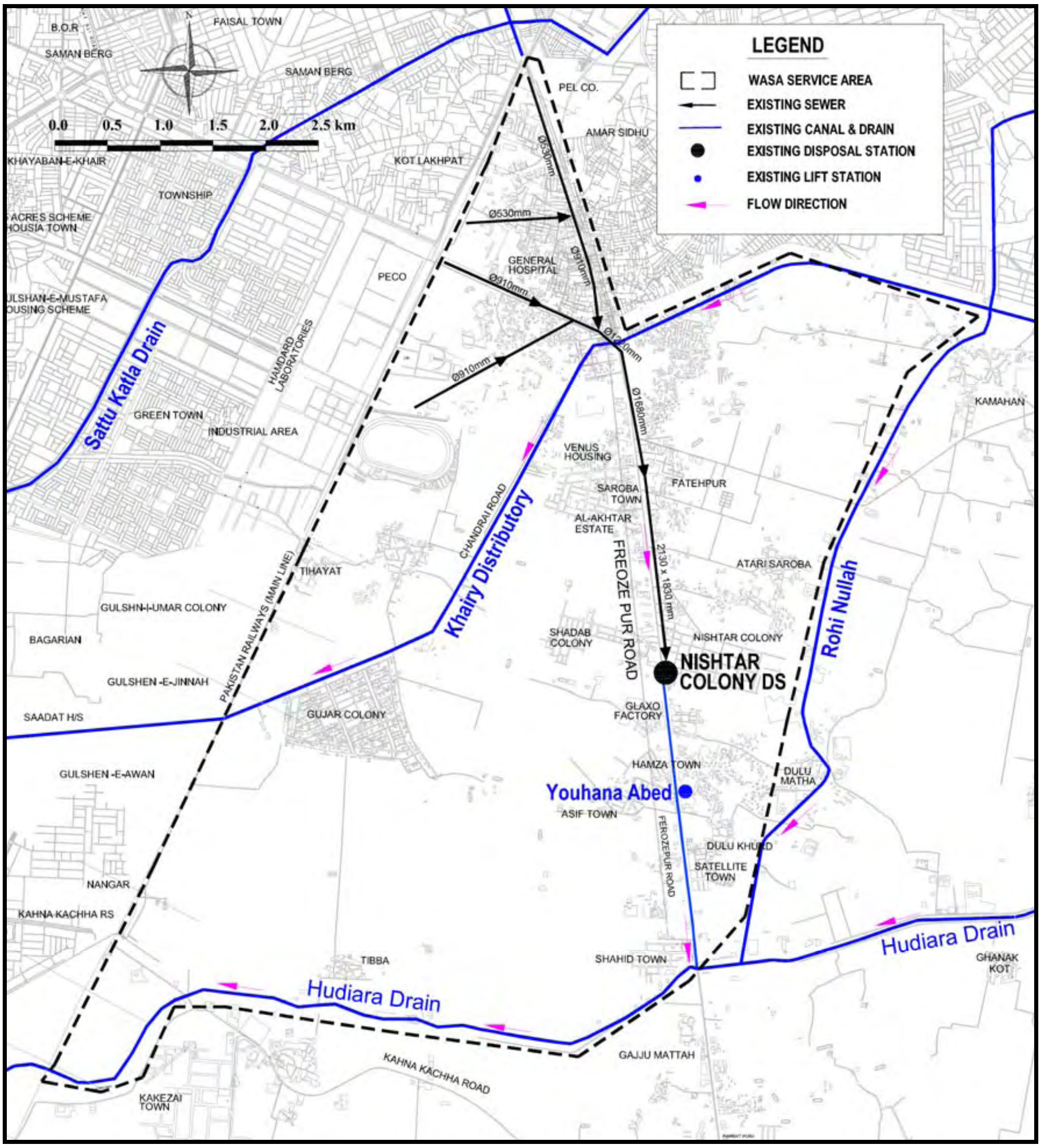


Figure 5.30 Existing Sewerage System in the South East Area

5.3.2 Cantonment Area

The Cantonments Area are located on the eastern side of the city. The present limits of the Cantonment Area marked by the Ghazi Road to the North, Khairy Distributory to East and South East, Ferozpur Road to the South West and the Karachi-Peshawar Railway line to the West. Total area and projected population in 2009 is about 93.5 km^2 and 755,000 persons, respectively. The Cantonment Area comprises of the Lahore Cantonment Area, the Walton Cantonment Area and the DHA Area as shown in **Figure 5.31** and there are their own engineering section. The basic date for the Cantonment Area are given in **Table 5.33**.

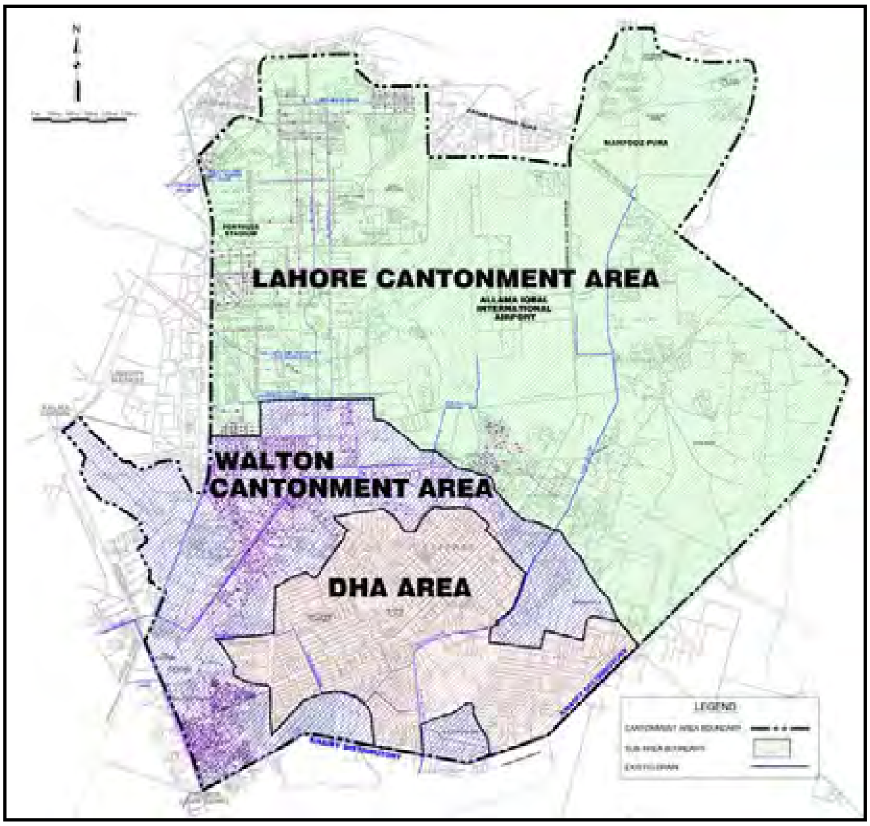


Figure 5.31 Cantonment Area

Table 5.33 Basic Data for Cantonment Area

Cantonment	Area (km^2)	Population (Year 2009)	Number of Lift Station	Total Length of Sewer (km)
Lahore Cantonment	58.7	275,000	11	48.5
Walton Cantonment	19.6	288,000	14	121.7
DHA	15.2	192,000	2	94.4
Total	**93.5**	**755,000**	**27**	**264.6**

Source: Inventory Study by JICA Study Team, 2009 and "Feasibility Study of Sewerage and Drainage System of Lahore & Walton Cantonment Areas" NESPAK, 2007

(1) Lahore Cantonment Area

The Lahore Cantonment Area is upper part of the Cantonment area and the Lahore Cantonment has an area of 58.7 km^2 with 275,000 persons. The existing sewerage system in the Lahore Cantonment Area mainly consists of RCC sewers ranging from 0.23 m to 0.76 m diameter along with 11 disposal stations. The sewage from the Lahore Cantonment Area is finally discharge into Cantonment Drain and Rohi Nullah without any treatment.

The sewage through following disposal station is being discharged into Cantonment Drain.

- Sadar Bazar Disposal Station
- Shakimar Disposal Station
- Mianmir Disposal Station
- Fatehabad Disposal Station
- Khan Colony Disposal Station
- Askari Villas Disposal Station
- Askari 9 Disposal Station
- Bagh Ali Road Disposal Station
- Askari 1 Disposal Station

The sewage through following two disposal stations is being discharged into Rohi Nullah.

- Nadirabad Disposal Station
- Rohi Nullah Disposal Station

Some of the relevant data on these disposal stations are shown in **Table 5.34**.

Table 5.34 Existing Disposal Stations in Lahore Cantonment Area

No	Name	Established Year	Service Area	Pump		Status of Pump	Final Discharge Point
				Number	Capacity (m3/s)		
1	Saddar Bazar	1948	Zarar Shaheed Road, Mubarik Road, Delhi Road, Dhaka Road, Sarwar Road, Taufail	3	20.0	OK	Shalimar Drain → Cantt. Drain
2	Shalimar	1992	Sagar road e.g. Bajaj Mohallah, Khrass Mohallah, Bangali Mohallah	1	6.0	OK	Cantt. Drain
3	Main Mir Colony	1994	Mianmir colony	1	6.0	OK	Cantt. Drain
4	Fathabad	1999	Saint John's Park, CMA Colony, Bridge Colony, Fatehabad and Hussnainabad	1	6.0	OK	Gulberg Drain-1→ Cantt. Drain
5	Khan Colony	1992	Nisar Colony	2	6.0	OK	Gulberg Drain-2→ Cantt. Drain
6	Askari Villas Shami Road	1998	Askari Villas	1	1.0	OK	
7	Naderabad	1995	Nadirabad area	1	6.0	OK	Rohi Nullah
8	Rohi Nahtla	2001	Gulshan Ali Colony, Khuda Bakhsh Colony	1	6.0	OK	
9	Askari 9	2002	Askari IX Area	3	5.0	OK	Cantt. Drain
10	Bagh Ali Road	1994	Bagh Ali Road	1	2.0	OK	
11	Askari 1	1988	Askari Villas	1	2.0	OK	

Source: Inventory Study by JICA Study Team, 2009 and "Feasibility Study of Sewerage and Drainage System of Lahore & Walton Cantonment Areas" NESPAK, 2007

The location of existing sewerage system in the Lahore Cantonment Area is shown in **Figure 5.32.**

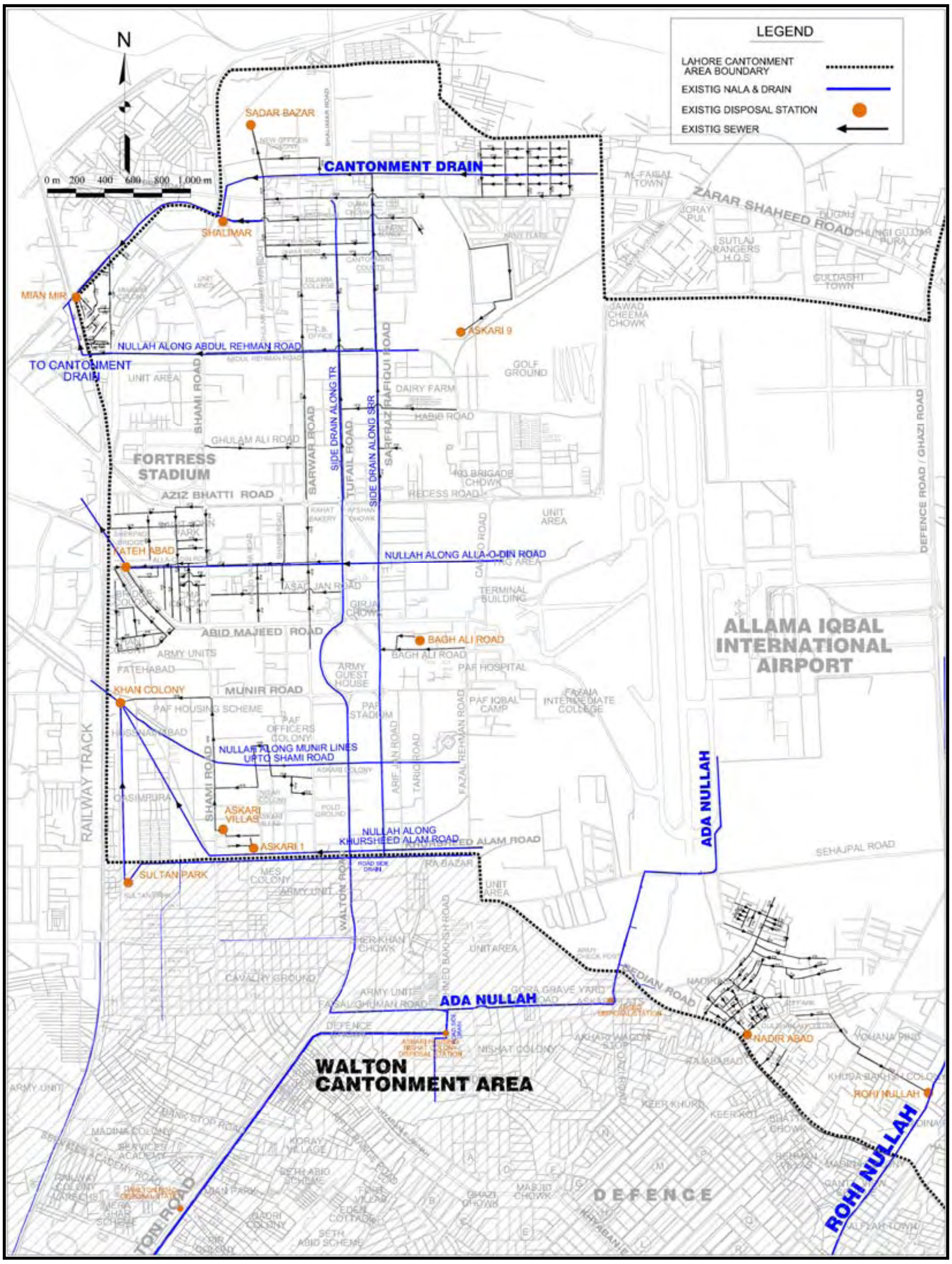


Figure 5.32 Existing Sewerage System in Lahore Cantonment Area

(2) Walton Cantonment Area

The Walton Cantonment Area is lower part of the Cantonment Area and the Walton Cantonment has an area of 19.6 km^2 with 288,000 persons in 2009. The existing sewerage system in the Walton Cantonment Area mainly consists of RCC sewers ranging from 0.23 m to 1.07 m diameter along with 14 disposal stations. The sewage from the Walton Cantonment Area is being discharged into ADA Nullah, Rohi Nullah and Cantonment Drain without any treatment.

Existing 14 disposal stations has established since 1982. The sewage through following disposal station is being discharged into ADA Nullah.

- Askari Housing Nishat Colony Disposal Station
- Askari Flats Bedian Road Disposal Station
- Gora Graveyard Disposal Station
- Workshop Stop Disposal Station
- Walton Road Disposal Station
- Askari Housing Complex Walton Disposal Station

The sewage from following disposal stations is conveyed to Ferozpur Road Drain.

- Ghazi Road Disposal Station
- Mast Iqbal Disposal Station
- Gulistan Colony Disposal Station
- Package Road Disposal Station

The sewage from following disposal stations is discharged into Cantonment Drain, Rohi Nullah and Khairy Distributory, respectively.

- Sultan Park Disposal Station
- Cantt. View Scheme Disposal Station
- Bandian Wala Pul Disposal Station

Some of the relevant data on these disposal stations are shown in **Table 5.35**.

Table 5.35 Existing Disposal Stations in Walton Cantonment Area

No	Name	Service Area	Pump Capacity (m3/s)	Status of Pump	Final Discharge Point
1	Sultan Park	Cavalry Ground, Sultan Park, Gulbahar Colony, Akramabad, Madina Colony, Shama Colony, Zaman Colony, Qasimpura and some portion of Hussnainabad	30.0	OK	Qasimpura Drain → Gulberg Drain-2
2	Askari Housing Nishat Colony	Askari Housing colony, Nishat Colony	9.0	OK	ADA Nullah
3	Askari Flats Bedian Colony	Askari Flats Bedian Colony	2.0	OK	ADA Nullah
4	Gora Graveyard	Nishat Colony, Maryam Colony, Keer Khurd and Keer Kot	6.0	OK	ADA Nullah
5	Cantt. View Scheme	Cantt. View Scheme	3.0	OK	Rohi Nullah
6	Ghazi Road	Yaseen Town, Gulistan Colony, Abid Colony, Shahid Town, Shoukat Town and Millat Road	10.0	OK	Ferozpur Road Drain→ Sattu katla Drain
7	Mast Iqbal	Firdos Park, Mast Iqbal Road and Muhammad Pura Bazaar	5.0	OK	Drain along Ferozpur road
8	Bandian Wala Pul	Sitara Colony and Toheed Road	5.0	OK	Khairy Distributory
9	Gulistan Colony	Gulistan Colony	2.0	OK	Ferozpur Road Drain
10	Package Road	Amar Sidhu Village	3.0	OK	Main drain along Ferozpur Road.
11	Workshop Stop	Farooq Colony, Al-Noor Town, Model Colony and Pir Colony	9.0	OK	ADA Nullah
12	Walton Road	Madina Colony, some portion of Zaman Colony, Shaheen Colony, Ghousia Colony, Pir Colony, Qadri Colony and Super Town	20.0	OK	ADA Nullah
13	Askari Housing Complex Walton	Askari Housing Complex Walton	7.0	OK	ADA Nullah
14	Talib Wala		2.0	OK	

Source: Inventory Study by JICA Study Team, 2009 and "Feasibility Study of Sewerage and Drainage System of Lahore & Walton Cantonment Areas" NESPAK, 2007

The location of existing sewerage system in Walton Cantonment Area is shown i**n Figure 5.33.**

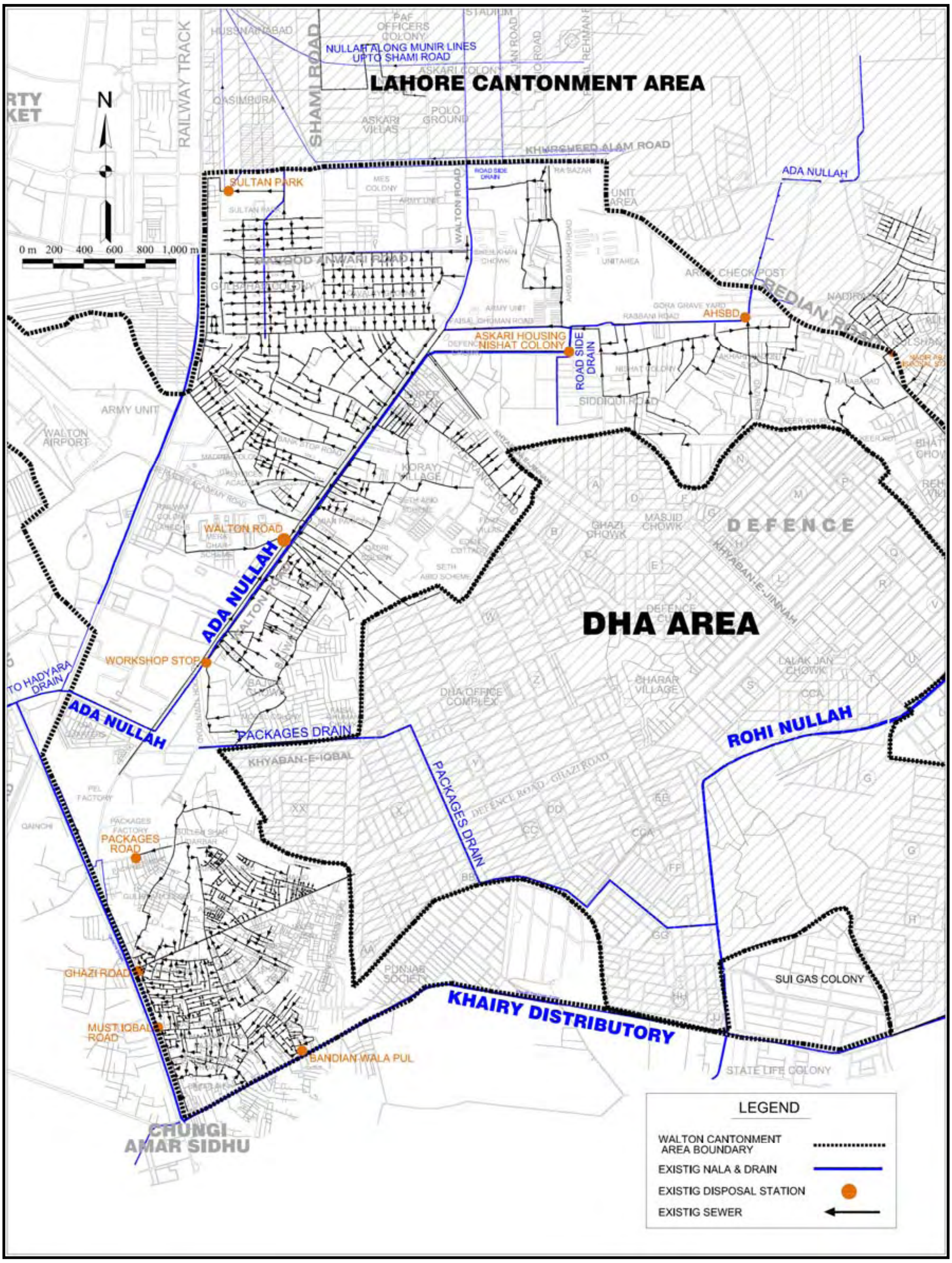


Figure 5.33 Existing Sewerage System in Walton Cantonment Area

◊◊(3) Defense Housing Authority (DHA) Area

The DHA Area is inside of the Walton Cantonment Area and the DHA has an area of 15.2 km^2 with 192,000 persons in 2009. The existing sewerage system in DHA Area mainly consists of RCC sewers ranging from 0.23 m to 1.52 m diameter along with 2 disposal stations. The sewage from DHA Area is being discharged into Rohi Nullah through existing 2 disposal stations. In this area, the percentage of population served is almost 100 % and all of building such as house, shop, store and restaurant has own septic tank. The location of existing disposal station in DHA Area is shown in **Figure 5.34.**

Some of the relevant data on these disposal stations are shown in **Table 5.36**.

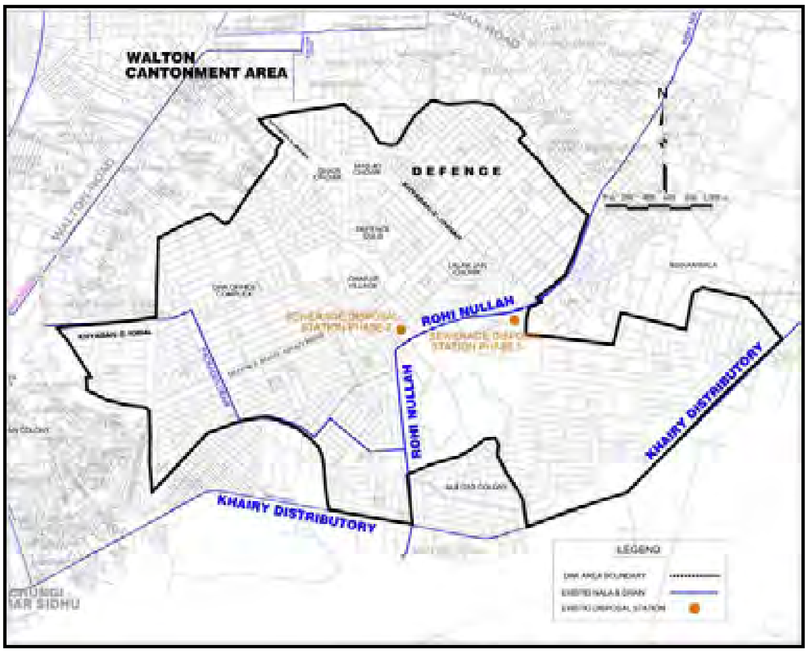


Figure 5.34 Location of Existing Disposal Stations in DHA

Table 5.36 Existing Disposal Stations in Walton Cantonment Area

No	Name	Established Year	Service Area	Pump		Status of Pump	Size of Inlet Pipe
				Number	Capacity (m3/s)		
1	Sewerage Disposal Station Phase 2	1985	Northwestern part from Rohi Nullah	1 4	0.28 0.57	OK	1.52 m ϕ
2	Sewerage Disposal Station Phase 5	2005	Southeastern part from Rohi Nullah	4	0.28	OK	1.14 m ϕ

Source: Inventory Study by JICA Study Team, 2009

5.3.3 TMA (Town Municipal Administration) Area

The following TMAs have jurisdiction area in the Study Area.

- Iqbal Town
- Nishtar Town
- Aziz Bhatti Town
- Wahga Town
- Ravi Town
- Data Gunji Bakhsh Town
- Samanabad Town

The jurisdiction area of the Ravi Town, Data Gunji Town and Samanabad Town are mostly inside of the WASA Service Area so they are utilizing the sewerage and drainage facilities of the WASA. Each TMA has the Engineering Section but their main activities for infrastructures are construction of small road with road drain inside of community and village, providing streetlights and maintenance work for these infrastructures. For sewerage and drainage scheme, TMA doesn't have any activities of planning and construction work, in these area the Public and Health Engineering Department (PHED) is in charge of sewerage and drainage planning with construction works. After completion, facilities turn over to TMA form PHED and operation & maintenance work will be executed by TMA. However, TMA carrying out repair of sewer and drain, in case of the request from residents is received.

The summary of sewer sub-catchment area are given in the following table.

Table 5.37 Existing Disposal Stations in TMA Area

No	Name	Location	Established Year	Number and Capacity of Pump	Status of Pump	Final Discharge Point
1	Raiwind Disposal Station	Raiwind, Iqbal Town	1984	2 nos. x 0.06 m^3/s	OK	Bypass Drain
2	Hakeema Wala No.1 Disposal Station	Raiwind, Iqbal Town	Under Construction	2 nos. x 0.14 m^3/s	-	Bypass Drain
3	Hakeema Wala No.2 Disposal Station	Raiwind, Iqbal Town	Under Construction	2 nos. x 0.11 m^3/s	-	Bypass Drain
4	Kahna Nau Disposal Station	Nishtar Town	1975	3 nos. x 0.11 m^3/s 1 no. x 0.06 m^3/s	Only one pump (0.11 m^3/s) is working	Hudiara Drain
5	New Kahna Nau Disposal Station	Nishtar Town	Under Construction	4 nos. x 0.17 m^3/s	-	Hudiara Drain

Source: Inventory Study, JICA Study Team, 2009

Pictures of existing disposal stations are shown below.

Photo 5.6 Existing Raiwind Disposal Station

Photo 5.7 Existing Raiwind Disposal Station (Discharge from pump to drain)

Photo 5.8 Hakeema Wala No.1 Disposal Station (Under Construction)

Photo 5.9 Hakeema Wala No.2 Disposal Station (Under Construction)

Photo 5.10 Khana Nau Disposal Station

Photo 5.11 New Kahna Nau Disposal Station (Under Construction)

The PHED has improvement plan for sewerage and drainage system in these towns. The summary of the PHED Projects is given in the following table.

Table 5.38 The Summary of PHED Projects in TMA Area

No	Name of Project	Location	Description of Sewerage & Drainage Works	Total Cost (million Rs.)
1	Urban Water Supply & Sewerage, Drainage Scheme, Dubai Town	Iqbal Town	RCC Sewer pipe 0.23 m ϕ : L=0.84 km 0.30 m ϕ : L=2.83 km 0.38 m ϕ : L=0.14 km 0.53 m ϕ : L=1.41 km	18.747 (including water supply works)
2	Urban Water Supply, Sewerage and Drainage Scheme, Nawizishabad	Iqbal Town	RCC Sewer pipe 0.30 m ϕ : L=0.55 km 0.38 m ϕ : L=0.21 km 0.46 m ϕ : L=0.61 km 0.53 m ϕ : L=0.32 km Drain Open Channel: L=6.16 km	17.272 (including water supply works)
3	Urban Water Supply, Sewerage and Drainage Scheme, Sultan Town	Iqbal Town	RCC Sewer pipe 0.23 m ϕ : L=1.23 km 0.30 m ϕ : L=0.37 km 0.38 m ϕ : L=0.25 km	17.533 (including water supply works)
4	Urban Sewerage Scheme, Raiwind	Raiwind, Iqbal Town	Disposal Station (1) Hakeema Wala No.1 (2) Hakeema Wala No.2 Force Main 0.30 m ϕ : L=0.30 km 0.38 m ϕ : L=0.17 km RCC Sewer pipe 0.23 m ϕ : L=20.09 km 0.30 m ϕ : L=11.73 km 0.38 m ϕ : L=1.61 km 0.46 m ϕ : L=1.07 km 0.53 m ϕ : L=1.93 km 0.61 m ϕ : L=0.84 km 0.69 m ϕ : L=2.38 km 0.76 m ϕ : L=0.08 km 0.91 m ϕ : L=0.13 km	156.156
5	Rural Drainage Scheme, Azeemabad Barkat Pura	Nishtar Town	Drain 0.3 x 0.3 m: L=2.01 km 0.6 x 0.6 m: L=0.40 km 0.6 x 0.76 m: L=0.52 km	5.384
6	Rural Drainage Scheme, Attoki Awan	Aziz Bhatti Town	Drain 0.3 x 0.3 m: L=0.76 km 0.6 x 0.6 m: L=0.36 km 0.76 x 0.76 m: L=0.26 km 1.2 x 1.2 m: L=0.43 km	10.000
7	Rural Drainage Scheme, Rampura	Aziz Bhatti Town	Drain 0.3 x 0.3 m: L=0.89 km 0.6 x 0.6 m: L=0.20 km 1.2 x 1.2 m: L=0.91 km	10.000
8	Rural Drainage Scheme, Lakho Dair	Wahga Town	Drain 0.3 x 0.3 m: L=5.16 km 0.6 x 0.6 m: L=2.83 km 1.2 x 1.2 m: L=0.68 km	15.000
9	Rural Sewerage and Drainage Scheme, Manawan G.T Road	Wahga Town	Drain 0.3 x 0.3 m: L=4.60 km 0.46 x 0.46 m: L=0.54 km RCC Sewer pipe 0.38 m ϕ : L=0.23 km 0.46 m ϕ : L=0.22 km 0.53 m ϕ : L=0.17 km	15.000

Source: Inventory Study by JICA Study Team, 2009

The location of PHED Projects and existing disposal station in TMA Area is shown in **Figure 5.35**.

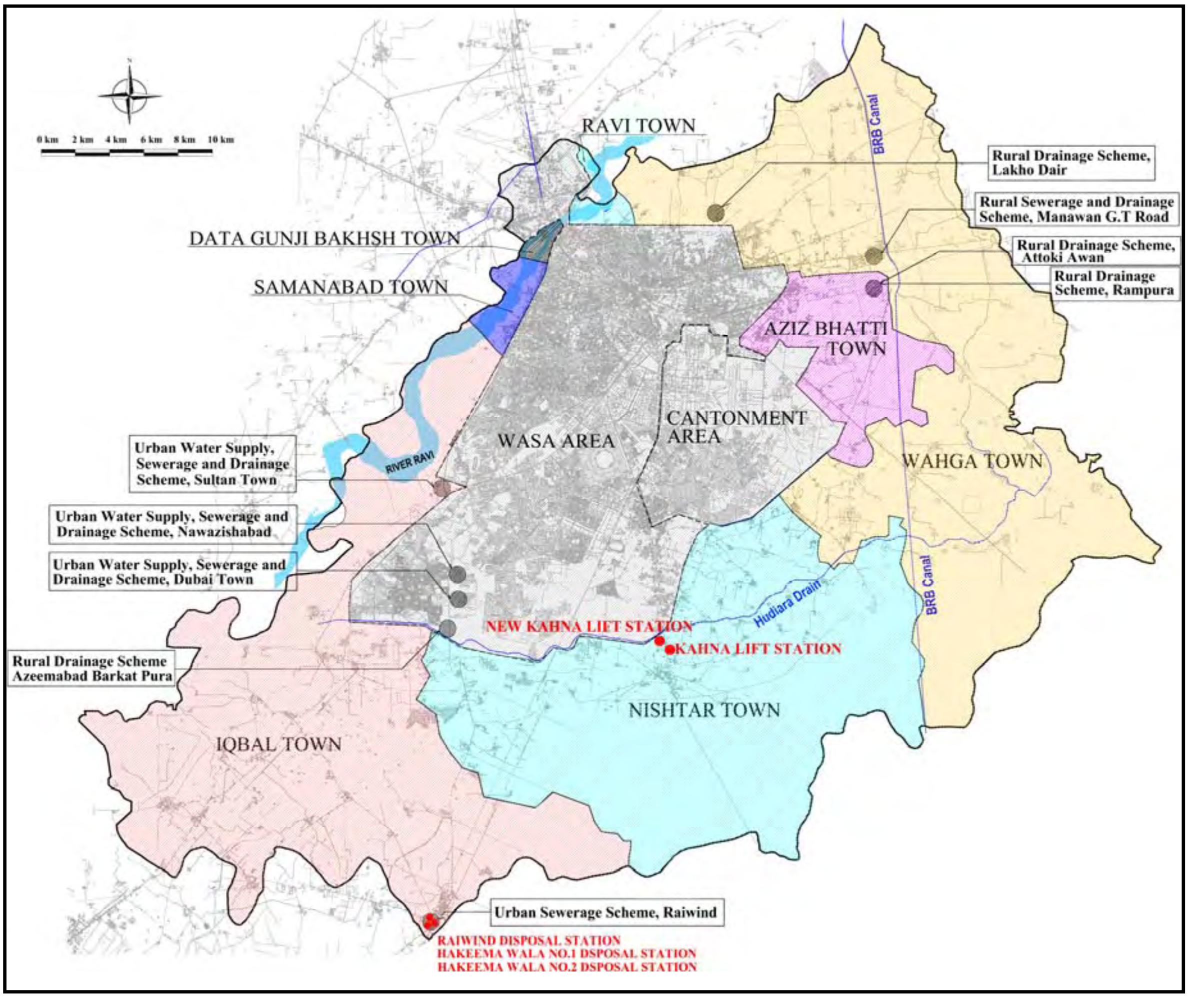


Figure 5.35 The Location of PHED Project and Existing Disposal Station in TMA Area

The PHED Project was planed in 2008 and it is carried out in 2009. The latest jurisdiction area of the WASA was set in November, 2008, therefore, some of PHED Projects are inside of the WASA Service Area on **Figure 5.35**.

5.3.4 Wastewater Treatment Plant

There is no wastewater treatment plant in Lahore city at present. Only the part of factories have own treatment facilities to follow the effluent standard. Almost all raw sewage is discharged to river Ravi through sewer, drainage and pumping stations. This condition directly causes the contamination of river Ravi.

Meanwhile, in “Master Plan for Urban Wastewater Treatment Facilities in Pakistan Final Report, June 2002 (Gov. of Pakistan, Ministry of Environment, Local Government and Rural

Development)", current WASA jurisdiction area is divided to six treatment areas and six wastewater treatment plants are planned.

5.3.5 House Connection

According to the Benchmark Indicator of WASA, sewerage coverage (house connected) rate in current WASA jurisdiction area at 2008 is 84 %. This number is estimated based on the information of Census report - District Lahore published by statistics department. Even if it judges from survey results of present wastewater discharge volume conducted in this study (**Appendix 9.4**), this number is in general appropriate. Collected information about house connection is as follows.

- Connection pipe is constructed by each household.
- Material of connection pipe is reinforced concrete pipe and standard diameter is 6 inches.
- Average installation cost of house connection is 10,000~20,000 Rs/house.
- There is no financial support by public sector for installation of house connection.
- There is no duty of installation of house connection.
- Excreta, sullage and also storm water are discharged to sewer in many households.

Drawing of typical house connection is shown in **Appendix 5.2**.

5.3.6 Sanitary facilities

Table 5.39 shows the condition of sanitary facilities provision in Punjab province.
Sanitary facilities include being connected to a septic tank, to a public sewer, pour flush toilet, traditional closed pit latrine, ventilated improved pit latrine or service/bucket latrine.

Table 5.39 Adequate Sanitary Facilities

(% Households)

Whole Punjab	Major City	Other Urban	Rural
58 %	98 %	92 %	43 %

Source: Punjab MICS 2003-2004, Planning and Development Department, Gov. of Punjab

According to the Punjab MICS (Multiple Indicators Cluster Survey), all towns in Lahore have sanitary facilities relatively high levels (over 90 %).

5.4 Drainage

Storm water drainage has become a major environmental hazard / civic challenge. The situation becomes worst in the monsoon season which normally extends from July to September. The storm water drains also function as sludge carries. A few drains are flowing to their full capacity even in the dry weather and after only a light rainfall these start over flowing. Encroachments along and over the drains have further deteriorated the situation. The dumping of solid waste in the drainage system is very common. Another bottleneck in the operation of the system is low head clearance of bridges across these drains, which reduces the waterway of the drain thus affecting their capacities.

5.4.1 WASA Service Area

Lahore is comparatively a flat area with a mild slope towards southwestern side. There are natural barriers like river protection bund along the River Ravi, railway track which divides the city into northern and southern parts and the canal which runs east-west and is situated on the ridge. WASA service area is divided into seven drainage sub-catchment areas as shown in **Figure 5.36**. Drainage sub-catchment boundaries have been determined primarily on basis of topographical features, existing drain network and site investigations.

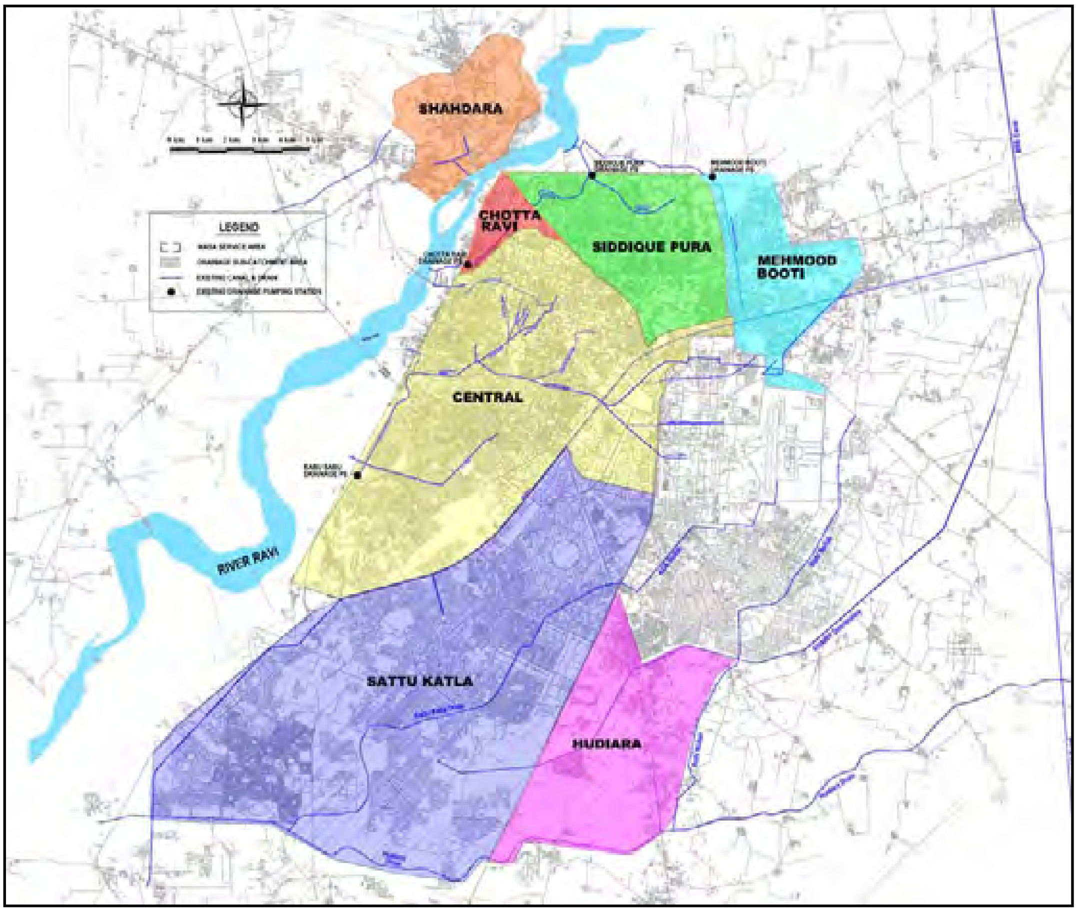


Figure 5.36 Drainage Sub Catchment Area

Out of the seven areas, four has own drainage pumping stations. The drainage system consist of 82.15 km of main drain and 133.53 km of secondary / tertiary drain, making a total length of 215.68 km and 4 drainage pumping stations. In this area, there are 12 main drains and run on the lowest contours and finally discharge into the River Ravi. The summary of drainage sub-catchment area and some of the relevant data on these drainage pumping stations are shown in **Table 5.40** and **Table 5.41**, respectively.

Table 5.40 Summary of Drainage Sub-catchment Area

Sub-catchment Area	Area (km^2)	Main Drain	Length of drain (km)			Drainage Pumping Station
			Total	Main	Secondary	
Shahdara	18.44	- Shahdara Drain - Farakhabad Drain	6.85	4.11	2.74	-
Mehmood Booti	22.79	- Shalimar Escape Drain	17.02	5.03	11.99	Mehmood Booti PS
Siddique Pura	29.19	- Siddique Pura Drain - Railway Drain - Upper Chotta Ravi Drain	6.71 5.83 6.25	3.51 2.83 4.27	3.20 3.00 1.98	Siddique Pura PS
Chotta Ravi	4.78	- Lower Chotta Ravi Drain	7.89	2.13	5.76	Chotta Ravi PS
Central	95.48	- Cantonment Drain - Central Drain - AIT Drain	49.26 15.71 14.97	15.39 4.42 6.80	33.87 11.29 8.17	Babu Sabu PS
Sattu Katla	138.95	- Sattu Katla Drain	61.69	11.43	50.26	-
Hudiara	39.65	- Hudiara Drain	37.65	22.23	15.42	-
Total	**350.85**	**12**	**215.68**	**82.15**	**133.53**	**4**

Source: WASA 2009, Inventory Study by JICA Study Team 2009

Table 5.41 Technical Data the Existing Drainage Pumping Stations

Pumping Station	MEHMOOD BOOTI	BABU SABU	CHOTTA RAVI	SIDDIQUE PURA
Location	Bund Road Mehmood Booti	Bypass Motorway Road between Thokar Niaz Baig & Babu Sabu Interchange.	Bund Road near Mian Munshi Hospital.	Bund Road, Shadbagh
Name of Inflow Drain	Shalimar Escape Drain	Cantonment Drain	Lower Chotta Ravi Drain	Upper Chotta Ravi Drain Railway Drain Siddique Pura Drain
Established Yeare	1978 / 2008 *1	1978	1967	1997
Donor	Govt. of Punjab	World Bank	World Bank	World Bank
Pump Size and Type*2	HAF	HAF	HAF	VAF
Total Capacity	150 Cfs (4.26m^3/s)	200 Cfs (5.68m^3/s)	100 Cfs (2.82m^3/s)	213 Cfs (6.03m^3/s)
Total Number of Pumps	6	8	7	3
Number and Capacity of Pumps [year installed]	6 x 25 Cfs (0.71m^3/s) [1985]	4 x 25 Cfs (0.71m^3/s)[1985] 2 x 25 Cfs (0.71m^3/s)[1990] 2 x 25 Cfs (0.71m^3/s)[2001]	5 x 10 Cfs (0.28m^3/s)[1967] 2 x 25 Cfs (0.71m^3/s)[1990]	3 x 71 Cfs (2.01m^3/s)[1997]
Status of Pump	All pumps are in working condition	All pumps are in working condition	One pump [1990] is out of order	One pump is out of order
Number of Gates x Width(m) x Height(m)	4 Nos. x 3.00 x 2.00 m 3 Nos. x 3.00 x 2.00 m	14 Nos. x 1.22 x 1.83 m	3 Nos. x 2.13 x 0.91 m 5 Nos. x 2.13 x 1.52 m	Flap Gate (3 Nos. x ϕ 30 inch (0.76m))
Status of Gate	All OK	All OK	All OK	All gate are not functioning
Photographs				

NOTE: *1: It was relocated in 2008 due to construction of Band Road
*2: VAF - Vertical Axial Flow Pump HAF - Horizontal Axial Flow Pump

Drainage sub catchments, location of the existing drainage stations and main drain are shown in **Figure 5.37**.

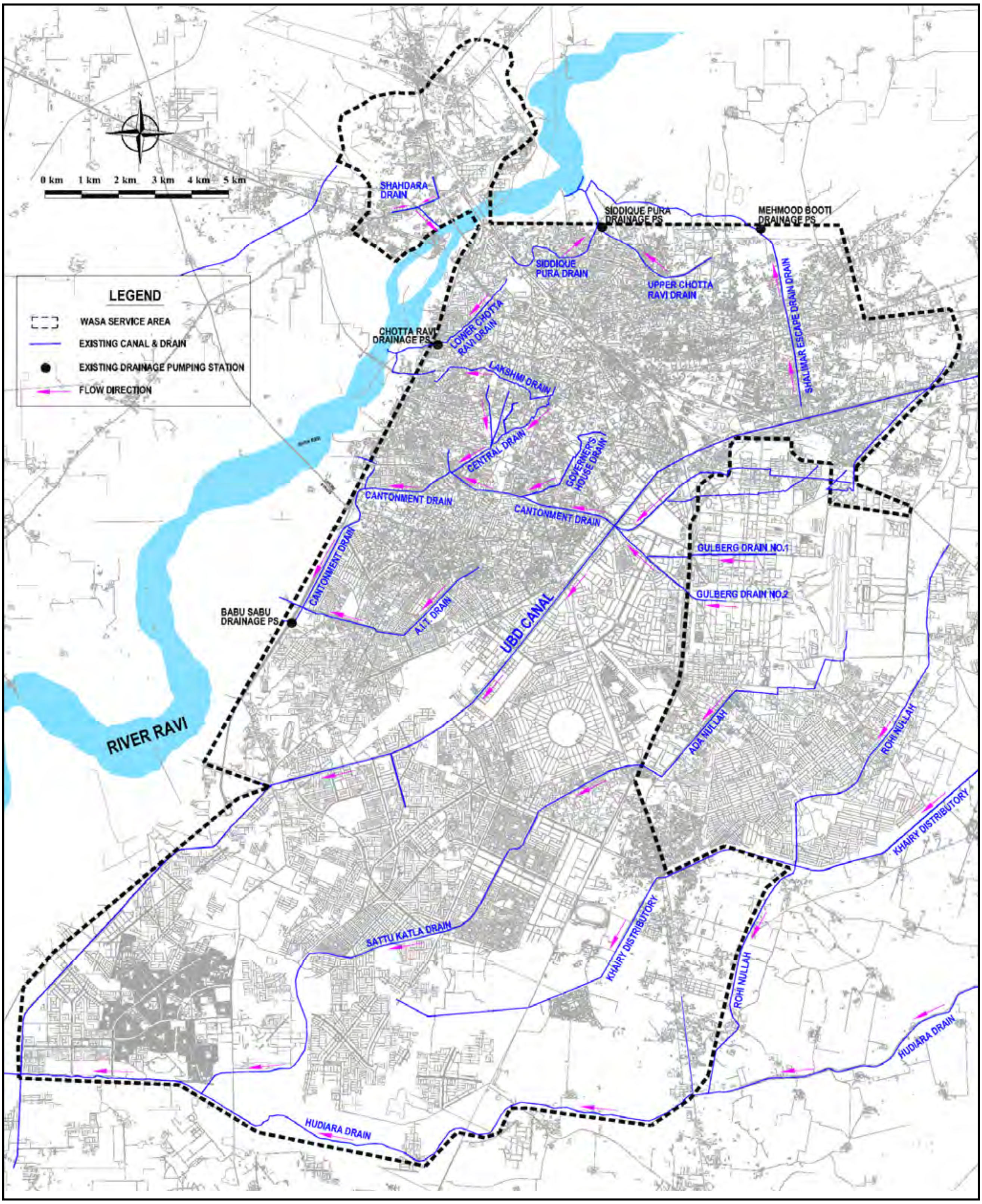


Figure 5.37 Location of Existing Drainage Pumping Station and Main Drains

(1) Shahdara Area

WASA has provided drainage system for the Shahdara Area since 1980's. The catchment area of the Shahdara Area is 18.45 km^2. The Railway Line is a barrier that has divided the Shahdara Area into east and west sides.

For west side, the existing drainage system is primarily dependent on the Shahdara Drain and drainage system consist of 4.11 km of the Shahdara Drain and 2.74 km of secondary / tertiary drain, making a total length of 6.85 km. The total length of the Shahdara Drain starting from Tayyab Plaza near GT Road to confluence point of River Ravi Drain is 4.11 km. Its width varies from 3.7 m to 15.3 m while its depth ranges from about 1.5 m to 3.0 m. A number of sewers are connected to the Shahdara Drain so this drain is flowing to almost full capacity even during the dry season as shown in **Photo 5.12**. Its original section in some reaches has been greatly reduced due to dumping of solid wastes as shown in **Photo 5.13**.

Photo 5.12 Shahdara Drain
(Almost full capacity, June 2009)

Photo 5.13 Shahdara Drain
(Dumping of solid wastes, June 2009)

In this area, there is no drainage pumping station, the storm water from this area discharge to the River Ravi through main drains by gravity.

In the eastern part, presently there is only road drain and house drain. The sewerage system needs to be planned and constructed.

Table 5.42 shows the data of existing drains and location of existing drains in the Shahdara Area is shown in **Figure 5.38**.

Table 5.42 Data of Existing Drains in Shahdara Area

Main Drain	Length (km)	Secondary / Tertiary		
		Name	Length (km)	Size (m)
Shahdara Drain	4.11	Farakhabad Drain	1.22	3.66 x 3.0
		G.T Road Drain	1.52	1.83 x 1.2
Total	***4.11***		***2.74***	

Source: WASA, 2009

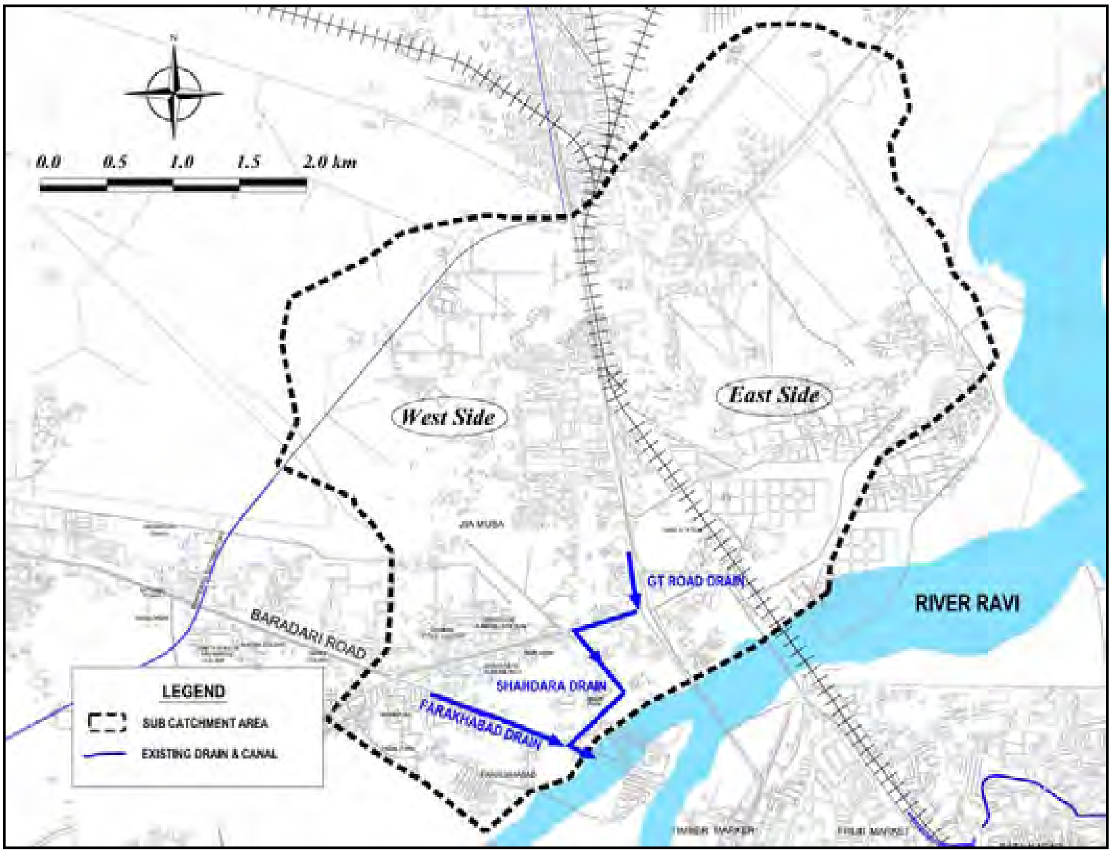


Figure 5.38 Existing Drains in the Shahdara Area

(2) Mehmood Booti Area

Mehmood Booti Area is located in the northeast of WASA Service Area. The catchment area of this area is 22.79 km^2 and WASA has constructed drains since 1970's. The existing drainage system is primarily dependent on the Shalimar Escape Drain and drainage system consist of 5.03 km of main drains and 11.99 km of secondary / tertiary drain, making a total length of 17.02 km and the Mehmood Booti Drainage Pumping Station.

The Shalimar Escape Drain is flowing from the Lal Pul Bridge near Pakistan Railway to the Mehmood Booti Drainage Pumping Station. Its width varies from 13.1 m to 17.7 m while its depth ranges from about 2.00 m to 3.00 m. The Shalimar Escape Drain is comparatively in better flowing condition and well maintained as shown in **Photo 5.14**. However, its original section in some reaches has been reduced due to encroachment and collapse by livestock as shown in **Photo 5.15**. And also a number of sewers are connected to this drain so it is flowing to almost full capacity even during the dry season.

	
Photo 5.14 Shalimar Escape Drain (Good condition, June 2009)	**Photo 5.15 Shalimar Escape Drain (Encroachment and collapse, June 2009)**

Table 5.43 shows the data of existing drains and location of existing drains in the Mehmood Booti Area is shown in **Figure 5.39**.

Table 5.43 Data of Existing Drains in the Mehmood Booti Area

Main Drain	Length (km)	Secondary / Tertiary		
		Name	Length (km)	Size (m)
Shalimar Escape Drain	5.03	Businessman Trust Hospital Drain	0.56	7.62 x 3.05
		G.T Road Drain	11.43	1.52 x 1.52 1.22 x 1.22 0.91 x 0.61
Total	***5.03***		***11.99***	

Source: WASA, 2009

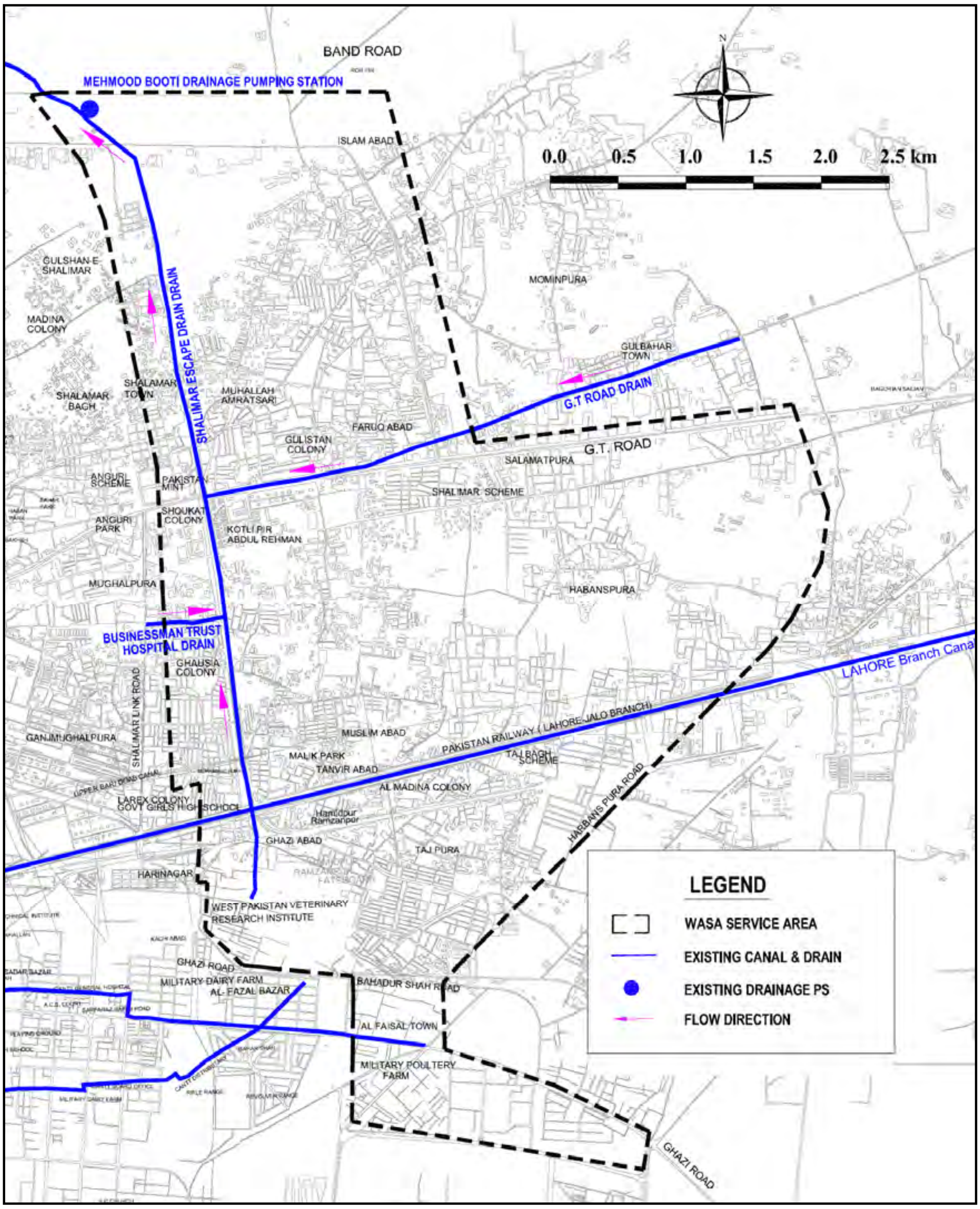


Figure 5.39 Existing Drains in the Mehmood Booti Area

(3) Siddique Pura Area

The catchment area of the Siddique Pura Area is 29.19 km^2. The existing drainage system is primarily dependent on the Siddique Pure Drain, the Railway Drain and the Upper Chotta Ravi Drain. The drainage system consist of 10.61 km of these 3 main drains and 8.18 km of secondary / tertiary drain, making a total length of 18.79 km. In this area, there are 2 disposal stations and 1 drainage pumping station. As described in section 5.5.1 (3), inlets of these 3 pumping stations meet at the same wet well i.e. there are only one wet well for 3 pumping stations.

The Siddique Pure Drain was constructed in 1970's and was remodeled into box culvert type from open drain in 1998. The Railway Drain was constructed in 1970's and was remodeled into box culvert type from open drain in 2005, and the size of this box culvert is 2.0 m (width) x 1.0 m (height). The Railway Drain is not connecting to the wet well, this drain connect to the Siddique Pure Drain, and the size varies from 4.5 x 2.0 m to 8.0 x 6.0 m. The Upper Chotta Ravi Drain is open drain, which was constructed in 1970's and was improved in 1998. Its width varies from 5.0 m to 8.0 m while its depth ranges from about 2.0 m to 4.0 m.

The Siddique Pure Drain and the Railway Drain are comparatively in better flowing condition and well maintained. Most section of the Upper Chotta Ravi Drain is in good flowing condition however, a lot of dumping of solid waste is observed just near the pumping station and this section is blockaded with much garbage as shown in **Photo 5.16** and **Photo 5.17**.

	
Photo 5.16 Upper Chotta Ravi Drain (Good condition, June 2009)	**Photo 5.17 Upper Chotta Ravi Drain (A lot of dumping of solid waste, June 2009)**

Table 5.44 shows the data of existing drains and location of existing drains in the Siddique Pura Area is shown in **Figure 5.40**.

Table 5.44 Data of Existing Drains in Siddique Pura Area

Main Drain	Length (km)	Secondary / Tertiary		
		Name	Length (km)	Size (m)
Siddique Pura Drain	3.51	Circular Road Drain	0.76	1.22 x 1.83
		Ravi Link Road Drain	2.44	0.91 x 1.83
Railway Drain	2.83	Landa Bazar Drain	0.76	ϕ 1.22 m
		Rajput Road Drain	0.91	1.22 x 0.91
		Chah Miran Drain	1.22	0.91 x 1.07
		Sarai Sultan Drain	0.11	0.91 x 1.07
Upper Chotta Ravi Drain	4.27	Amir Road Drain	0.30	0.76 x 0.91
		Makham Pura Drain	1.68	1.07 x 1.22
Total	***10.61***		***8.18***	

Source: WASA, 2009

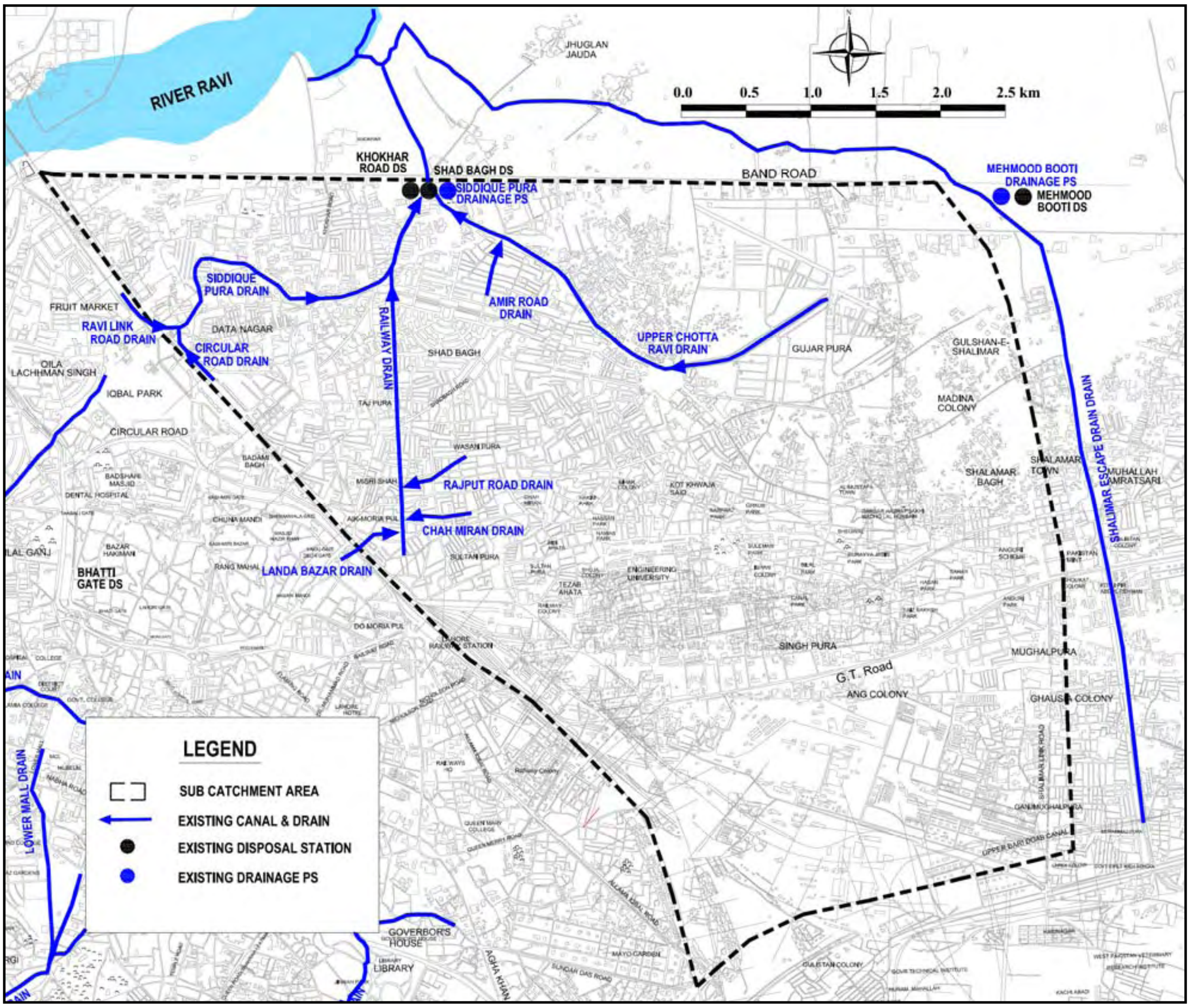


Figure 5.40 Existing Drains in the Siddique Pura Area

(4) Chotta Ravi Area

WASA has provided the drainage system for this area since late in 1960's. The catchment area of the Chotta Ravi Area is 4.78 km^2. The existing drainage system is primarily dependent on the Lower Chotta Ravi Drain and drainage system consist of 2.13 km of the Lower Chotta Ravi Drain and 5.76 km of secondary / tertiary drain, making a total length of 7.89 km and the Chotta Ravi Drainage Pumping Station. The Lower Chotta Ravi Drain is flowing from Bagh Munshi Ladha to the Chotta Ravi Drainage Pumping Station near the Bund Road. Its width varies from 5.0 m to 5.5 m while its depth ranges from about 1.5 m to 2.0 m. There are residences, buildings and small markets on either sides of the drain in almost whole of the reach, which may obstruct cleaning and rehabilitation of drain by machines therefore, solid waste accumulation within the drain section at several locations has reduced the flow carrying capacity of the drain as shown in **Photo 5.18**. As a result, a lot of garbage is flowing into the Chotta Ravi Drainage Pumping Station as shown in **Photo 5.19**. And also a number of sewers are connected to this drain so it is flowing to almost full capacity even during the dry season.

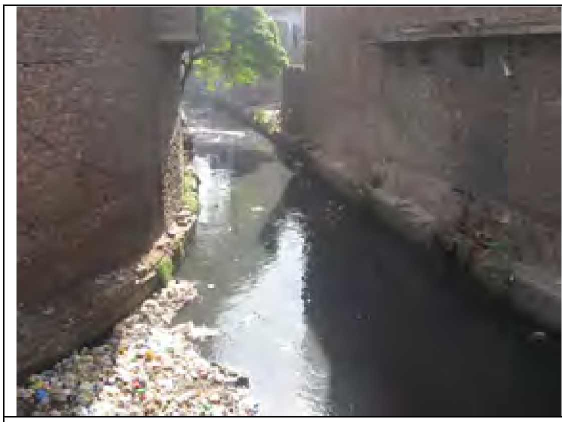


Photo 5.18 Lower Chotta Ravi Drain (Present situation of the drain, June 2009)

Photo 5.19 Chotta Ravi Pumping Station (A lot of dumping of solid waste, June 2009)

Table 5.45 shows the data of existing drains and location of existing drains in the Shahdara Area is shown in **Figure 5.41**.

Table 5.45 Data of Existing Drains in the Chotta Ravi Area

Main Drain	Length (km)	Secondary / Tertiary		
		Name	Length (km)	Size (m)
Lower Chotta Ravi Drain	2.13	City Drain	3.20	3.66 x 3.05 2.44 x 3.05
		Ravi Road Drain - 1	1.28	1.52 x 1.83
		Ravi Road Drain - 2	1.28	1.83 x 2.13
Total	***2.13***		***5.76***	

Source: WASA, 2009

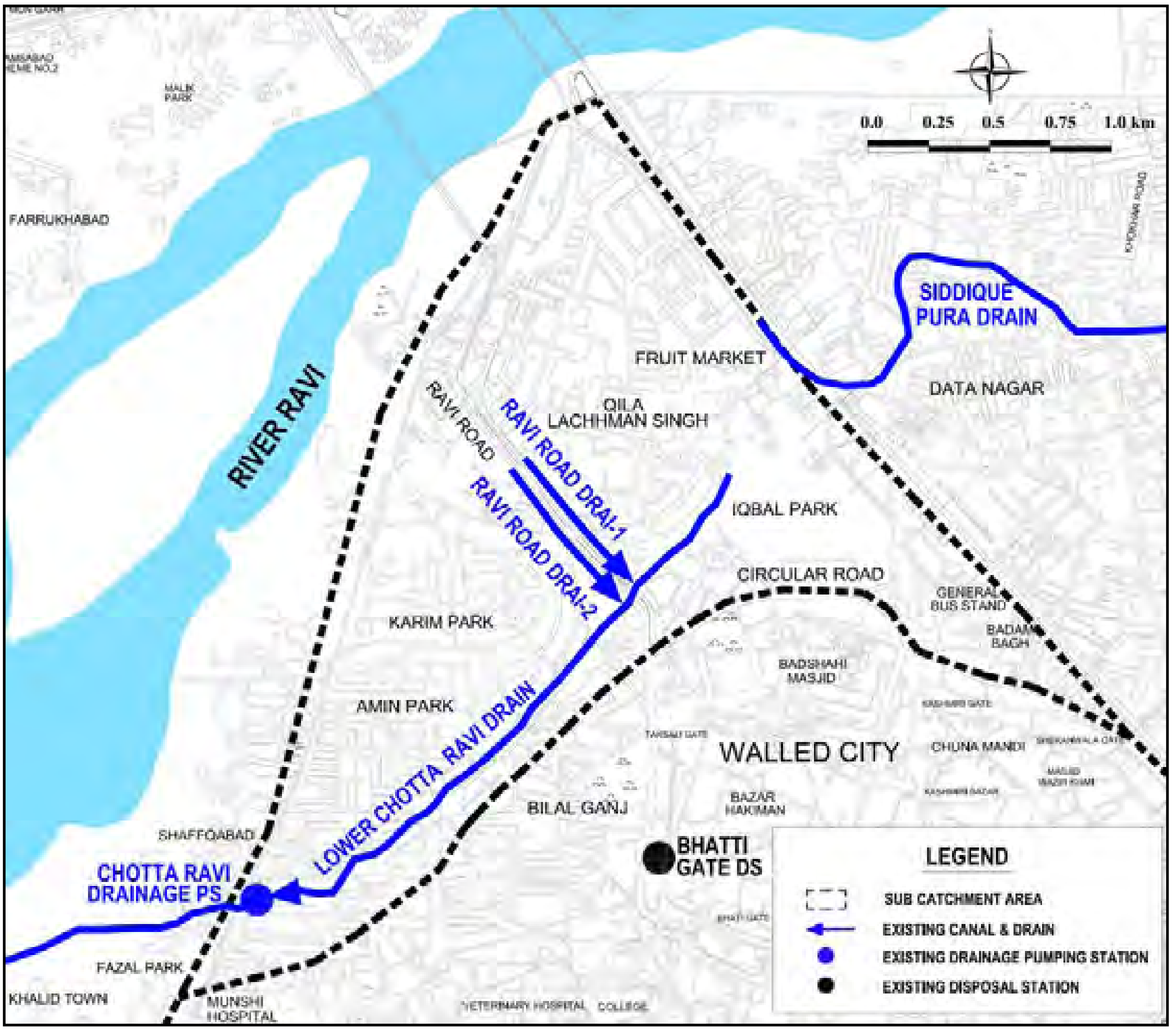


Figure 5.41 Existing Drains in the Chotta Ravi Area

(5) Central Area

This area is core of WASA Area and covers the old area located in North, which has been developed for long time and has an old drainage system. The catchment area of the Central Area is 95.48 km^2. The existing drainage system is primarily dependent on the Cantonment Drain, the Central Drain and the AIT Drain. The drainage system consist of 26.61 km of these 3 main drains and 53.33 km of secondary / tertiary drain, making a total length of 79.94 km.

The Central Drain is one of the main tributary of the Cantonment Drain serving the most critical areas of the upper part of the Central Area like Lakshami Chowk, Railway Station, Gawal Mandi, Mcleod Road, Brandreth Road and Hall Road. Its width varies from 3.5 m to 9.5 m while its depth ranges from about 1.2 m to 3.8 m. At present, the Central Drain is badly silted up / filled and encroached at the number of place. Especially, from Chuburgi Chowk to beginning point of this drain there are residences and buildings on either sides of the drain, which may obstruct cleaning and rehabilitation of drain by machines therefore, solid waste accumulation within the drain section at several locations has reduced the flow carrying capacity of the drain as shown in **Photo 5.20**. And also a number of sewers are connected to this drain so it is flowing to almost full capacity even during the dry season as shown in **Photo 5.21**, thereby virtually no space is left to carry the storm water during the rainy season. Thus results in flooding of catchment areas in rainy season.

Photo 5.20 Central Drain
(A lot of dumping of solid waste, June 2009)

Photo 5.21 Central Drain
(Almost full capacity, June 2009)

The AIT Drain is also one of the main tributary of the Cantonment Drain serving the critical areas of the lower part of the Central Area like Milat Chowk, Shabab Chowk, Mansoora, Scheme More and Chungi Multan Road. Its width varies from 2.0 m to 5.0 m while its depth ranges from about 1.2 m to 2.0 m. The upstream of this drain is comparatively in better flowing condition and well maintained, however a number of sewers are connected to this drain so it is flowing to almost full capacity even during the dry season as shown in **Photo 5.22**. And the reach from middle stream to downstream is badly silted up / filled and encroached at the number of place, therefore the drain section at several locations has reduced the flow carrying capacity of the drain as shown in **Photo 5.23**. Thereby virtually no space is left to carry the storm water during the rainy season. Thus results in flooding of catchment areas in rainy season.

Photo 5.22 AIT Drain
(Almost full capacity, June 2009)

Photo 5.23 AIT Drain
(Dumping of solid waste & Encroachment, June 2009)

The Cantonment Drain is main drain in Central Area. The total length of the drain starting from Al Faisal Town to the Babu Sabu Drainage Pumping Station is about 15.40 km. Its width varies from 5.0 m to 26.0 m while its depth ranges from about 1.5 m to 4.0 m.

The Cantonment Drain is comparatively in better flowing condition and well maintained as shown in **Photo 5.24,** however a number of sewers are connected to this drain so it is flowing to almost full capacity even during the dry season and its original section is greatly reduced due to dumping of solid wastes and encroachments at a number of locations as shown in **Photo 5.25**.

Photo 5.24 Cantonment Drain
(Good condition, June 2009)

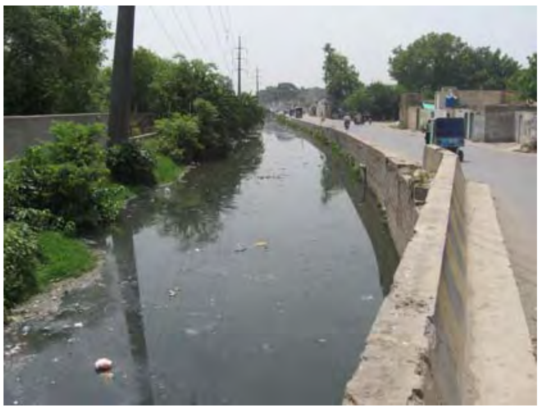


Photo 5.25 Cantonment Drain
(Almost full capacity, June 2009)

Table 5.46 shows the data of existing drains and location of existing drains in the Central Area is shown in **Figure 5.42**.

Table 5.46 Data of Existing Drains in the Central Area

Main Drain	Length (km)	Secondary / Tertiary		
		Name	Length (km)	Size (m)
Cantonment Drain	15.39	Dry Port Drain	1.52	0.61 x 1.37
		Gulistan Colony Drain	0.76	0.76 x 0.91
		Nagra Drain	1.01	1.22 x 1.07
			2.01	1.22 x 1.37
		Dholan Wal Drain	0.76	0.91 x 1.22
		Samanabad Drain	1.07	0.61 x 0.76
			1.07	0.91 x 0.91
		F & V Merket Drain (A.I.T)	0.76	0.91 x 0.91
		Garhee Shahu Drain	0.24	0.91 x 1.22
		Lawrance Road Drain	10.67	0.76 x 0.91
		Gulberg-I Drain	1.52	4.27 x 3.66
		Gulberg-II Drain	1.37	1.22 x 1.83
		Basti Saidan Shah Drain	0.46	3.05 x 1.52
		Upper Mall Drain	0.76	1.52 x 1.22
		Fazalia Colony Drain	2.74	0.91 x 1.22
		Ferozepur Road Drain	0.61	0.91 x 1.22
		Queens Road Drain	0.98	0.91 x 1.37
		Waris Road Drain	2.44	0.91 x 1.22
		Gulberg Donghi Ground Drain	0.86	0.91 x 1.07
		Gulshan-e-Ravi S/Carrier	1.07	9.14 x 2.44
		Mall Road Drain	0.12	0.61 x 1.07
		Sodiwal Colony Drain	1.07	0.91 x 1.22
Central Drain	4.42	Mcleagn Road Drain	0.49	0.76 x 0.91
		Lyton Road Drain	0.46	2.13 x 0.91
		Nabah Road Drain	0.17	1.22 x 1.52
		Thorton Road Drain	0.46	0.76 x 0.91
		Edward Road Drain	1.37	2.13 x 0.91
		Raj Garh Drain	2.13	3.05 x 2.44
		Birdwood Road Drain	2.74	2.44 x 1.22
		Lake Road Drain	0.70	0.91 x 1.07
		Mozang Road Drain	1.22	1.22 x 1.07
		Mubarik Pure Drain	0.15	0.76 x 1.22
		Secretariat Drain	0.30	0.76 x 0.61
		Temple Road Drain	0.67	0.76 x 0.91
		Zoo Drain	0.43	0.91 x 1.07
AIT Drain	6.80	Sabzazar Drain	1.04	2.44 x 2.44
			1.01	1.83 x 1.83
		Rehman Pura Drain	6.12	0.61 x 0.91
				ϕ1.22、 ϕ0.76
Total	***26.61***		***53.33***	

Source: WASA, 2009

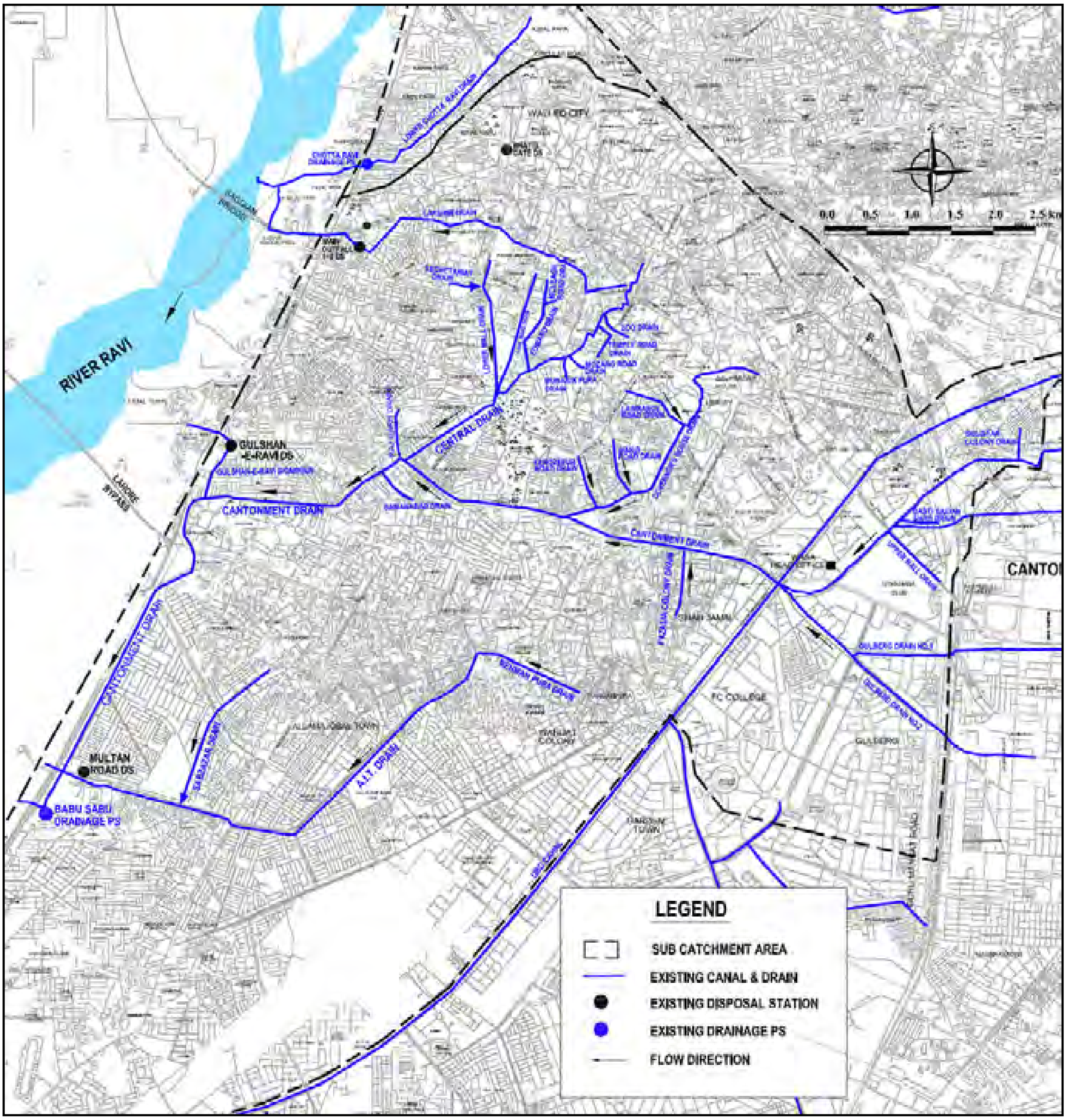


Figure 5.42 Existing Drains in the Central Area

(6) Sattu Katla Area

The existing drainage system is primarily dependent on the Sattu Katla Drain, and its width varies from 4 m to 30 m. while its depth ranges from about 1.5 m to 5.0 m. The drainage system consist of 11.43 km of the Sattu Katla Drain and 38.83 km of secondary / tertiary drain, making a total length of 50.26 km. Currently major portion of the Sattu Katla Area comprises of proposed housing societies which will be developed with the passage of time; whereas some housing schemes have already been developed. Therefore, drainage system of this huge area will become a major environmental concern when the area becomes fully developed. The reason being that the existing drainage system will not be sufficient to cope with the increased run-off caused by augmented population densities and built up areas of the city. In the absence of adequate facilities for the refuse collection system, solid waste is also disposed into the drains and hence causing blockages. Untreated industrial effluent from industrial estates is also entering the Sattu Katla Drain as shown in **Photo 5.26**. Untreated wastewater is ultimately discharged into River Ravi and is causing alarming situation for aquatic life. The connection of sewers with the drains, no doubt provides some relief but at the same time results in a negative impact on the overall environmental condition of the area, as these drains usually pass through very important residential and commercial areas. It also results in making the operation and maintenance of the drains very difficult. Encroachments and uncontrolled solid waste dumping especially in the Sattu Katla Drain has greatly reduced the original cross section and is hindering its smooth functioning as shown in **Photo 5.27**.

Photo 5.26 Sattu Katla Drain
(Entering of untreated industrial effluent)

Photo 5.27 Sattu Katla Drain
(Encroachments and uncontrolled solid waste dumping)

Table 5.47 shows the data of existing drains and location of existing drains in the Shahdara Area is shown in **Figure 5.43**.

Table 5.47 Data of Existing Drains in the Sattu Katla Area

Main Drain	Length (km)	Secondary / Tertiary		
		Name	Length (km)	Size (m)
Sattu Katla Drain	11.43	Johar Town Drain	1.07	0.91 x 0.91
			1.22	0.61 x 0.91
		C-1-Block, Johar Town Drain	6.31	2.44 x 1.83
		General Hospital Drain	2.90	2.13 x 1.52
		Garden Town Drain	1.80	1.83 x 2.44
			0.88	1.83 x 1.83
			0.76	0.91 x 1.52
			1.83	0.91 x 1.22
			1.77	0.61 x 0.76
		Faisal Town Drain	2.74	1.07 x 1.52
				0.91 x 1.22
		Mecca Colony Drain	4.57	0.91 x 1.22
		Qanchee Main Bazar Drain	1.83	1.22 x 1.22
		Moulana Shaukat Ali Road Drain	2.44	1.52 x 1.22
		College Road Township Drain	3.96	3.66 x 2.13
		Industrial Area Drain	2.44	3.66 x 1.83
		Behar Colony Drain	2.01	1.22 x 1.22
		A-Block, Johar Town Drain	0.30	0.76 x 0.91
Total	***11.43***		***38.83***	

Source: WASA, 2009

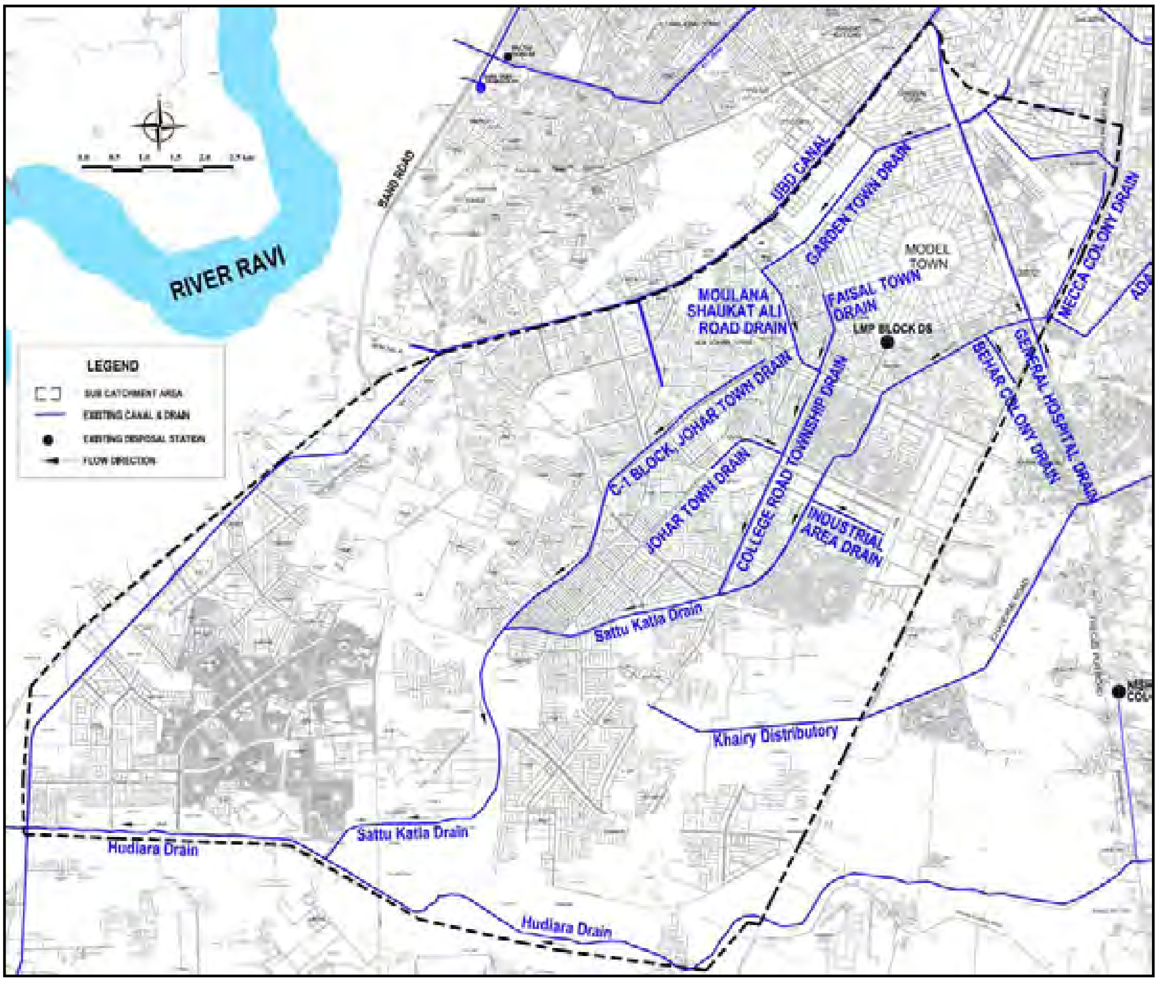


Figure 5.43 Existing Drains in the Sattu Katla Area

(7) Hudiara Area

The Hudiara Area, in the lower part of South Lahore, mainly consisting of new developments and the catchment area is 39.65 km^2. The existing drainage system is primarily dependent on the Hudiara Drain, and drainage system consist of 22.23 km of the Hudiara Drain and 15.42 km of secondary / tertiary drain, making a total length of 37.65 km. In this area, there is no drainage pumping station, storm water is discharged into the Hudiara Drain or into the nearby storm water drains and where no storm water drains exist, storm water is discharged to even in open fields. The Hudiara Drain serves as one of the most important drains of South Lahore. The Hudiara Drain runs parallel along the Defence Road. The Hudiara Drain covers a total length of 100 km, 45 km in Indian Territory and about 55 km in Pakistani Territory. Its width varies from 5.0 m to 30.0 m while its depth ranges from about 1.5 m to 6.0 m. The drain receives industrial and urban/rural wastewater from both India and Pakistan. At present, its original section in some reaches has been greatly reduced due to dumping of solid wastes as shown in **Photo 5.28**. Untreated industrial effluent from industrial estates is entering the Hudiara drain, which is ultimately discharged into River Ravi, therefore it is causing alarming situation for aquatic life as shown in **Photo 5.29**.

Photo 5.28 Hudiara Drain
(A lot of dumping of solid waste, June 2009)

Photo 5.29 Hudiara Drain
(Alarming situation, June 2009)

Table 5.48 shows the data of existing drains and location of existing drains in the Hudiara Area is shown in **Figure 5.44**.

Table 5.48 Data of Existing Drains in the Hudiara Area

Main Drain	Length (km)	Secondary / Tertiary		
		Name	Length (km)	Size (m)
Hudiara Drain	22.23	Altaf Colony Drain	0.76	0.76 x 0.91
		AI-Faisal Town Drain	1.22	1.07 x 1.52
		Behar Shah Road Drain	0.82	0.61 x 1.22
		Ghazi Road Drain	1.74	0.91 x 1.52
		Jubil Town Drain	10.88	3.66 x 1.83
Total	***22.23***		***15.42***	

Source: WASA, 2009

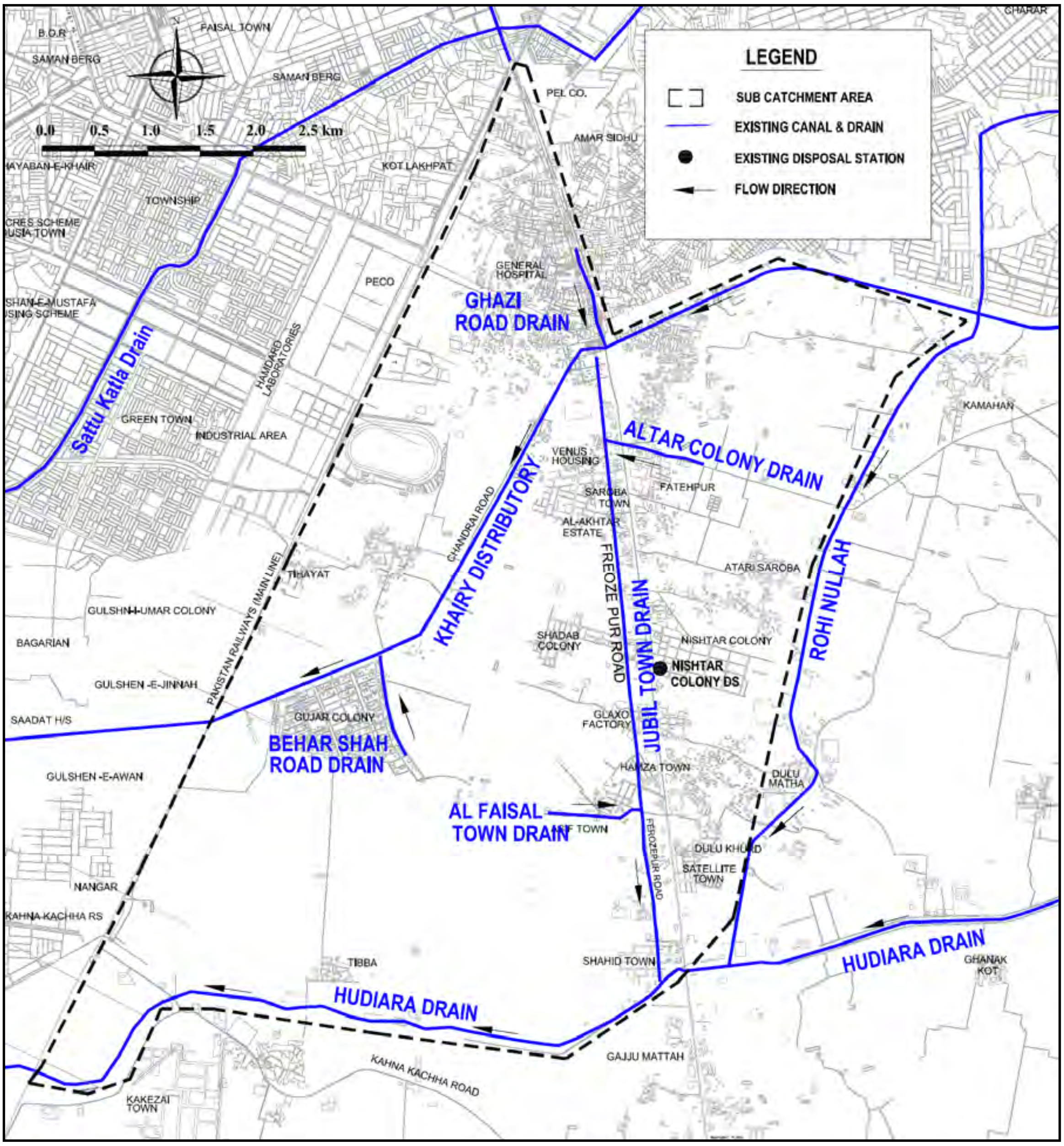


Figure 5.44 Existing Drains in the Hudiara Area

5.4.2 Cantonment Area

(1) Lahore Cantonment Area

The drainage system of Lahore Cantonment is primarily dependent upon three major drains, namely the Cantonment Drain, the ADA Nullah and the Rohi Nullah. Due to the inadequacy of the trunk sewers in this area, these drains are being used as sullage carriers. The existing drainage system of Lahore Cantonment is shown in **Figure 5.45**.

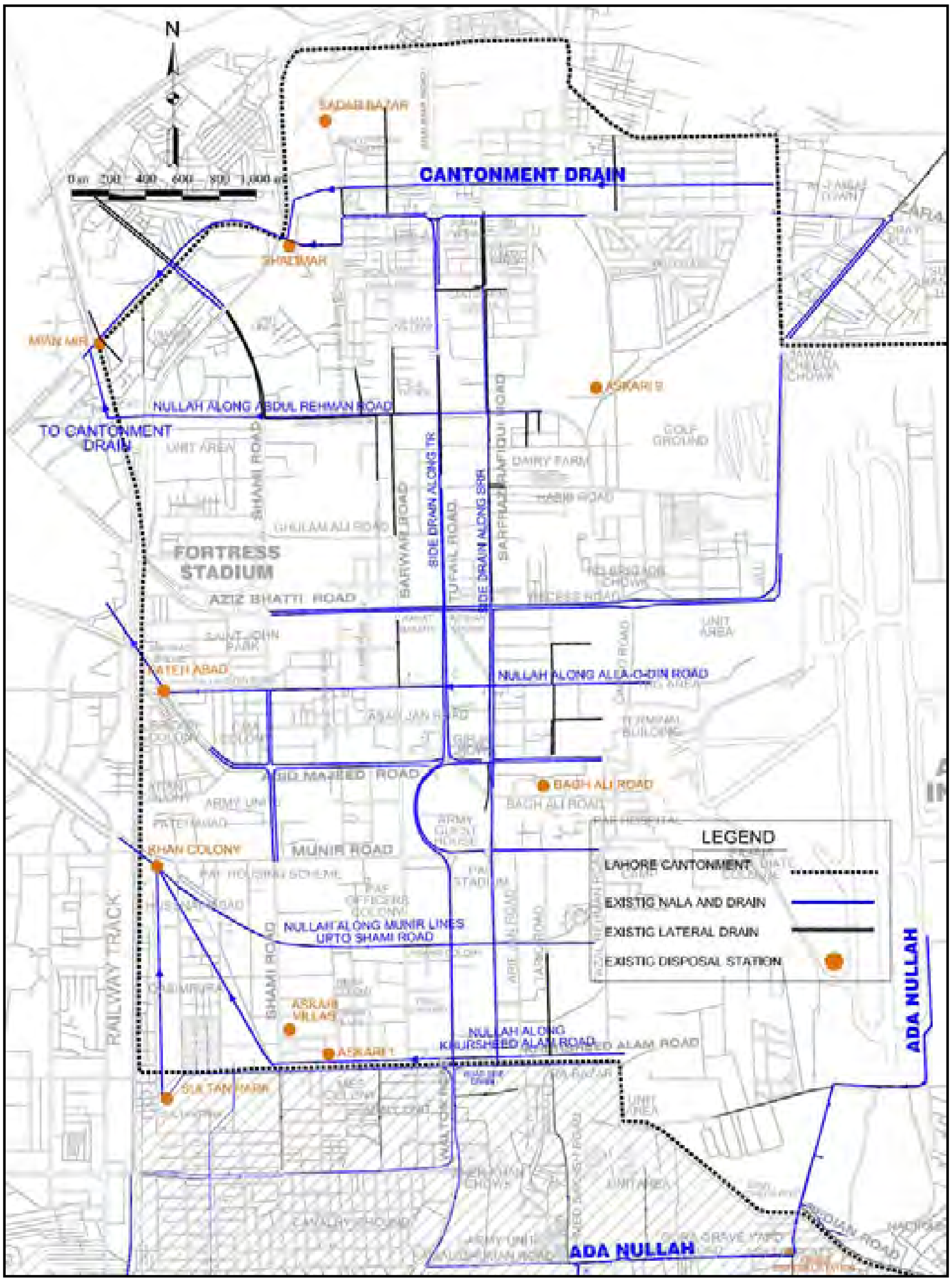


Figure 5.45 Existing Drains in the Lahore Cantonment Area

The brief descriptions of existing drains are as under.

1) Rohi Nullah

Rohi Nullah, with its original name of "Charrar Drain", was a natural surface drain owned by the Punjab Irrigation Department. This Drain, with a total length of 18.4 km, starts from Barki Road, flows southwards and ultimately falls into the Hudiara Drain about 0.3 km upstream of the confluence point of the Hudiara Drain and Ferozpur Road. Main areas along the Rohi Nullah in Lahore cantonment boundary are Bahu Wala village, Park View, Malik pur, Eden city, Madina Park etc. Sewage of unplanned areas falls into Rohi Nullah through open drains and pipes at various locations. A lot of vegetative growth and solid waste dumping has been observed in and along this Nullah at various reaches which reduces the flow velocity and consequently its entire reach has been silted. As a result, carrying capacity of Rohi Nullah has been reduced much as shown in **Photo 5.30** and **Photo 5.31**.

Photo 5.30 Rohi Nullah
(A lot of vegetative growth)

Photo 5.31 Rohi Nullah
(A lot of solid waste dumping)

After crossing Bedian road after traversing a length of 5.68 km it enters in Walton cantonment and then flows southwards parallel to Ghazi road. Bottom width of Nullah ranges from 3.7 m to 6.4 m whereas top width ranges from 4.5 m to 11.0 m and depth ranges from 1.2 m to 2.5 m.

2) Cantonment Drain

The Cantonment Dain starts form Al Faisal Town and ends at the Babu Sabu Drainage Pumping Station covering a distance of 15.40 km. After traversing length of 4.15 km in Lahore Cantonment, collecting storm water surface run off and sewage of the areas, it enters in the Central Area. Main areas located along the Cantonment Drain are Officers House Survey # 15, Subedar Colony, Officer Colony, Karachi Mohallah, New officer Colony, Ghousia Colony, Shutar Mohallah, Bakkar Mohallah, Mochi Mohallah, Qazi Mohallah, Dungar Mohallah, Khrass Mohallah, Diggi Mohallah, Bajaj Mohallah, Mohallah Eidgah, Mianmir Colony, Sagar Road, Delhi Road and Zarar Shaheed Road etc.

Sewage of above mentioned areas is being disposed of into Cantonment Drain through 6 disposal stations as discussed in Section 5.3.2 (1). During rainy season storm water of the areas along it contributes flow in the drain however, the carrying capacity of the drain has been reduced due to dumping of solid waste.

The other Nullahs which fall into the Cantonment Drain are;

- Nullah along Abdul Rehman Road
- Nullah along Alla-o-din Road
- Nullah along Munir Road
- Nullah along Sharif Road
- Nullah along Khursheed Alam Road

3) ADA Nullah

The ADA Nullah starts from the Allama Iqbal International Airport, flows towards southwest and after traversing a distance of about 8.50 km, discharge into the Sattu Katla Drain near the LDA quarters. It caters the storm water of the Allama Iqbal International Airport and Army Unit Area in Lahore Cantonment. After covering a distance of about 2 km in Lahore Cantonment near the crossing of Bedian road it enters in the Walton Cantonment. The bottom width of Nullah ranges form 3.0 m to 3.7 m whereas top width ranges from 3.0 m to 5.5 m and depth of Nullah ranges from 0.9 m to 2.1 m. At present, its original section in some reaches has been greatly reduced due to dumping of solid wastes as shown in **Photo 5.32** and **Photo 5.33**.

	
Photo 5.32 ADA Nullah **(A lot of solid waste dumping)**	**Photo 5.33 ADA Nullah** **(A lot of solid waste dumping)**

(2) Waltone Cantonment Area

The drainage system of the Walton Cantonment Area is also dependent upon the Cantonment Drain, the ADA Nullah, the Rohi Nullah and the drain along Ferozpur Road. The drainage system of the Walton Cantonment Area has the same problems as discussed above in the Lahore Cantonment Area section i.e. dumping of solid waste in drains, vegetative growth etc. Due to an overall inadequacy of the trunk sewers in this area, sewage from a number of adjoining areas are connected to these drains and these drains as such are acting as sullage carriers. Dumping of solid waste and encroachments along the drains have also reduced the cross sectional area. The existing drainage system of the Walton Cantonment Area is shown in **Figure 5.46**.

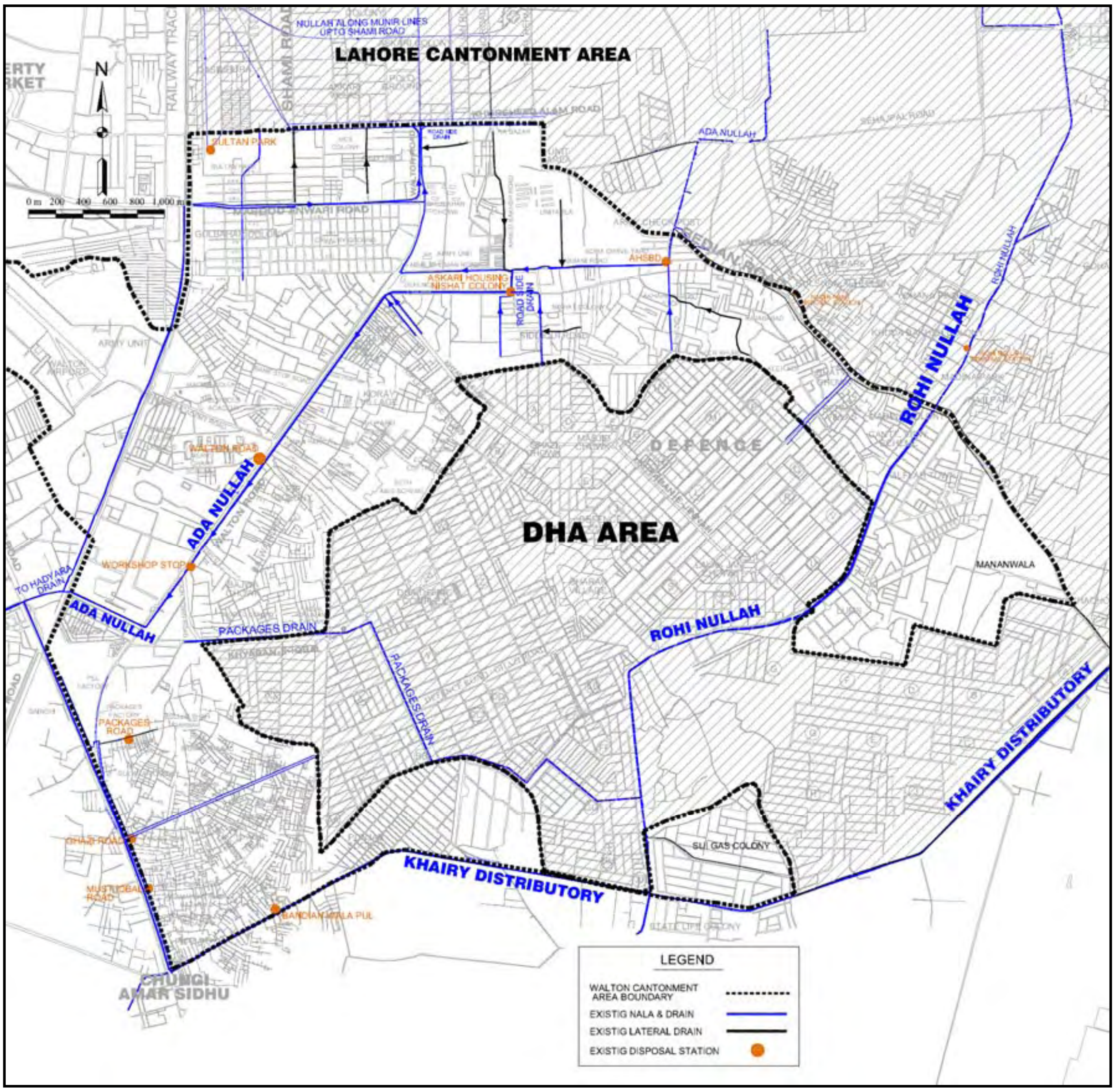


Figure 5.46 Existing Drains in the Walton Cantonment Area

The brief descriptions of existing drains are as under:

1) Rohi Nullah

As discussed above, it starts from Barki Road, flows southwards and after crossing Bedian Road by traversing a length of 5.68 km it enters into Walton Cantonment boundary. It caters the storm water of the areas along it which are DHA, Cantt View Scheme, Alfalah Town, State life colony and Sui Gas Colony. In addition to storm water, sewage of Cantt View Scheme, DHA Phase (I-V) and other housing schemes along it are also being discharged into the Rohi Nullah. Existing Condition of Rohi Nullah in the Walton Cantonment Area at different reaches are shown in **Photo 5.34** and **Photo 5.35**.

Photo 5.34 Rohi Nullah
(A lot of solid waste dumping)

Photo 5.35 RohiA Nullah
(A lot of solid waste dumping)

2) ADA Nullah

It enters the Walton Cantonment Area by crossing the Bedian road and after traversing a length of about 6.44 km it finally fall into the Sattu Katla Drain near LDA Quarters. The ADA Nullah caters the storm water runoff of Askari Flats Bedian Road, Nishat colony, Super town, Zaman Colony, Koray Village, Seth Abid Scheme, Qadri Colony, Shama Colony, Pir Colony, Model Colony, Al-Noor Town and LDA Quarters etc. It takes sewage of 6 No disposal stations as discussed in Section 5.3.2 (2) and acts as a sullage carrier in dry season. The existing conditions of Nullah at Rabbani Road and Walton Road are shown in **Photo 5.36** and **Photo 5.37**.

	
Photo 5.36 ADA Nullah (At Rabbani Road)	**Photo 5.37 ADA Nullah (At Walton Road)**

3) Ferozpur Road Nullah

It starts from Mast Iqbal Road flows parallel to Ferozpur Road and ultimately falls in Satu Katla Drain by crossing the Walton Road near Packages (Pvt.) Ltd. It traverses a distance of 2.1 km and serves the areas of Muhammad Pura, Firdos Park and Gulistan Colony etc. Sewage of 4 disposal stations as discussed in Section 4.3.2 (2) is also being discharged into it. Its width varies from 0.9 m to 3.0 m while its depth ranges from about 0.6 m to 3.3 m. The existing conditions of drain in its different reaches are shown in **Photo 5.38** and **Photo 5.39**.

	
Photo 5.38 Ferozpur Road Nullah (At Ferozpur Road)	**Photo 5.39 Ferozpur Road Nullah (Near the Package Road)**

5.4.3 TMA Area

As described in Section 5.3.3, in the TMA Area, there are no drainage pumping station and main drains. The storm water is discharged to open filed through the small drain and road drain which were provided by the PHED and TMA.

The PHED has improvement plan for drainage system in this area. The summary of the PHED Projects is given in **Table 5.38** and the location of PHED Projects in TMA Area is shown in **Figure 5.35**.

5.4.4 Inundation Condition

Lahore City is still perennially ravaged by a series of major floods despite structural measures that have been implemented to counter this calamity. This is a grim reminder that man has not yet proven itself equal against the forces of nature.

At present, six (6) rain gauges are installed in Lahore City for rain observation. Out of the six (6) rain gauges, two (2) rain gauges belong to the Meteorological Agency, four (4) of are installed by WASA in 2009.

WASA has monitored inundation situation, such as inundated depth and inundated period, during heavy rain at 80 frequently inundation points in WASA service area, however, inundated area has not been monitored. In this study, therefore, JICA Study Team had conducted inundation condition survey to confirm average inundation areas of 80 frequently inundation points.

The monitored inundation data for the past three years from 2007 to 2009 are shown in **Appendix 5.3**, the location of 80 frequently inundation areas and rain gauges are showing in **Figure 5.47** and average inundation areas of frequently inundation points are shown in **Table 5.49**.

Table 5.49 Average Inundation Areas

No.	Inundation Point	Average Inundation Area (ha)	Sub-catchment Area	No.	Inundation Point	Average Inundation Area (ha)	Sub-catchment Area
1	Laxami Chowk	1.56	Central Area	41	Model Town Link Road	1.11	Sattu Katla
2	GPO	0.44	Central Area	42	Mini Market Gulberg	0.34	Babu Sabu
3	Kashmir Road	0.28	Central Area	43	Aik Moria Pul	0.08	Siddique Pura
4	Thorton Road	0.39	Central Area	44	Rahim Road	0.38	Siddique Pura
5	Cooper Road	0.51	Central Area	45	Aziz Road	0.24	Siddique Pura
6	Bashir Sons	0.12	Central Area	46	Umer Din Road	0.78	Siddique Pura
7	Rehman Gallian	0.79	Central Area	47	Chowk Na-Khuda	0.00	Siddique Pura
8	Do Moria Pul	0.08	Siddique Pura	48	Shairanwala Gate	0.54	Babu Sabu
9	Lytton Road	0.79	Central Area	49	O/S Bhati Gate	0.69	Babu Sabu
10	Plaza Cinema	0.65	Central Area	50	Main Road, Shahdara	1.48	Shahdara
11	Nabha Road	0.90	Central Area	51	Lajpat Road Shahdara	8.42	Shahdara
12	Church Road	0.44	Central Area	52	Timber Market	2.22	Babu Sabu
13	Mozang Chungi (Chowk Qurtaba)	1.26	Central Area	53	Haq Nawaz Road	0.22	Mehmood Booti
14	Shadman/Shah Jamal	0.68	Central Area	54	Toheed Park	0.21	Mehmood Booti

15	Waris Road	0.31	Central Area	55	Milap Street	0.24	Siddique Pura
16	Galaxy Plaza	0.37	Central Area	56	Angoori Cinema (Shalimar Link Road)	0.32	Siddique Pura
17	Park Lane Road	1.66	Central Area	57	Police Station (Mughalpura)	0.20	Mehmood Booti
18	Chauburji	3.96	Central Area	58	Shah Kamal Road	0.42	Mehmood Booti
19	Lake Road	1.72	Central Area	59	Yammi 36, Begum Pura	0.26	Siddique Pura
20	PU Ground, HCC	1.22	Central Area	60	Bagheechi Saithan	0.33	Siddique Pura
21	Rewaz Garden	0.68	Central Area	61	UET G.T. Road	0.40	Siddique Pura
22	Sanda Road	0.62	Central Area	62	Scheme More	1.06	Babu Sabu
23	Fazlia Colony	0.90	Central Area	63	Rachna Block Road	1.05	Babu Sabu
24	SSP Office Dev Samaj Road	0.23	Central Area	64	Al-Hamad Colony	1.79	Babu Sabu
25	Malik Park	0.11	Central Area	65	H-Block Sabzazar	0.36	Babu Sabu
26	Nasir Park (Tonga Adda)	0.15	Central Area	66	Poonch Road	0.45	Babu Sabu
27	Secondary Board	0.33	Central Area	67	Millat Chowk	0.57	Babu Sabu
28	Firdous Market	1.60	Sattu Katla	68	Multan Road Bhalla Stop	0.53	Babu Sabu
29	Kalma Chowk	1.82	Sattu Katla	69	Sultan Ahmed Road Rehmanpura	0.21	Babu Sabu
30	Central Point	2.39	Central Area	70	Zaildar Road Ichhra	0.25	Babu Sabu
31	Gari Shahu	1.26	Central Area	71	Chowk Yateem Khana	0.82	Babu Sabu
32	Muhammad Nagar	2.65	Central Area	72	Infantory Road	6.75	Babu Sabu
33	Bibi Pak Daman	1.84	Central Area	73	Allama Iqbal Road Mustafabad	0.69	Babu Sabu
34	Empress Road	0.60	Central Area	74	B-Block Tajpura	0.35	Mehmood Booti
35	Railway Station	0.70	Central Area	75	Laxami Chowk	1.56	Babu Sabu
36	Akbar Chowk	1.25	Sattu Katla	76	GPO	0.44	Sattu Katla
37	Hussain Chowk	0.73	Central Area	77	Aziz Road	4.50	Sattu Katla
38	Barkat Market	3.91	Sattu Katla	78	Chowk Na-Khuda	5.50	Sattu Katla
39	L-Block Gulberg	1.26	Sattu Katla	79	Sheranwala Gate Pully	6.75	Sattu Katla
40	Tipu Block Garden Town	0.63	Sattu Katla	80	Mustafabad Under Pass		Sattu Katla

Source: JICA Study Team, 2009

The result is that there are many frequently inundation points in the Central Area, especially, along the main drains namely, the AIT Drain, Cantonment Drain and Central Drain, there are severely inundated areas. The summary of the results for each sub-catchment is tabulated in **Table 5.50**.

Table 5.50 Inundation Condition for Sub-catchment area

	Shadara	Mehmood Booti	Siddique Pura	Chotta Ravi	Central	Sattu Katla	Hudiara
Number of Location	2	5	11	-	50	12	-
Total Inundation Area (ha)	9.90	1.40	3.10	-	49.75	21.18	-

In Lahore, WASA has a concern in rainwater storage/infiltration facilities as the measures to reduce the frequent inundation. The basic information is given in **Appendix 5.4** for reference.

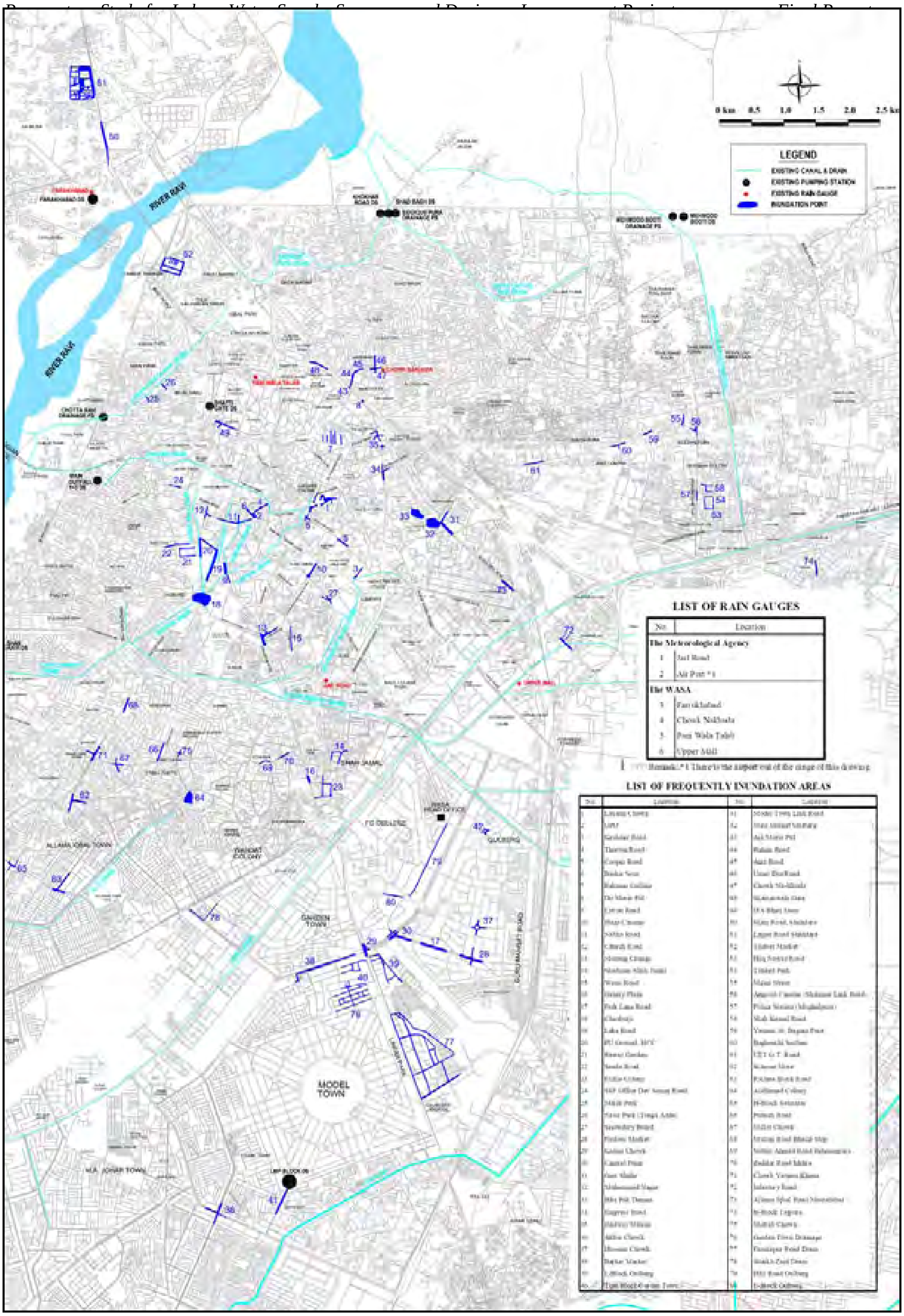


Figure 5.47 Location of the frequently inundation Areas

5.4.5 Solid Waste Management

Presently solid waste generated in Lahore is collected from the communal bins placed at various locations in the city and transported for dumping site. Both public and private sectors are involved in managing solid waste within the city. In public sector the City Government and LCB are responsible for collection and disposal of solid waste within the ex-municipal and cantonment limits of Lahore city respectively. In the private sector MTS and LCCHS are responsible for the collection and disposal of solid waste from their respective areas. In addition some NGOs are also involved in the solid waste management but their activity is generally limited only to the collection of solid waste in some parts of the city. Generally the collection of solid waste in the city is carried out both by the public and private sectors by employing manual as well as mechanical means but the final disposal is the sole responsibility of the City Government (Solid Waste Management [SWM] department) and LCB and such private sector is only limited to the collection of solid waste.

The existing solid waste collection is not very effective and some of the solid waste generated in the city finds its way into open drains, sewers, streets or in open areas. (Refer to **Photo 5.48**)
It is estimated that only about 70 % of the total solid waste generated is collected by the City Government or other responsible agencies.
(Described above is quoted from "Integrated Master Plan for Lahore-2021, LDA")

Photo 5.48 Disposal Condition of Solid Waste

The sewers and drains are cleaned out regularly according to scheduled programs by WASA. The sludge deposited at the bottom and solid waste in the drains are collected and placed along the drains or close to sewerage pipelines but preferably carried to tipping points on the other side of the bund (flood protection wall or embankment on River Ravi) as final disposal . Then, the dried sludge is also collected by solid waste management department of City District Government and co-disposed with municipal solid waste at the dumping site.

The solid waste in the drain not only decreases the capacity of drains but also increase the maintenance cost of drain cleaning. WASA should strengthen the campaign to reduce illegal dumping of solid waste. Furthermore, it should be consider that official budget cover the cost of drain cleaning for solid waste.

CHAPTER 6 WASA OPERATION

6.1 Organization

6.1.1 WASA (Lahore)

(1) Changes of Organization

With regard to the business and O&M on water & wastewater operation, construction on lifting pump and service reservoir, and O&M at Ravi Town (ancient capital: Wall City) in 1881 under the control of UK are the starting line. Subsequently, water & wastewater utility was operated as a "Water Wing of Lahore Improvement Trust" under the supervision of Government of Punjab around 1971.

As the original model on present organization, WASA was established under the control of Lahore Development Authority (LDA) around 1991 accompanying the augmentation of population and water consumption. Such organization was characterized by dividing the jurisdictional area for O&M into two (2) blocks (South & North).

Appendix 6.1.1 shows the organization chart of governmental agencies concerned to efficiently execute the WASA's water and wastewater project in 2002.

WASA (Lahore) was reorganized around 2002, and the governance area (about 350 km^2) with 6 towns and 25 sub divisions for O&M was thus set up instead of the divide by north-south or district so far. The respective working jurisdictional limits for the· O&M by each town is the O&M on water supply, storm water and wastewater drainage facilities; however, the responsible control lines for the water service area by waterworks, drainage area and O&M are different respectively.

Table 6.1 shows the actual WASA's O&M area for 6 towns on May 2009 and **Figure 6.1** shows the O&M District Office boundaries.

(2) Operation Concept

Operation concept on WASA is stated as below by the interview from MD, DMD, and Director. The organization is aimed at the soundness of water and wastewater business operation, improvement on rate of facility in operation, planning, efficiency promotion on facility planning and construction management, efficiency promotion on facility O&M, improvement on tap water quality analysis capacity, efficiency promotion on water and wastewater tariff collection, income increase by leakage detection, improvement on inventory management, and reinforcement on customer services etc.

Table 6.1 Actual WASA's O&M Area for 6 Towns

Total Area for Operation & Maintainance works				Total Area for Water Supply Services			Total area for Sewrage Services		
Sr. No.	**Description of Area/Sub Divisions**	**Population (2008)**	**Area (Km^2)**	**Description of Area**	**Sub Divisions**	**Area (Km^2)**	**Description of Area**	**Sub Divisions**	**Area (Km^2)**
1	**RAVI TOWN**		**42.00**	**Nortn Division**	Data Nagar		**Shahdra**	Shahdra	18.44
1-1	City		5.48		Misri Shah		**Khokhar**	North	29.19
1-2	Shahdra		9.98		Baghban Pura		**Mehmood Booti**	North East	22.49
1-3	Farakhabad		6.57	**Central division**	Shahdra				
1-4	Data Nagar		4.43		Ravi Road		**South west**	Central	101.74
1-5	Misri Shah		8.03		City				
1-6	Shadbagh		7.47						
2	**SHALIMAR TOWN**		**32.90**						
2-1	Mughal Pura		17.20						
2-2	Baghban Pura		15.68						
3	**GUNJ BUKSH TOWN**		**59.80**						
3-1	Krishan Nagar		9.20					South Civil Line	
3-2	Ravi Road		9.10	**East Division**	Mughal Pura			South West	
3-3	Mozang		10.84		Mustafaabad		**South East**	Nishtar Town	39.65
3-4	Anarkali		6.52		Shimla Hill			Cantonment	
3-5	Gulberg		16.17	**West Division**	Karishan nagar		**South**	South East	138.95
3-6	Shimla Hill		7.95		Iqbal town			Johar Town	
4	**AZIZ BHATTI TOWN**		**13.70**		Samanabad			Far-South West	
4-1	Mustafabad		2.13	**South Division**	Mozang		**Total**		**350.46**
4-2	Tajpura		11.54		Ichra				
5	**ALLAMA IQBAL TOWN**		**117.40**		Gulberg				
5-1	Iqbal Town		6.66	**A. I. T. Division**	Garden Town				
5-2	Samanabad		5.04		Industrial Area				
5-3	Sabazar		6.68		Town Ship				
5-4	Ichra		6.26		Green Town				
5-5	Johar Town		92.77						
6	**NISHTAR TOWN**		**71.90**						
6-1	Industrial Area		20.87						
6-2	Green Town		32.96						
6-3	Garden Town		12.10						
6-4	Town Ship		6.01						
	Total (WASA)		**337.70**						
7	**Cantonement Area**		156.10						
8	Defence Housing Authority								
	G.Total		493.80						

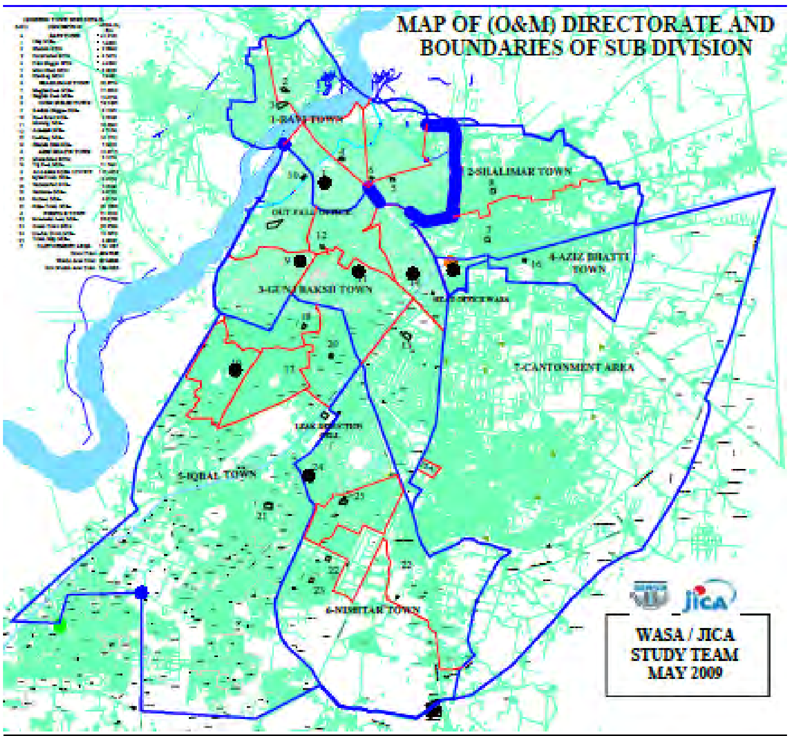


Figure 6.1 Map of O&M District Office Boundaries

The management conditions by various departments can be shown as follows.

1) Head Office: To unify management of O&M, operation, organization and finance
2) 6-site regions for O&M: The respective affairs by each administrative region were further divided into several departments in charge of drainage/O&M, rainwater/inundation measures, tap water quality analysis, and workshop respectively. In addition, branch offices under Head Office carries out the water meter reading, water tariff collection and affairs on receipt and answer of complaints.
3) Two storages for parts conduct the inventory management.
4) **Table 6.2** shows the scale on O&M target facilities managed by WASA.

Table 6.2 Summary of Actual O&M Works

Pump operation		Sewers & drains	
Tube-wells	423 Nos.	Sewers	3,508 km long
Disposals pumps	90 Nos.	Drains	215.68 km long
Boosters pumps	10 Nos.	-	-
Total	523 Nos.	Total	4,022 km long

Source: WASA Budget 2008-2009 & Re.2007/08

5) **Figure 6.2** illustrates the WASNs organization chart.

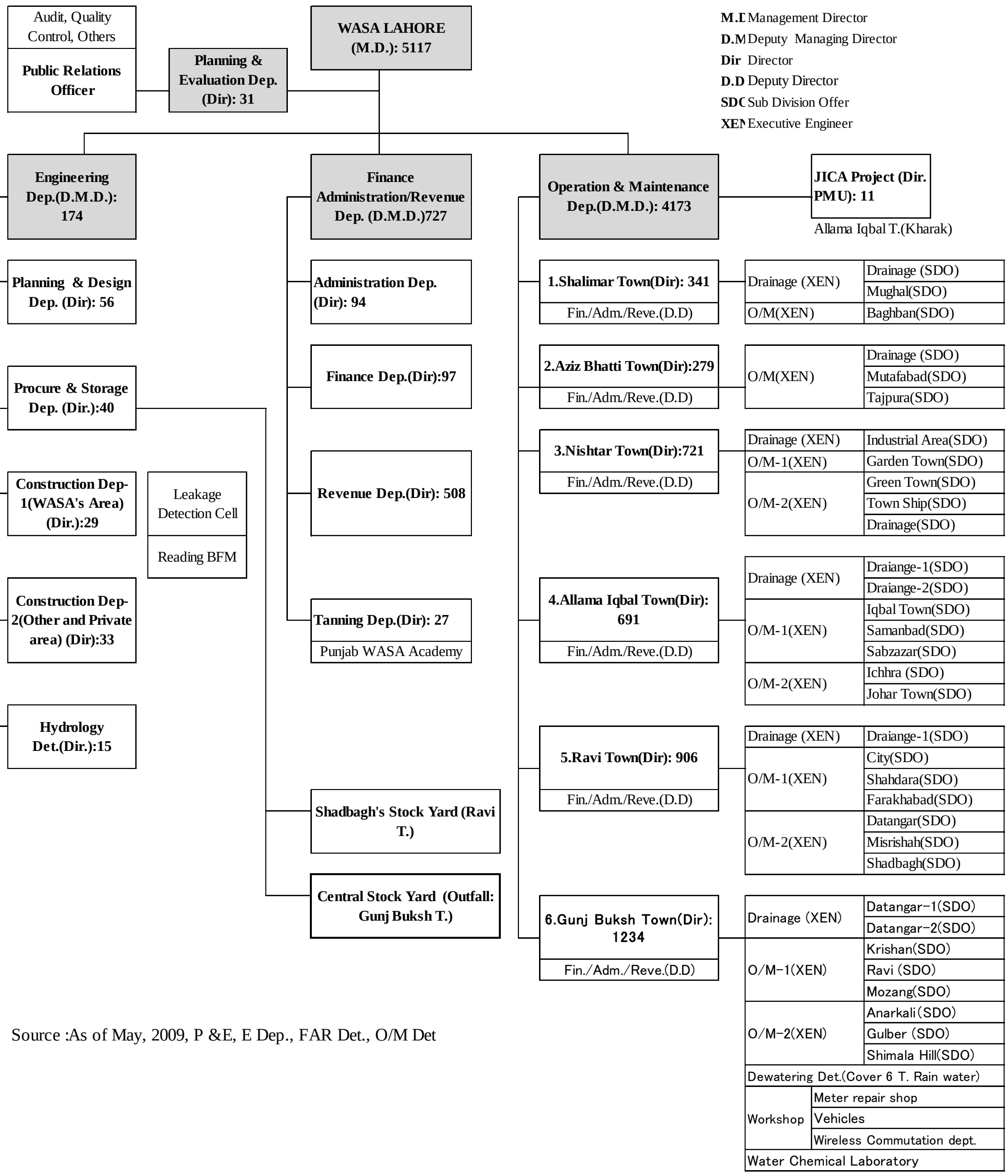
(4) Command-and-Control

The MD is in charge of the command-and-control for the organization, especially for the important affairs such as operation policy, financial management, customer's serious complaint measures, emergency countermeasure, and reporting to the related governmental agencies. With regard to the command-and-control for each department, each DMD shall follow the MD's intension and then manages the organization based on the instruction in term of technical, complaint measures and water tariff collection affairs.

The internal meetings were frequently held to unify the intention within the WASA. On the other hand, Director work for the Planning & Evaluation Division will transmit the WASA's public comments (media: employee's employment information, enlightenment to town people).

6.1.2 Major Duties (Roles) and Scope of Work

The details are given in **Appendix 6.1.2**.



Source :As of May, 2009, P &E, E Dep., FAR Det., O/M Det

Figure 6.2 WASA's Organization Chart

6.1.3 Problem Analysis

The following problems are raised from the existing organization in step with organizational complication, augmentation on work contents/load and employee's aging.

- Information exchange among the organizations was not enough. Responsible area by jurisdiction for each O&M was undefined.
- Tasks on O&M were not thoroughly established.
- Same tasks were duplicated among the organizations in charge O&M.
- Administrative data were not unified.
- Management and administration data were not timely prepared/arranged.

— Cases on complaint frequently occurred.

As a countermeasure, review and reassignment on organization are required.

6.2 Operation and Maintenance

6.2.1 Status of Accounted-for water &Unaccounted-for water

Water consumption of the WASA is categorized into AFW/UFW and RW/NRW as shown in **Figure 6.3**. Although other consumption includes some water that the water charge is collected from some governmental offices/employees under the discounted rate, but they are regarded as a part of non-revenue water as well as excess usage by unmetered connections and water wasted during making new Grid connections / consumer water connections / repairing of water supply pipelines in calculation.

<table>
<tr><td rowspan="4">Water Production
（354 MGD）
100%</td><td rowspan="3">Accounted-for Water
(AFW)
(241 MGD)
68%</td><td>Metered Consumption
(108 MGD)</td><td rowspan="2">Revenue Water (RW)
(211 MGD)
60%</td></tr>
<tr><td>Unmetered Consumption
(103 MGD)</td></tr>
<tr><td>Other Consumption
(31 MGD)</td><td rowspan="2">Non-revenue Water
(NRW)
(144 MGD)
40%</td></tr>
<tr><td colspan="2">Unaccounted-for Water
(UFW)
(113 MGD)
32%</td></tr>
</table>

Source: "Report on Accounted and Unaccounted for Water for the Period of Jan. & Feb. 2009", WASA

Figure 6.3 Analysis of AFW/UFW and RW/NRW in the WASA

Although the NRW ratio is variable depending on whether other consumption is categorized into NRW as shown in **Figure 6.3**, the practice in the WASA is accepted in this report as it is, since it originally includes both different characters that the water charge is collected and cannot be collected.

Moreover, the average AFW by six (6) towns went up about 5% as the result of rises on numbers of connections during the period from November 2007 up to November 2008. **Table 5.3** and **Table 5.4** show the average status of AFW & UFW ratios in 6 towns.

Table 6.3 Status of AFW & UFW Ratio by Town in 2009

Sr. No.	Name of Town	Accounted for Water	Unaccounted for Water
1	Allama Iqbal Town	70%	30%
2	Shalimar Town	77%	23%
3	Aziz Bhatti Town	71%	29%
4	Nishtar Town	70%	30%
5	Ravi town	75%	25%
6	Gunj Bukhsh Town	55%	45%

Table 6.4 Average Status of AFW & UFW Ratios in 6-Towns

Sr. No.	All Towns	Sept.07	Oct.07	Nov.07	Dec.07	Jan.08	Feb.08	Mar.08	Apr.08	May.08	Jun.08	July-Aug.08 (Ave)	Sept-Oct.08 (Ave)	Nov-Dec.08 (Ave)	Jan-Feb.09 (Ave)
1	Metered Connections Numbers	261,213	261,213	262,884	262,884	265,069	265,069	267,471	267,471	273,611	273,611	275,993	279,060	279,810	285,442
2	Un-metered connection Numbers	274,891	274,891	274,599	274,599	274,496	274,496	274,396	274,396	274,361	274,361	274,195	274,153	273,918	271,447
3	Number of Tube Wells	403	403	403	403	403	402	402	402	417	417	417	417	417	412
4	Water Production(MGD)	392	374	374	363	354	365	360	372	366	375	358	358	349	354
5	Daily Meter consumption(MGD)	99	99	101	101	103	103	100	100	101	101	101	106	107	108
6	Daily Un-Meter consumption(MGD)	104	104	105	105	107	107	103	103	101	101	100	105	105	103
7	A F W	63% 240 MGD	63% 240 MGD	66% 244 MGD	66% 244 MGD	65% 236 MGD	65% 236 MGD	64% 234 MGD	64% 234 MGD	65% 238.5 MGD	65% 238.5 MGD	66% 237 MGD	67% 241 MGD	70% 243 MGD	68% 241 MGD
8	U F W	37% 143 MGD	37% 143 MGD	34% 124 MGD	34% 124 MGD	35% 123.5 MGD	35% 123.5 MGD	36% 132 MGD	36% 132 MGD	35% 132 MGD	35% 132 MGD	34% 121 MGD	33% 117 MGD	30% 106 MGD	32% 113 MGD
9	R W	53% 203 MGD	53% 203 MGD	56% 206 MGD	56% 206 MGD	58% 210 MGD	58% 210 MGD	55% 203 MGD	55% 203 MGD	55% 202 MGD	55% 202 MGD	56% 201 MGD	59% 210 MGD	61% 212 MGD	60% 211 MGD
10	N R W	47% 180 MGD	47% 180 MGD	44% 162 MGD	44% 162 MGD	42% 149.5 MGD	42% 149.5 MGD	45% 163 MGD	45% 163 MGD	45% 168.5 MGD	45% 168.5 MGD	44% 157 MGD	41% 148 MGD	39% 137 MGD	40% 143 MGD

Source: Leakage Detection Cell, April 15, 2009

(3) Problem Analysis

The provident measures for reduction of the unaccounted-for water are indispensible to aim at the promotion on operating revenue. In addition, the reduction on unaccounted-for water has an effect on pushing up the accounted-for water. Existing ratio on accounted-for water differed by each town with some 55-77%; however, it bears improvements. Particularly, the investigation on the ratio of unaccounted-for water is required to immediately conduct for securing the equality to those inhabitants who shouldered the water tariffs. Investigation on accounted-for/unaccounted-for was so difficult due to the slow-up on improvement of pipeline network diagram and without installation by intermediate flow meters/valves.

As a result, problems are raised below.

- Accounted-for water was not accurately grasped.
- Investigation of the causes on unaccounted-for water was still not completed.

- Reduction measures on unaccounted-for water were behind time.
- Modification/rehabilitation and computerization on service pipeline network were behind time.

Improvement on service pipeline network diagram and long-term securement on water balance by water volume measurement instruments such as water-gauges are required as a useful measure. In addition, such investigation can also be conducted by the method that model region was set up and the ratio on accounted-for water may be augmented in stages after grasping the actual situations.

6.2.2 Leakage Control

(1) Unit in charge of repairs

Regarding the leakage control on pipeline for water & wastewater, each O&M unit carried out the investigation/repair works according to the complaint information from the town people. With regard to the small-scale pipe breakage and leakage control, each organization for O&M can respond by itself; however, major work was conducted through outsourcing due to the deficiency of heavy equipment. In addition, the repair work was carried out if conditions worsen.

(2) Leakage detection equipment

The leakage place can be speculated from the viewpoint of soil movement because the water usually blows out. On the other hand, the leakage detection (1 to 2 times per month on average) was requested from all of 6 towns to the leakage detection cells of Construction Department-2 under the Planning & Evaluation Department in the case that leakage place detection is so difficult. In addition, such leakage detection cells cover the leakage inspection for WASA's whole area.

With regard to the leakage detection work, four staff conducted the on-site survey with the own equipment and materials (metal detector, acoustic leakage detector, and discharge/pressure measuring instrument). However, number of the leakage cases occurred and detailed information collection on leakage volume (unaccounted-for water) within the area of WASA concerned were not available. In addition, the repair equipment and materials are still in poor condition. **Table 6.5** shows the leakage detection and repair equipment owned by leakage detection section.

Table 6.5 List of Leakage Detection Equipment

#	Instruments	No.	Remarks
1	Metal Detector	1	Location of Manhole cover
2	Sonic Stick	2	Leakage sound detection Kits
3	Logger and Probe	4	Veracity and Pressure of pipe line

Acoustic Leak Detector

Velocity/Pressure Indicators

(3) Prediction on leakage factor

The most frequent cause on leakage can be judged as below.

I) Leakage by service pipes from distribution main up to water service meter

- It was described that the leakage percolated from the attaching portion (5 years approximately passed) where is located at service pipe (15-25 mm steel pipe) from the service pipe by PVC/asbestos pipe (150-300 mm) occurred and counted 90% on leakage at large.
- With regard to the materials on service lines (buried at 3-5 ft below ground) so far, galvanized iron pipes were conventionally applied. However, the soil property of area with 70-80% under the control of W ASA shows that steel pipe is easily corroded due to high water content.
- As one of the countermeasures, polyethylene pipe (PE) as an alternative product instead is recommended by WASA's Design Criteria (issued by Water and Sanitation Agency, Lahore Development Authority, Part-3, 3-5 Service Line 1974); however, nothing has worked.

2) Breakage of pipeline

Detailed information was not available; however, 23 cases on leakage detection are recorded in past two years (from April 2007 until April 2009). **Appendix 6.2.1** shows the leakage investigation activities by leakage detection cell.

(4) Problem Analysis

The improvement measures on reducing the leakage rate are indispensable to aim at the improvement on effective water volume, reduction on leakage complaint cases, reduction on water quality contamination, and improvement on saving water. Detection on leakage is to investigate the leakage place where leakage accident occurred. Leakage measure plans and pipeline network diagram were still not improved nowadays. Furthermore, the leakage inspection devices, numbers of inspector, leakage repair materials and heavy equipment etc. are not enough.

As a result, problems were risen blow.

- Ineffectual water volume caused by leakage is not accurately grasped.
- Effective repair work is still not completed.
- Appropriate countermeasures and PR to the inhabitants are behind time.

As the countermeasures, improvement on service pipeline network diagram and reinforcement on inspection facilities and reinforcement on numbers of inspector are required.

6.2.3 Operation & Maintenance of Water Supply Facilities

(1) O&M on Water Supply Facilities

Water supply facilities are consisted of tube-well equipment and water supply pipe lines. Drinking and commercial water were serviced to the customers by i) direct water service from the tube-wells (about 417 wells, April 2009) sourced from the groundwater; and ii) gravity flow from the service reservoir. At present, it is predicted that direct water service occupy more than half with water pressure of approximately 0.5-1.5 kg/cm^2.

1) Composition of facilities

Facilities is consisted of submerged turbine pump, gate valve, pressure gauge, sterilization equipment, incoming panel, on-the spot panel, and hoist equipment (crane) etc., and of curse to be installed inside of the brick structure. It can be predicted that the pump and motor efficiency had being lowered because the tenures of use are more than 10-30 years (30%) in terms of running submerged pump facilities. Furthermore, the risks by short circuit become high due to the aging equipment of on-the spot panel. With regard to the repair frequency on pump facilities, approximately 15-20 sites per month by outsourcing were repaired.

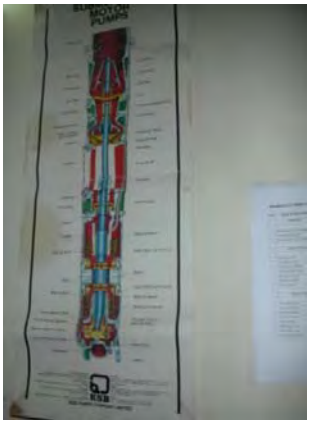
Table 6.6 Status of Existing Tube-wells

Year	Number of units	Ratio (%)
1975-1988	19	5.0
1989-1998	95	24.9
1999-2009	268	70,1
Total	382	100

2) Installation condition on submerged pump

Submerged water pump was adopted to pump out the water from 150-200 m below ground.

With regard to the pump running conditions, rotational vibration markedly appeared can be judged by the poor installation on pumps and motors. In addition, it may cause the groundwater contamination because the crack/subsidence is found on the parts of concrete of installation floor. Based on the design idea that the delivery pipe must be installed with check valves, check valves exist on all the tube-wells.



Schematic View of Submerged Pump

Crack on the Concrete Floor

3) Measurement of water table

Hydrology Division periodically measured the water table in tube-wells by simplified water level detector.

Simplified Water Level Detector

4) Records on running and O&M of submerged pumps

With regard to the operation management on submerged pumps, 24-hour resident person (three persons work in 8 hour shifts) has recorded the operation conditions in accordance with the running hours of pumps.

Recording items on the ledger are shown as follows.

- Date and hour and name of person in charge
- Pump running hours
- Calculation of water volume (running hours of submerged pump/pump capacity)
- Voltage access to electricity and wattmeter
- Special instruction (decrease of pumping discharge, noise & vibration, defect of

structure etc.)

5) Chlorine agent

Chlorine agents were conveyed from chemical factory to major part supply center where is located at Outfall Stock Yard in Gunj Buksh Town for further breaking bulk (vessel with approximately 0.5m3), and temporarily stored within the compound and thus finally supplied to each town. In general, stocks were cleared and restocked by the pace of 2-day duration. With regard to the quality control on the purchased chlorine, water quality analysis laboratory of W ASA is responsible for the confirmation tests in comparison with the delivery quality. The contract chloride concentration is approximately 20%.

Two kinds of chlorine agents, sodium hypochlorite and Twin Oxide which is the name of commodity of Twin Oxide Co., and has 2.6 times strong oxidative power than the conventional chlorine agent, were studied.

The sodium hypochlorite solution, a conventional agent, is recommended on this project, because there is no merit to change the use of present chlorine agent into Twin Oxide ClO_2.

Main reasons for the recommendation are as follows,

a) Water source for drinking water is pumped up from about 200m deep tube-wells and the water source has less chance of being contaminated by microbes, therefore, the strong agent is not necessary to inject into the tube wells.
b) The residual chlorine period of sodium hypochlorite can sufficiently respond contamination through the pipelines.
c) The chemical agent sodium hypochlorite is available in domestic market and more flexible for delivery time than Twin Oxide which is to be imported from out of the country.
d) O&M operators have more experience on handling of sodium hypochlorite.
e) To produce ClO_2 liquid from ClO gas on the spot, special technical knowledge for the plant is required for the operation management. Moreover, due to the possibility of explosion accident caused by mixing of ClO gas and oxygen existing in atmosphere, plant operation is highly risky.

Salient features of two kinds of chlorine agents are compared in **Appendix 6. 2.2**.

6) Chlorine injection facility

About 2-4 ppm of sodium hypochlorite solution with concentration of 20% was injected into the outlet pipe of the submerged pump. However, both of injection pumps and titrating pump did not work due to the shortage of spare parts and insufficient O&M respectively. Drip system by gravity was adopted instead; however, adjustment on chlorine injection quantity still cannot work together with tube-well pump operation. It can be understood that actual chlorine feeding method is not effective due to the poor condition on O&M. In addition, the records on chlorine agent injection quantity are unclear. Furthermore, liquefied chlorine vessels of 50 kg was disused till now because a gas leakage accident occurred before.

Empty 50kg Liquefied Chlorine Vessels

Example for Defected Drip System

7) Installation condition on bulk flow meter (BFM)

BFMs are installed at the delivery pipe and to measure the amount of water transmission per month. However, 60% of meters are poor condition and 15% of meters are out of order. Accordingly, the amount of water transmission per month is measured only by 25% of meters available. O&M unit is responsible for the O&M on BFM; however, renewable situation cannot be expected due to short stock of meters. The amount of water transmission per month is predicted by meter flow rate and running hours from pump operation ledger. The person of Leakage Detection Cell routinely (once a month) conducts the monitoring to check the records by meter measurement. **Table 6.7** shows the current running conditions by existing BFM.

Table 6.7 Status of Existing BFM

Description	Jan. -Feb. 08	Mar.-Apr.08	May-June 08	July-Aug. 08	Sept.-Oct. 08	Nov.-Dec. 08	Jan. -Feb. 09	Ave. Nos of BFM	% of Status	Remarks
Out of order BFM	135	135	103	128	128	128	126	126	75%	75%
Low reading/ DNC BFM	12	13	25	21	21	18	20	19	11%	25%
BFM in Working order	17	16	44	23	23	26	21	24	14%	
Total	164	164	172	172	172	172	167	169	100%	100%

Source: WASA Leakage Detection Dep. April 15, 2009

Covered BFM **Without Installation of BFM**

8) Repair on bulk flow meter (BFM)

The repairs on BFM in the past two years, the number of BFM to be installed on condition that such repairs were carried out by the ratio of26 per month *(104/4=26)* and thus can be estimated as 167 against 412 tube-wells (2008). Frequent repairs can be recognized due to the shortage of replacement parts. In addition, the weighting accuracy on the repairs cannot be verified due to the out-of-order calibrating apparatus. In addition, the stock on April 2009 is exhausted as zero. At present, there is a newly purchase plan for eighty (80) units of BFM (total budget with roughly 8 Mrs.). **Table 6.8** summarized the numbers of BFM repaired for tube-wells.

Table 6.8 Number of BFMs Repaired

S.No.	Date	Gunj Buksh T.	Ravi T.	Allame Iqbal T.	Shalimar T.	Nishtar T.	Aziz Batti T.	Tota(Qty)
1	Feb 2008	12	-	6	-	-	-	18
2	Mar 2008	19	12	-	-	-	5	36
3	Apr 2008	9	2	8	8	5	4	36
4	May 2008	9	1	1	2	-	1	14
G.Total		49	15	15	10	5	10	104

Source: Work shop, May 12, 2009

9) Installation conditions by water meter

Water meter were installed with about 51.3% to the numbers of connection by 556,000. Among these above-mentioned meters, only 13% of water meters were working because 74.5% was out of order. The reason of trouble can be considered that the deposits/sediments by iron included in groundwater and scale on revolving portion/counter (occupy 80% of cause) and the wear of revolving portion (occupy 20% of cause). With regard to the dead water meters, removal of deposits/sediments and substandard products such as broken articles/counter/rotary vanes and movements by PVC can be replaced in workshop.

Table 6.9 shows the existing running conditions by domestic and commercial water meters.

Table 6.9 Status of Existing Water Meters for Domestic/Commercial Water

Name of Towns	Un-Meter	Metered			Total
		Domestic	Commercial	Total	
Gunj Buksh Town(Oty)	61,734	47,696	12,713	60,409	122,143
Ravi Town(Oty)	92,386	52,906	7,313	60,219	152,605
Allame Iqbal Town(Oty)	28,564	64,301	4,097	68,398	96,962
Shalimar Town(Oty)	42,141	35,314	1,887	37,201	79,342
Nishtar Town(Oty)	31,049	45,309	2512	47,821	78,870
Aziz Bhatti Town(Oty)	15,573	11,031	364	11,395	26,968
1) Total (Qty.)	271,447	256,557	28,886	**285,443**	**556,890**
% of Metered	48.7%			51.3%	100%
2) Total Working Meter(Qty)	-	**61,693**	**11,172**	**72,865**	-
% of Domestic Vs Comm.	-	84.7%	15.3%	-	-
% of Working Meter	-	24.0%	38.7%	**25.5%**	-
% of Working Meter per total Connections	-	-	-	**13.1%**	-
3) Total Not Working Meter(Qty)	-	194,864	17,714	**212,578**	-
% of Not Working Meter	-	91.7%	8.3%	74%	-
% of Not Working Meter per Total Comnnections	-	-	-	**38%**	-
Source: WASA Finacial Dep, 22 April, 2009				51%	

10) Maintenance of water meters

Water meters and BFNM as the waterworks facility by WASA were delivered to the Rainwater Department in Gunj Buksh Town for fix by batch repairing and performance checking. The mean time to repair the water meter (0.5") takes around six (6) hours per unit and five (5) technicians in charge. Those repairs were checked by performance with calibrating flow meters and were delivered or return to the clients together with those articles impossible for repairing within one month. The existing water meters (imports) were made in China (roughly 1,000 Rs/Unit) and by KENI Co. in United Kingdom (roughly 4,000 Rs/Unit). Although the spare parts of water meters are easily replaced with Chinese-made in comparison to the same of British make, poor performance of Chinese make was recognized. In addition, spare parts of water meters made in China are stored within the parts cabinets; however, spare parts made in UK takek 2-3 weeks for procurement due to short stock. The repair capacity on water meter should be improved judging from technicians and purchased status on spare parts.

Equipment in repair shop is consisted as follows.

- Working bench
- Tools, machines, and such
- Cabinet for storing the spare parts
- Discharge calibrating apparatus (0.5”-1.5”)
- Discharge calibrating apparatus (6”-12”): out of order

Water Meter with 4-ditigal Dispay: Blue (China), Brown(UK)

11) Numbers of water meter repaired

According to the repair ledger of 2008, 1,211 water meters for the year were delivered throughout the W ASA's area. Therefore, roughly 1,865 were the objects to be repaired in 2008 by adding the carry-over repair cases from 2007. Among of these objects, 65 water meters (about 3.5% of sum total) were return to the clients because they were impossible to repair. However, carried-over on repairs in 2008 were 589 together for the shortage of technicians and replacement parts. **Appendix 6.2.3** tabulates the numbers of water meters repaired by each town.

12) Scrapped numbers on water meters

The numbers of water meters scrapped in the past four years were as estimated with 1,005 by annual average. It was estimated that the annual scrapped aging water meters were equivalent to approximately 0.35% against the existing connected water meters (roughly 286,500 units). **Table 6.10** shows the annual numbers of water meters scrapped

Table 6.10 Number of Water Meters (Domestic) Scrapped by Year

S.No	Year	1.Gunj Buksh Town	2.Ravi Town	3.Allama Iqbal Town	4/5.Shalimar/ Aziz Bhatti	6.Nishtar Town	Total(Qty)
1	2006	0	0	0	122	0	122
2	2007	279	25	0	269	0	573
3	2008	813	93	0	0	0	906
4	Apr-09	0	475	1,603	339	0	2,417
Total		1,092	593	1,603	730	0	4,018
Ave. of year		**273**	**148**	**401**	**183**	**0**	**1,005**
% of Scrap by Town		**27.2%**	14.8%	**39.9%**	18.2%	0.0%	100.0%
Total No of Meter installed (All)		60,409	60,219	68,398	48,596	47,821	285,443
Ave. % of Scrap per Mater		**0.45%**	**0.25%**	**0.59%**	**0.38%**	**0.0%**	**0.35%**

Source: WASA P & S Dep. May 7, 2009

Request on Improvement/Renewal of O&M Equipment/Materials

Inquiry survey on the present situation for the existing equipment/materials was carried out to improve the process conditions. The renewal on facilities and numbers of objects were requested as below.

- Enlargement on discharge calibrating apparatus (0.5"-1.5")
- Rehabilitation/renewal on discharge calibrating apparatus (6"-12")
- Repair apparatus for large-size flow meters
- Compound extension for the repair shop

Appendix 6.2.4 shows the list of existing maintenance equipment and request contents.

6”-12” Water Meter Calibration Bench (Out of Order)

1/2” Water Meter Calibration Bench (In-service)

13) Replacement/progress conditions on water meters in Gunj Buksh Town

The repairs/replacement on water meters of Gunj Buksh Town in 2008-2009 were as estimated with 114 per month (annual roughly 1,400) against the remaining water meters of approximately 13,500.

Among of 114 cases mention above, the replaced water meter from the repair shop were about 8 water meters per month (31/4=7.7) and the remaining 11 water meters were replaced by using the new water meters in stock. It was estimated that the stock for new water meters may be exhausted. In addition, the reason why the water meters in 2009 come down in comparison to the same in 2008 is that some water service districts were relocated to Ravi Town.

Table 6.11 shows the numbers of running/replaced water meters.

Table 6.11 Number of Running Water Meters

Descriptions	Nov-Dec 2008			Jan-Feb 2009			Average
	Number of routine work done (Qty)	Amount of Water supply(Gallon)	Amount of Water supply(m^3)	Number of routine work done(Qty)	Amount of Water supplyGallon)	Amount of Water supply(m^3)	Number of routine work done(Qty)
Meter Change or Replaced	189	7,654,248	34,796	266	10,199,539	46,367	228
Meter Reading	13,544	283,672,302	1,289,574	12,794	250,960,103	1,140,865	13,169
Rounded(Meter Counter Full circle)	50	2,639,034	11,997	53	2,311,881	10,510	52
Subtotal	**13,783**	**293,965,584**	**1,336,368**	**13,113**	**263,471,523**	**1,197,742**	**13,448**

14) Purchase of water meter

Purchase of water meter

According to the water meter control ledger by WASA, water meters were purchased with roughly 59,356 units within 2002-2008 (7 years) and the stock on April 2009 be mostly exhausted as zero. At present, application (February 2009) on buyable budget of 12,315 units (roughly equivalent to 50 MRs) was under way and was pending approval. With regard to the purchase scheduled model, Elster Meter Inc. made in UK. (unit price: 4,060Rs) was on the table because water meters mad in China show poor performance/evaluation. **Table 6.12** shows the past records on purchase of domestic water meters.

Table 6.12 Balance of Domestic Water Meters

S.No	Year	Procure (Qty)	Issued (Qty)	Balance (Qty)
1	2002	23,855	3,400	20,455
2	2003	0	13,700	6,755
3	2004	11,111	8,355	9,511
4	2005	0	9,511	0
5	2006	24,390	19,700	4,690
6	2007	0	4,275	415
7	2008	0	415	0
0	Total	59,356	59,356	0

Source: WASA Perocue & Stock Dep. April 27, 2009

Delivery address on water meter

It was estimated that a considerable number with about 3% of whole water meters was outfit by comparing the supplied water meters and existing water meters (including in-service plus out-of-order ones). The distribution factor was as low as some 2-3.5% for each town with lowly supply ratio. In addition, water meter needed to be replaced by 15% per year on condition that water meter was assumed with 7-year life-span. **Table 6.13** shows the numbers on new water meters supplied to each town (see **Appendix 6.2.5** for details).

Table 6.13 Amount of Supplied New Water Meter (Domestic)

Name of Town	Total Supplied WMs (Qty/7-year)	Ave Supplied WMs /year(Qty/Y)	Number of Installed WMs (Qty)	Number of Supplied WMS per Installed WMs(Supplied/Installed)	% of Supplied WMs by Town (Qty)
Gunj Buksh Town	11,330	1,619	60,409	**2.7%**	**19%**
Allama Iqbal Town	15,264	2,181	60,219	**3.6%**	**26%**
Ravi Town	6,330	904	68,398	1.3%	11%
Nishtar Town	11,337	1,620	48,596	**3.3%**	**19%**
Aziz Bhatti Town	2,235	319	-	-	4%
DDR Shlimar & Aziz Bhatti Town	3,800	543	-	-	6%
Shalimar Town	8,135	1,162	47,821	2.4%	14%
Others	925	132	-	-	2%
Total	59,356	8,479	285,443	**3.0%**	100%

Source: WASA Procure & Stock Dep. April 27, 2009

15) Service Reservoir

There exist approximately 52 small-scale elevated tanks (50,000ga11ons) and one 1-MG service reservoir (built at Ravi Town in 1883) within the jurisdictional area of WASA. Only such service reservoir functioned; however, it was disused by reason that water service was changed as direct supply taking the insufficient distribution capacity, cleanup, and labor hours for inspection into account. The interior space in the structure and foot space under the unused elevated tank itself were utilized such as warehouse. Response room for complaints and response contact for connect application. The items on operation management of service reservoir are shown as follows:

- Date/time and name
- Service hours
- Drainage time
- Water gauge
- Calculation of water volume (water gauge/service hours)
- Special instruction (bad condition of tank. leakage. operation of gate valve, defect of structure etc.)

16) Pipeline network

Water supply system is adopted for water supply and water service. Numerous leakage places (leakage volumes and water measuring cases were unknown) exist in the existing pipeline network under jurisdiction of W ASA due to deterioration because pipelines were built during British era (1883) especially that of Gunj Buksh Town and Ravi Town.

Cast iron pipes with diameter of 150-300 mm were applied to transmission main. AC/PVC pipes with diameter of 100-250 mm were adopted for distribution pipe. And steel pipes with diameter of 0.5-l inch for service pipe prevail.

17) Temporal water supply

Operation by temporal water supply

The excuses for operation by temporal water supply were remarked below.

- Conservation of groundwater source
- Reduction of non-revenue water caused by leakage ratio that reaches approximately 35%
- Saving on operation cost
- Suspension of waterworks facilities caused by power failure (power generators were available in some places)

Running/handling example of tube-wells: Ravi Town (O&M-I)

The operative outline on running/handling the tube-wells was stated below.

The scheduled temporal water supply on water supply system by tube-wells may be affected by brown out duration (normal outage: 7-12 hours a day); however, operation mostly functions in conjunction with peak demand/utilization. In the case that multiple tube-wells were connected with pipework, minimum unit of pump run to ensure 24-hour water pressure as much as possible for the backflow prevention from the leakage/breakage portion on the water supply pipeline network.

Running/handling example of elevated tank: Ravi Town (O&M-I)

With regard to the operation of service reservoir (elevated tank) with IMG, worker methodically conducted water service of design water volume by observing the water level of tank and switching extent of valve based on the long years of experience. Water service hours are eight hours in total by three times a day in conjunction with peak demand and summarized as below.

- 1st round: 4-8 a.m. (4 hours)
- 2nd round: 13-15 p.m. (2 hours)
- 3rd round: 18-20 p.m. (2 hours)

Self-defense measures by residents

As a self-defense measure, most residence's and commercial office's rooftop were equipped with homegrown tank by concrete or FRP with 1-2 m^3. Low-income person store water into water tank as much as possible and saving of water usage as self-defense measure. On the other hand, hotels and upper-income earners use private well pump/standby generator together with tap water.

2-1/2“Private Motor Well

Various Concrete & FRP Water Tanks

18) Improvement status on drawing management (Asset management by drawings)

Asset management by drawings was behind time because most of drawings by W ASA were prepared by penciling and modification tasks on drawings were also behind schedule. Moreover, Urban Unit was always waiting the data to be provided from W ASA; however, drawing management cannot progress due to the slow-up on drawing management system by WASA.

19) Mapping

The Urban Unit under P&D Department in the Provincial Government of Punjab started GIS (Geographic Information System) room in 2006. Preparation on drawing management of urban planning and water/wastewater facilities with the background by an updated satellite image of Quick-Bird kicked off. The formulation on mapping system for water and wastewater facilities was taken into consideration; however, examination on the content of menu/attributes and foundation data were poor condition yet.

The effectiveness by mapping system was shown as below.

- Information integration: Information on the whole facilities is integrated by using computer as an effective tool.
- Information processing: The required data are looked up, read out and tabulated based on an objective and prompt judgment.
- Management support: Waterworks management is to be supported according to the processing/offer of facilities information.

(2) Example of Gunj Buksh Town (O&M-I XEN) (see **Appendix 6.2.6**)

(3) Example of Ravi Town (O&M-I) (see **Appendix 6.2.7**)

(4) Problem Analysis

1) Waterworks facilities

<u>Submerged pumps</u>

Aging submerged pumps were gradually renewed but not sufficient. In addition, equipment such as measurement/inspection facilities, flow meters (BFM), pressure gauges, check valves, ammeters etc. are not enough. Consequently, it caused the following problems.

- Pump's determination conditions are not grasped (in comparison with design pump capacity).
- Water supply volume was not grasped.
- Prevention on reverse flow of water while suspension of pump is impossible.
- There was no repair plan.
- Effective repair work is impossible.
- Effective utilization on O&M records is impossible. (O&M ledger was prepared in handwriting and was not improved)
- Running by creaky facilities was costly.

As the countermeasures, renewal on aging facilities, improvement on appurtenances and formulation on data management system are required.

<u>Chlorine Equipment</u>

Feeding method of sodium hypochlorite solution was modified from the pump pressure method (pressure on discharge pipe side) to gravity method (add chlorine liquid into well water). The reasons why feeding method was changed are difficulty on maintenance of feeding pump and repair spare parts are not sufficient. Consequently, it caused the following problems.

- Control on chlorine feeding volume is difficult.
- Confirmation on chlorine concentration is difficult.
- Chlorine odor is strong in comparison with the same by pump pressure method.
- Chlorine may foster the casing corrosion of submerged pump.

As the countermeasures, renewal on aging facilities, promotion on employee education and formulation on data management system are required.

Service water-meters

Installation ratio on running service water-meters was low due to insufficient newly purchased meters, insufficient spare parts in meter workshop, insufficient repair skilled worker and insufficient workshop facilities. Consequently, it caused the following problems.

- Transparency on water tariff calculating method was poor because pay-as-you-go system prevails.
- Grasping on accounted-for water volume is difficult.
- No increasing operating revenue
- Enough complaints in terms of water tariff by customer occurred

As the countermeasures, renewal on aging facilities, promotion on new meter and formulation on data management system are required.

Standby generator

Portable standby generators were utilized for some tube-well stations within the area where water service is impossible by reason of rolling blackouts. However, equipment capacity differed because the larger the power capacity, the smaller the required capacity of pump motor. Consequently, it caused the following problems.

- Efficiency on facilities was poor.
- Fuel expenses were costly.

As the countermeasures, improvement on standby generator corresponds with motor capacity is required.

Improvement on O&M ledger

O&M ledgers for the tube-wells (about 417 wells) were prepared by hand in the respective tube-well station. Consequently, it caused the following problems.

- O&M data available were not effectively utilized.
- Statistical processing on data is slow.
- There was no effective repair plan.

As a countermeasure, formulation on O&M data management system on is required.

Drawing Management

Consolidation (including computerized process) and renewal on pipeline network drawings are behind time. Consequently, it caused the following problems.

- There is no effective renewal plan.
- Information such as piping route, piping material, and facility location is not available for immediate use.
- Replacement route is not available for immediate use.
- Complaint response is behind time.
- Cleanup on pipeline is not perfect.
- Appropriate response against the suspension is impossible.
- Prompt action against accidents and disasters are impossible.
- There is no integrated and renewed plan on creaky pipes.

As a countermeasure, formulation on drawing data management system is required.

2) Temporal water supply

Water service hours are as set round ten (10) hours a day; however, the said water service hours were not published. Consequently, it caused the following problems:

- Town people installed water tank for home consumption as a self-defense measure
- Well pump for private use was installed
- Leakage from private water tank occurred
- Water quality may be polluted by insufficient cleanup of tank
- Trusting relationship between customers and W ASA becomes less connected

As a countermeasure, promotion on customer service is required.

3) Heavy equipment for O&M

In the study area, cleanup and repair work on water conduits were not perfectly carried out due to late deteriorated renewal, insufficient equipment units/repair spare parts/repair skilled worker/janitor etc. taking materials and heavy equipment for O&M in the studied area in account. Consequently, it caused the following problems:

- O&M tasks are behind time
- Materials and heavy equipment were always not improved
- Living environment becomes worse due to the odor
- Many complaint cases are risen

As the countermeasures, reinforcement on heavy equipment/materials from manpower dependence and uniform management on workshop/materials are required.

6.2.4 Operation and Maintenance on Wastewater Facilities

(1) O&M on Wastewater Pipes: Example on O&M-1 (XEN) in Gunj Buksh Town

Wastewater pipes were consisted of the pipe conduits and aqueducts, and mostly as utilized by concrete pipe with caliber of 12-66 inches (300-1680mm). Deposits/sediments were removed by vacuum trucks, high-pressure washer and bamboo sticks for those conduits where cannot be cleared out by manual operation. Such removal tasks on deposits/sediments were carried out by the cleanup team mostly consisted of human power (3 person per team: 3 teams) in combination with the clearing equipment/materials (vacuum vehicles and pressure pumps). In addition, the eliminable volumes by manpower was roughly 2-4 m^3/day (100-200m in distance and removal sediments were disposed as wastes), that is, the removal ratio is very low in comparison with the same by machine. In addition, such maintenance on wastewater pipes was conducted at a frequency of roughly twenty (20) days a month. On the other hand, the removal volumes with roughly 30m^3/day by machine is possible; however, such cleanup duties were really executed by human power (expired contract staff) due to the saving on funds and the restraint on vehicles available.

1) Priorities

With regard to the priority on O&M tasks, the complaints from the customers, site cleanup and repairs on the leakage/broken places prevail. Such as a small-scale pipe breakage and leakage can be responded; however, outsourcing was applied to major works due to the shortage of heavy apparatus and staff shortage.

2) Occupational safety and health

Death accident by toxic gases due to hydrogen sulfide gas occurred twice in the past three years. With regard to the accident prevention steps, application on gas detector and wearing by gas mask were obligated; however, the response is always behind schedule due to the shortage of materials. On the other hand, the safety education on utility workers proceeded in accordance with the occupational safety education by regularly holding the workshop.

(2) O&M on Sewage Pump Station

1) Wastewater wet well

Wet well receives the wastewater from several wastewater conduits, and were managed by water gauge and unit control of pumps. Such wastewater was drained using the pumps after removing the garbage by screens. Wet well was cleaned up by removing the sediments regularly (at the ending of rainy reason, once or twice a year).

Typical Wet Well with Water Gauge

) Type of pump

A pumping station is consisted of screen, gate, pump equipment and control panels. With regard to the type of wastewater pumps, single-floor vertical shaft type axial flow pump was commonly adopted for operation in combination with water gauge and control of unit. Drainage pumps for emergency use were as applied by submerged pumps and ground volute pumps etc.

Typical Vertical Sewage Volute Pumps

Typical Arrangement of Drive Units

3) O&M tasks

With regard to the operation management on wastewater/drainage pumps, the site resident person records the pump operation time for 24 hours. Standby generators will be put in action while blackout. Major inspection items are as follows:

- Monitoring on automatic rubbish remover
- Management on removed screenings
- Removal work on deposits/sediments in pump station
- Monitoring on inflow waste water level in pump station
- Operation management on wastewater/drainage pumps (automatic/manual operation by water level)
- Inspection on standby generators
- Preparation on operation records of pump facilities (write-down by note)
  - Recording of date/time and name
  - Recording of numbers of running pumps and each pump running hours
  - Calculation on drainage discharge by pump's running hours/capacity
  - Voltage measurement by wattmeters
  - Recording on special instruction (decrement of pumping discharge, noise and vibration etc.)

4) Items of repair

Major repairs on small pumps were such as replacement on pump's bearing, shaft's axis, and pump vane. In addition, leakage inspection from the packing (gasket) portion and its clearing work was practically carried out once a year. On the other hand, the exchange frequency on large size pumps is less than the same of small pumps. Staff can perform the minor repairs/inspection/clearing work; however, outsourcing was adopted for those important maintenance tasks due to the shortage of materials and technicians.

Mechanical Screen

(3) Problem Analysis

With regard to the wastewater/sewage pumping stations, some decaying pumps were replaced by JICA grant aid and thus were running steadily. Operation management was not complete due to the slow-up on renewal speed of creaky facilities, unimproved measurement devices on pump/motor, hand-written recording on field running ledger in each pump station and ledger for O&M etc. On the other hand, drainage volumes were estimated from operation hours and design capacity due to without measurement facilities. Consequently, it caused the following problems.

- Accurate drainage volume was not grasped.
- Power consumption per drainage volume was not grasped.
- O&M data available were not effectively utilized.
- There was no repair plan.
- Facilities were not managed by package.
- Running by creaky facilities was costly.

As the countermeasures, renewal on aging facilities, formulation on inspection equipment with data management system and improvement on uniform management system for O&M are required.

6.2.5 Operation and Maintenance of Drainage Facilities

(1) Drainage Works

Major tasks are such as the repair, cleanup and removal of deposits/sediments within the open channel. The shape of open channel to be clean up have more variety in terms of narrowness/breadth/linearity/curvedness/depth/slip and where is densely-packed with buildings etc. Poor work efficiency and bad working conditions for the removal work on deposits/sediments are recognized due to the water stops at the upstream reach of open channel or even under the flowing condition. Safety and efficiency of work may create more problems due to the unstable scaffolding especially the said working in a stream.

Dredge work was be dominated by human-wave sweep due to the shortage of heavy apparatus and equipment/materials owned by themselves even though by way of outsourcing. If such removal work on deposits/sediments got delayed, the environmental contamination/deterioration/malodor may expand owing to the wastewater overflowed from the sewage manhole in the city and inundation occurred in many places during the rainy season.

1) Priority on dredging

The goal with cleaning the drainage conduits under jurisdiction was as set within one year prevailing the complaint measures (offensive odor, leakage and wastewater overflowing) from the customers; however, the achievement ratio was estimated inasmuch as 50-60%.

2) Disposal on dredged spoils

The dredged spoils will be disposed into the wastewater repository site. In addition, the specific gravity of dredged objects was as applied by 1.0 due to the high water content.

3) Repairs

With regard to the collapsed slope on open channel, repair was conducted by heavy equipment. In addition, brick bricklaying construction method was adopted for the slope works to be currently conducted.

4) Example in Gunj Buksb Town (Drainage XEN) (see **Appendix 6.2.8**)

5) Problem Analysis

Removal tasks on deposits/sediments within pipeline are under back-breaking working surroundings with unsanitary situations, poor false work and risks by congestion of toxic gases. Tasks were mainly depending on manpower. Handling course on safety materials was given by WASA Training Center; however, safety materials were not thoroughly provided in the field. In addition, equipment and materials cannot be repaired due to deterioration of heavy equipment for O&M and insufficient units/spare parts/repair skilled worker etc. Furthermore, removal tasks on deposits were not complete because contract worker cannot be timely assembled. Consequently, it caused the following problems.

- Effective work was impossible due to insufficient materials
- Living environment becomes worse due to the odor
- Flow area on drainage conduits/channel decreased
- Flood damage enlarged
- A lot of complain cases occurred

As the countermeasures, reinforcement on heavy equipment/materials instead of manpower and uniform management on workshop/repair spare parts are required.

(2) Dewatering Works

The dewatering unit for storm water is under the control of O&M Department in Gunj Buksh Town. Main duties are as follows.

- Storm water drainage as an inundation measure covering the whole WASA's jurisdiction
- Repairs on storm water drainage equipment/materials and operation on workshop
- Management on radiotelegraphy facilities
- Operation on workshop of water meter

1) Drainage of storm water

The task is to drain the storm water by the portable engine pumps and submerged pumps to prevent the minimum damages from the inundation on the lowland residents, underground garages and roads etc. caused by the storm water usually falls in the rainy season of three months from June until August.

2) Damaged conditions

Inundation caused by a rainfall of 221 mm with the depth of 0.2-0.78 m occurred at approximately 17 places on 12th August 2008. In addition, it took roughly 2-7 days to drain such inundation. However, the detailed information for the said inundation was unclear. Measures are required due to the escalation of complaints cases during rainy season.

3) Numbers of staff

Staff are consisted of twelve (12) material inspectors, three (3) technicians for workshop and other contract-based workers employed during rainy season.

4) Equipment/materials for dewatering

Numbers of pumps including both of large- and small-size ones are roughly 545 units in total; however, some 95% of pumps are required to be replaced due to high failure frequency by deterioration. In addition, equipment/materials were short but one generator available only. The details on the list of equipment/materials were shown in **Appendix 6.2.9**.

5) Corresponding services by radiotelegraphy

WASA's controlled vehicles are equipped with the wireless communication system (UHF) to grasp the on-the-site conditions against the storm water, mutual arrangements on vehicles and equipment/materials and to comprehend the emergency accurately for reporting the current situation.

Wireless Communication System (Mobil)

Wireless Communication System (Vehicle)

6) Patching/repair workshop on storm water drainage equipment/materials

WASA's exclusive workshop belongs to the Rainwater Department in Gunj Buksh Town is to improve and repair the equipment/materials for inundation measure purpose during rainy season. The area with roughly I,200 m^2 covers the storage location for outdoor equipment/materials also serving as a workplace, and other indoor dewatering workshop and machine shop with roughly 100 m^2 and 150 m^2 respectively, and thus are 1,450 m^2 in total.

- There exists simple crane at the outdoor workshop, therefore, the disassembly of pumps and the replacement of parts are possible.
- Indoor workshop is the workplace for the disassembly/cleanup of engine.
- There exists a houseroom for the tools such as working lathe, twist drills, welding equipment, and materials etc. in the indoor workshop.
- Repair/maintenance on vehicles etc. is conducted by outsourcing.

Major repair items:-

- Overhaul of small engine
- Clearing work on piston-ring, shaft's axis, spark plug, and oil filter etc.
- Confirmation work on abrasion and broken conditions of packing and bearing
- Inspection on engine and pumps
- Easy task such as welding operation

Equipment in Dewatering Workshop

7) Request on improvement/renewal on O&M equipment/materials

Inquiring survey on existing equipment/materials was carried out to improve the process conditions.

The following items on the rehabilitation of facilities and vehicle augmentation were requested.

- Replacement on the existing portable pumps of approximately 400 units
- Renewal and augmentation the numbers of truck
- Renewal of vehicle
- Renewal of power facilities

- Portable illuminating tower

Appendix 6.2.9 shows the list of existing maintenance equipment and request contents.

8) Problem Analysis

Storm water drainage tasks for the area which was inundated during rainy season were operated on 24-hour schedules. Equipment/materials for storm water drainage were mainly consisted of engine pumps, submerged pumps, generators, and drainage hose, etc. Dry season was applied for the maintenance on those creaky and dead facilities. However, holding equipment/materials were poor due to slow-up on rehabilitation of deterioration (purchase on new articles if not all), insufficient numbers of unit and spare parts in addition to insufficient night lighting facilities. Consequently, it caused the following problems.

- Drainage capacity was too poor due to insufficient equipments and materials even depending upon the rainfall depth.
- Inundation damage is expanding.
- Numbers of equipment/materials available for storm water drainage may decrease if the creaky equipment/materials had broken down again.

As a countermeasure, reinforcement on heavy equipment/materials is required.

6.2.6 Procurement and Stock Control

(1) Purchase of Equipment and Materials

1) Purchase request

Purchase request was delivered from the DMD of O&M Department to the DMD of Engineering Department, and its subordinate organ "Procure & Storage Department (P&D)" is responsible for the order procedures and stock control.

2) Purchase storage

Purchases were stored by both of Out fall Stock Yard in Gunj Buksh Town and Shadbagh Stock Yard in Ravi Town. Twenty-five (25) staff work for Outfall Stock Yard and Seven (7) staff work for Shadbagh Stock Yard respectively. **Figure 6.4** illustrates the procedures on the application, storage and management of purchase.

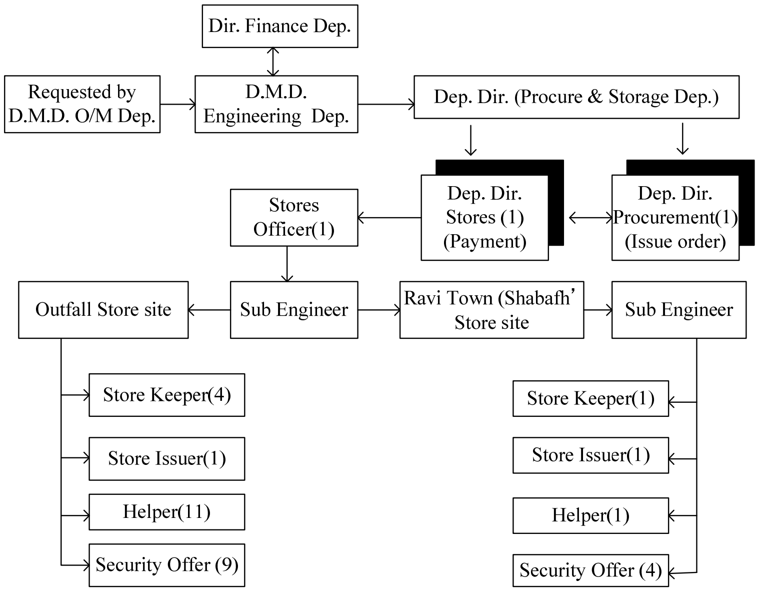


Figure 6.4 Procurement and Stock Control Procedure

3) Storage location

Purchases and scraps were stored outdoor and indoor respectively.

The storage conditions and locking control on the purchases in the major parts supply center at Gunj Buksh Town were given with sufficient attention.

Table 6.14 shows the status of materials and storage.

Table 6.14 Status of Material and Store

Discretions	Gunj Buksh Town(Outfall)		Ravi Town (Shadbagh)
	Outdoor	Indoor (4 Brick buildings+ 2	Outdoor +2 containers
Lot area	About 1.5 (Acre)	About 1,650 (ft^2)	About 2.0 (Acre)
Material Name	-Pipe, Fittings (Large size)	-Pipes & fittings (Small size)	-Pipe, Fittings (Large
	-Chlorine solution Containers	-Motors	-Valves
		-Parts of Tube-well	-Fire hydrants
		- Other type of Pumps	-Others
		-Impellers (Sewerage pump)	
		- Water meters	
		- Parts & accessories	
		-Safety equipment	
		-Valves (Gate valves, check Valves)	
		-Gauges, Packing, bolts & washer,	
		- Electrical parts & Panels, Cable	
		- Air filters & Spark plugs (For	
		-Others	
Scrap	-50kg Chlorine Cylinders,	-Steel, Iron & Copper material	-Pipes
	-Construction and demolition	- Water meters	-valves
		-Others	-Others

Note: Oil, Fuel, Grease and Lubricant are procured from market
Source: Gunj Buksh Town, outfall Store Officer, 28 April, 2009

4) Stock control

With regard to the stock control, Report of Material or Services (RMS warehousing form) and Issue on Requisition (Indent order form) were respectively applied to control the warehousing and delivery invoices. Items of control parts were as countered 2,112 in total; therefore, clerical work on stock control seemed somewhat cumbersome due to miscalculation caused by manual recording in the Stock Cards (warehousing volume in red color and delivery in black color).

The main entries for stock cards are as follows.

－Nomenclature (2,112 kinds of items)
－Date
－Reference No. of SIR or RMSR
－Amount of Receipt and Issue
－Balance

5) Disposal of scraps

All scrapped materials to be yielded from WASA's jurisdiction area were carried into the major parts supply center. Scrapped materials were clarified into iron, cast iron and cupper if the quantity is enough, and the competitive bid was executed with WASA's presence (Bidding amounts on April 2009 were 3.4 MRs). Such revenues will be post in financial statements as the special incomings. In addition, such scrapped materials were reused by the traders interested.

(2) Purchase Quantity of Disinfectant

1) Order procedures on disinfectant

With regard to the purchase of chlorine agents, DMD of O&M Department will apply to DMD of Engineering Department by receiving the requests from six (6) towns every three month.

The procurement and delivery were carried out by the following procedures and each town will pick the chlorine agents up at Central Stock Yard in Gunj Buksh Town. In addition, the unit price on chlorine agents of 2008/09 was roughly 15Rs/liter and thus 2,000 tons (liquid weight with concentration of 20%) were yearly purchased. **Figure 6.5** illustrates the procurement and distribution schedule

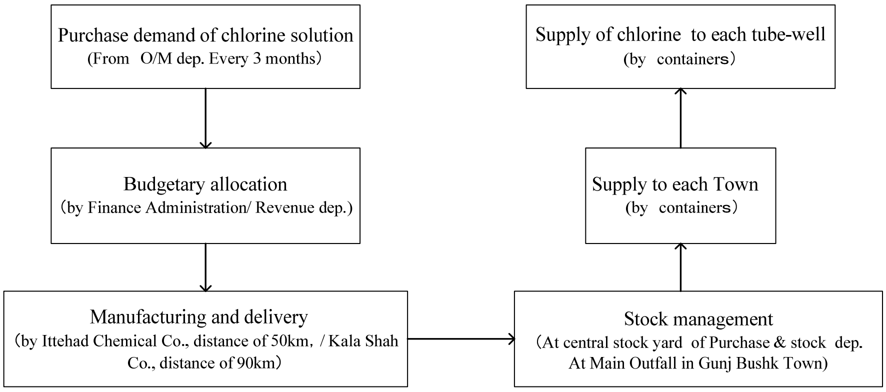


Figure 6.5 Procurement and Distribution Schedule

2) Handling/quantity consumed on chlorine agent

According to the delivery ledger from January up to November in 2008, some 60% of total chlorine agents were consumed by both of Gunj Buksh and Ravi Towns. In addition, chlorine consumption was estimated as 2.0g/day by monthly average reducing the weight of chlorine agent. Especially, the delivery volume increased by nearly twice as high during the rainy season in comparison to the same in January of dry season. In addition, estimation was carried out roughly by 1.0 for the specific gravity on liquid and chlorine agent.

Table 6.15 and **Table 6.16** show the status of chlorine consumption amount and **Figure 6.6** illustrates the change of chlorine consumption amount by month.

Table 6.15 Status of Chlorine Consumption Amount by Town (Jan-Nov 2008)

Name of Town	# of Conn.	20% Sodium Hypochlorite Solution (Kg/Month)	Weight of Sodium Hypochlorite (kg/Month)	Weight of Sodium Hypochlorite (g/Month)	Ratio of Consumption	Ave. Dosage of 20% Sodium Hypochlorite Solution kg/M/Connection	Ave. Dosage of 20% Sodium Hypochlorite Solution g/D/Connection	Ave. Dosage of Weight Sodium Hypochlorite g/D/Connection
Gunj Baksh Town	122,143	55,740	11,148	11.1	**33%**	0.46	**15.21**	**3.0**
Allama Iqbal Town	96,962	26,778	5,356	5.4	16%	0.28	9.21	1.8
Nishtar Town	78,870	13,589	2,718	2.7	8%	0.17	5.74	1.1
Shalimar Town	79,342	24,342	4,868	4.9	15%	0.31	10.23	2.0
Ravi Town	**152,605**	**45,150**	**9,030**	**9.0**	**27%**	**0.30**	**9.86**	**2.0**
Aziz Bhatti Town	26,968	2,008	402	0.4	1%	0.07	2.48	0.5
Total	556,890	167,607	33,521	33.5	100%	0.30	10.03	2.0

Source: WASA P & S, April28, 2009

Table 6.16 Status of Chlorine Consumption Amount by Month (Jan-Nov 2008)

							Raining Season: Jul Aug Sep				
Description	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Nov-08	Total	Ave.
20% Sodium Hypochlorite Solution (Ton/month)	109.9	101.9	124.8	144.1	222.9	236.5	263.1	216.4	88.9	1,508.5	167.6
20% Sodium Hypochlorite Solution (kg/day)	3,663	3,397	4,158	4,804	7,430	7,884	8,770	7,212	2,964	50,282	5,587
% of Consumption ratio	7.3%	6.8%	8.3%	9.6%	14.8%	15.7%	17.4%	14.3%	5.9%	100.0%	-
Ratio of Consumption	1.0	0.9	1.1	1.3	2.0	2.2	2.4	2.0	0.8	-	-
Remarks: Total Connections=	556,890										

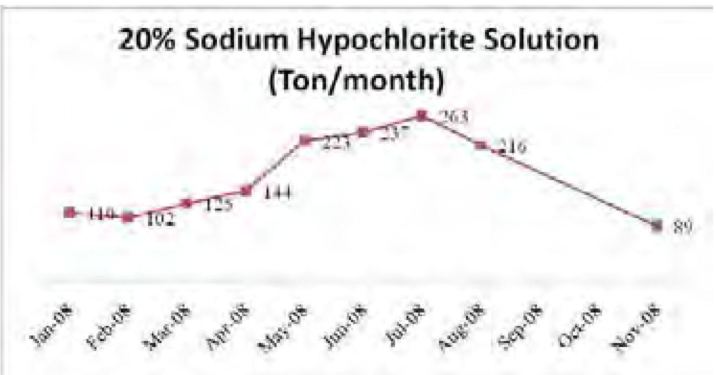


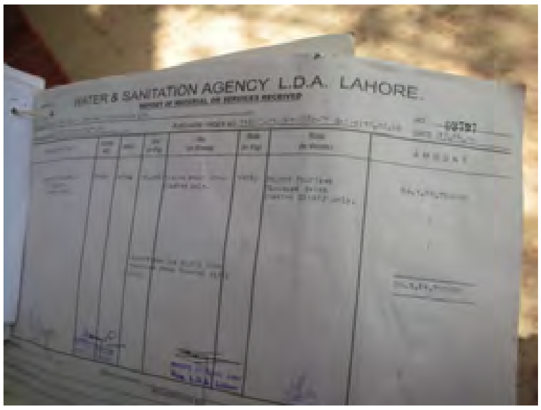
Figure 6.6 Change of Chlorine Consumption Amount by Month

3) Data book on delivery management

The items of record on the chlorine delivery ledger are as follows.

- Date/time and person in charge
- Injection hours
- Residual quantity/quantity consumed in chemical tank
- Special instruction (abnormality on tank/injection pump, injection hose, leakage, abnormality on valve operability)
-

Delivery operation



Delivery voucher/document

(3) Problem Analysis

A lot of articles on equipment/materials exist in the ledger on stock management. Document control becomes complicated because the said ledger was done in handwriting with register mistakes.

Consequently, it caused the following problems.

- Data on stock control increased.
- Management data cannot be timely verified.

As a countermeasure, reinforcement by personal computerized system is required.

6.2.7 Monitoring System

(1) Facilities Operation Management

Operation management on water and wastewater facilities was carried out by field itself. Information on operation management among the wastewater/dewatering pump stations with about more than 400 tube-wells is by way of fixed local telephone. On the other hand, each maintenance town office carried the internet circuit works (need to verify the type, ADSL: Asymmetric Digital Subscriber Line) into execution as a means of communication nowadays.

With regard to the operation status on water & wastewater utilities, on-the-spot running was still adopted but without the improvement on batch monitoring together with facilities operation.

(2) Simple SCADA System

Since the simple SCADA system has not been fixed yet, unified management of the service is not carried out. In order to grasp a service situation from now on, unified management of information is required to be taking into account a "simple SCADA operation supervising system."

Minimum items of monitoring required are as below.

- Operation conditions (running hours) of pumps
- Flow rate of tube-wells
- Power (KWh)
- Water table of tube-wells
- Water level at pump stations (wastewater/storm water pump stations)
- Indicating defect on facilities

(3) Problem Analysis

Collective control system on O&M for equipment and facilities was not improved yet. In addition, engineers in charge of system management/operators are not fostered.

Consequently, it caused the following problems.

- Operation status on machine and equipment is not grasped.
- Operation data is not timely verified.
- Facilities are not operated and managed effectively.

As a countermeasure, formulation on simple SCADA system is required by installing multiple monitoring rooms with simple data transmission method (a periodical communication frequency).

6.2.8 Water Quality Analysis Works

(1) WASA Laboratory

Water quality analysis tasks under the control of WASA Laboratory are consisted of the samplings from the tube-wells and water taps at customer’s end and analysis of such samplings (excluding the analysis tasks on wastewater).

(2) Analysis Materials

Digital analyzer (calibration is conducted every morning) was adopted as an analysis tool and water quality analysis by reagents was not executed. Employees in charge of analysis are 26 persons.

Table 6.17 shows the numbers and duties of laboratory employees.

Table 6.17 Number of Laboratory Employees

No.	Designations	No of Staff
1	Assistant chemist	1
2	Lab Supridentant	3
3	Technician	1
4	Lab assistants	4
5	Jnior lab assistant/Sample collectors	6
6	Computer operator	1
7	Driver	1
8	Dak runner	1
9	Lab attendants	8
	Total	26

(3) Analysis Items

Major items of analysis are consisted of pH, water temperature, turbidity, E-coliform, nitrite, residual chlorine, and conductivity etc.

Target sampling and analysis tasks are as below.

- Regular inspection
- Follow-up inspection
- Check on response of complaints

(4) Implementation by Regular Inspection

Regular inspection on the quality of raw water was conducted once a year for all tube-wells. In addition, water quality inspection schedule is arranged to carry out the water quality investigation on water taps as much as possible.

Daily samplings and analysis frequency are shown as below.

- Water quality inspection on tube-wells: 1-2 specimens/day
- Water quality inspection on water taps: 30-40 specimens/day (yearly target: 10,000-12,000 specimens)

(5) Implementation on Follow-up Inspection

Analysis results were consolidated within three (3) days. Reinspection was immediately done if any analysis data exceed the water quality standard. In addition, reporting on such outlier is directly reported to the superior.

(6) Implementation on Complaint Response Inspection

The customer complaints resulted from color, odor of chlorine, offensive odor and turbidity of tap water. Following the contact information recorded in the complaint response ledger, field samplings and analysis were promptly conducted to confirm water quality accommodates the water quality standard or not. Pipeline was drained and cleaned by use of fire hydrant in case of remarkable contamination on distribution pipe based on the confirmation results. In addition, the contaminated water volume in accordance with water quality determination will be adjusted and reduced to the charge of bill issued by Revenue

Department.

(7) Request on the Improvement/Renewal of O&M Equipment/Materials

While the inquiry survey on the existing conditions to improve the water quality analysis tasks, facilities rehabilitation and augmentation on the numbers were requested as follows.

- Office Automation (computer, printer, copy machine, camera)
- Analytical instruments
- Micro biological laboratory instruments
- Glassware
- Transportation (vehicles, motorcycles, bicycles)
- Others (COD/BOD apparatus, UV spectrophotometer)

In addition, **Appendix 6.2.10** shows the list of existing major instruments in Water/Wastewater Laboratory and requested contents.

Appendix 6.2.11 gives the status of other laboratories.

Turbidity Measuring Instruments

Microscope

(8) Problem Analysis

Water quality analytical equipment and materials of WASA are applied to drinking water. However, most of them become creaky and conk out in addition to the stock on analysis reagent was also insufficient. Furthermore, statistical processing system on analytical data was behind time. On the other hand, sampling of test specimens for normal water quality analysis and inspection against compliant measures were unsatisfactory due to aging vehicle/car shortage and limited inspection room etc. Analytical items are consisted of water temperature, turbidity, chromaticity, Coliform (Escherichia coli), pH, conductivity, and residual chlorine etc. except arsenic with low concentration.

Consequently, it caused the following problems.

- Water quality was not thoroughly analyzed due to the limit analytical specimens.
- Collecting time on sampling specimen always behind schedule.
- Wastewater quality inspection was still not conducted.
- Management & monitoring on analytical data were inadequate.

As the countermeasures, reinforcement on analytical appliance/sampling vehicle, augmentation on analyst and reinforcement by personal computerized system are required.

6.2.9 JICA Project Management Unit (PMU)

PMU is a unit in charge of the O&M on dredging with the equipment/materials by grant aid from JICA to WASA during the periods of 2004-2006.

(1) Equipment and Materials Granted

Employees are consisted of eleven (11) staff and other 179 just-in-time employees, i.e. management system is organized with 190 persons in total. Dredging on the deposits and sediments in open channel was executed by 49 vehicles' running at their capacity.

Table 6.18 shows the list of equipment and materials granted.

Table 6.18 List of Existing Maintenance Equipment

Sr. No.	Equipment Name	Qty.	Note
1	Damp trucks	24	
2	Clam Shell Cranes	2	
3	Excavator	3	
4	Wheel Loaders	2	
5	Generators	4	
6	Water tanker	2	
7	Jetting Machine	4	
8	Vacuum Vehicles	4	
9	Pick up trucks	4	
	Total	49	

Sources: JICA Project Management Unit, April 22, 2009

High-pressure Water Jet Vehicles

Dump Trucks

(2) Workloads

Dredging locations are targeted to the 9-10 key sites in the model area, and dredging on the silts mixed with garbage is conducted. Dredged silts are cast away in the dumping site.

Table 6.19 shows the workload on dredging.

Table 6.19 Performance of Dredging

Date	Working in (Km)	Weight Silt Removed in (Ton)	No. of Manholes
Jan-09	13	2,440	555
Feb-09	22	4,528	763
Mar-09	17	3,704	697
Total	53	10,672	2,015
Ave Monthly	18	3,557	672
Assumed amount in Year	**210**	**42,688**	**8,060**

Sources: JICA Project Management Unit, April 22, 2009

(3) Request on Improvement and Renewal of O&M Equipment/Materials

While the inquiry survey on the existing equipment/materials to improve the process conditions was conducted, facilities rehabilitation and augmentation on numbers of instrument were requested as below.

- Employment on technician on minor adjustment (alignment) and inspection timely
- To implement the skill/technical training
- Maintenance on tools, machines, and such

In addition, the important O&M was by way of subcontract (outsourcing arrangement).

Repair Workshop

Stock Room

(4) Problem Analysis

Dredging facilities provided by grant aid were carefully utilized. So far, vehicles did not have any mechanical problem. However, determination on equipment/materials was progressing steadily.

Consequently, it caused the following problems.

- Water quality is not thoroughly analyzed due to the limit analytical specimens.
- Service life of equipments worsens.
- Dredge work is overdue.
- Generating frequency of a retting damage becomes high.
- Living environment gets worse.

As a countermeasure, reinforcement on inspection equipment/tools is required to prolong their serviceable life and thoroughly keep the conditions of materials.

6.3 Personnel Management

6.3.1 WASA's Permanent Employee

(1) Disparity on Staff Numbers (Numeric Error by Data Available)

Total numbers of data on staff in 2008 provided by WASA differ one another depending on the destination of sources.

Table 6.20 shows the disparity in total number of WASA Employees. In addition, this problem can be judged because unified statistics by WASA are still not improved.

Table 6.20 Disparity in Total Number of WASA Employees

Source (Received Date)	Administration Dep. (13 May. 2009)	Finance/Revenue Dep. (13 April, 2009)	Difference
No. of Employees	5,476	5,729	253 (4.4%)
	Employee's Experience, Education, Age Distribution etc.	BS (Grade) Ratio, Pay Scale etc.	-

(2) Employee Numbers

The WASA operating organization is consisted of one (1) Managing Director, three (1) Deputy Managing Director (DMD) and their subordinates with some 5,730 officials, and the said contacted employees and staff related to JICA Projects with some 3,700 persons. In other words, persons concerned more than 9,300 per year worked for WASA.

Among the said 5,730 officials, staff in charge of O&M are some 4,200 persons in total, staff in charge of administration (waterworks meter reading, bill delivery, and complaint receptionist etc.) are some 640 persons, and staff in charge of design and construction supervision are some 890 persons respectively. In addition, the ratio on on-the-spot staff (Grade: 1-15) engaged on the O&M tasks occupied more than 95% at large. **Table 6.21** and **Table 6.22** show the staff numbers and O&M employee numbers work for 6 towns.

Table 6.21 Number of WASA Employees

BS (Grad)	2007-2008 (Full-time Employees)		
	Revised	Exising Staff	%
1	2,761	2,536	44.27%
2	1,240	1,313	22.92%
3	126	119	2.08%
4	344	438	7.65%
5	790	545	9.51%
6	110	63	1.10%
7	101	71	1.24%
8	9	4	0.07%
9	185	161	2.81%
10	66	62	1.08%
11	154	100	1.75%
12	20	8	0.14%
13	6	1	0.02%
14	57	43	0.75%
15	25	16	0.28%
16	99	82	1.43%
17	133	105	1.83%
18	53	44	0.77%
19	17	14	0.24%
20	4	4	0.07%
Total	6,300	5,729	100.00%

Source: BUDGET 2008-09, WASA Revenue Dep.13 April,

Table 6.22 Number of Contract Basis Employees

Basis on actual requirements	2007-2008
	Exising
Heavy Machinery Drivers	50
Junior Pump Operators	1,601
Sewerman	1,801
Subtotal	3,452
JICA Project for Retrieval of Sewage	212
G.Total	3,664

(3) Changes on Employee Numbers

Employee numbers increased as 5,476 persons in 2008 in comparison to the same of 4,508 in 2003 accompanying the augmentation on water consumption, and thus varied with mild growth by roughly 1.2 times.

Figure 6.7 illustrates the change of numbers of WASA's employees.

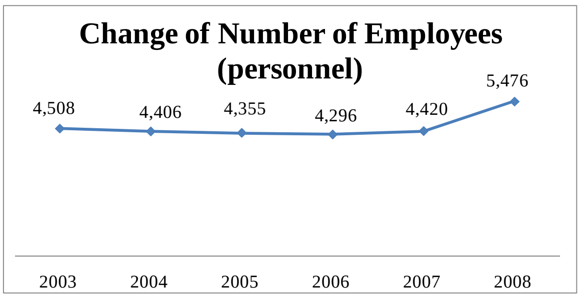


Figure 6.7 Changes of Numbers of WASA's Employees

Source: Administration Dep. May 13, 2009

(4) Grade

Task burden on the staff was classified based on the duty responsibility by the grade with 1-20 (Responsibility increases while the grade becomes higher). In addition, directorship (Grade: 18-20) and design engineering staff (Grade: 16-17) occupies about 5% at large.
Table 6.23 shows the relation between staff numbers and their grades.

Table 6.23 Number of O&M Employees

SR.No.	DESCRIPTION (O/M Dep.)	DMD (O&M)	Ravi Town	Shalimar Town	Gunj Buksh	Aziz Bhatti	Iqbal Town	Nishtar Town	Total
1	DMD(O&M)	1	-	-	-	-	-	-	**1**
2	Directors	-	1	1	1	1	1	1	**6**
3	XENs	1	3	1	4	1	3	2	**15**
4	SDOs	-	7	2	10	4	7	5	**35**
5	Sub Engineer	1	12	6	15	4	11	10	**59**
6	P.S/Stano Grapher	2	3	1	1	1	1	2	**11**
7	Staff officer	1	1	1	1	1	1	1	**7**
8	Sr. Clerk	-	10	3	12	5	5	6	**41**
9	Jr. Clerk	3	22	14	25	4	14	16	**98**
10	Head Clerk	-	4	1	5	1	4	2	**17**
11	Naib Qasid	2	3	2	2	3	2	8	**22**
12	W.L.I	-	2	1	3	-	1	-	**7**
13	Pipe Fitter	-	23	11	25	4	17	7	**87**
14	Asstt.Pipe Fitter	-	51	23	107	26	51	72	**330**
15	Supervisor	-	2	-	6	-	3	4	**15**
16	Assistant Supervisor	-	15	2	32	4	15	11	**79**
17	Sewermen	-	350	85	508	125	309	343	**1,720**
18	HMD/Vehicle Driver	-	15	10	10	6	7	13	**61**
19	Mechanical Supt.	-	-	-	-	1	-	-	**1**
20	Electrician	-	6	1	5	-	1	3	**16**
21	Pump Operators	1	341	158	452	80	216	202	**1,450**
22	Security Guard	-	6	2	-	1	-	8	**17**
23	Mechanical Helper	-	29	16	10	7	22	5	**89**
Total		**12**	**906**	**341**	**1,234**	**279**	**691**	**721**	**4,184**

Source: O/M Dep. April ,2008

(5) Pay System
Salary was specified by service years (30 years maximum counted from starting pay) and grades. Office hours were generally set up as 8:00-15:00 (40hrs/week) and overtime hours were unauthorized. With regard to the management on duty hours, there is no book for sign in and out especially and the salary was transferred into the individual account of employees one a month after the approval through the supervisor's checking on employee service records.
The privileged treatment system of WASA’s staff are consisted of regular pay raise (10-15%), paid time off, insurance join, health checkup, retirement age of 60, and lifetime pension system etc.
Promotion exam (interview and paper test) on sub-engineers was carried out twice a year. However, the grade on field staff may rise only by their supervisor's evaluation. Especially, in case of those elderly staff over 45-years-old are difficult to perform the field works were promoted to the superintendent job in the same section pursuant to the seniority system.
In addition, the promotion is approved by LDA Chairman.
Figure 6.8 illustrates the basic pay system by grade.

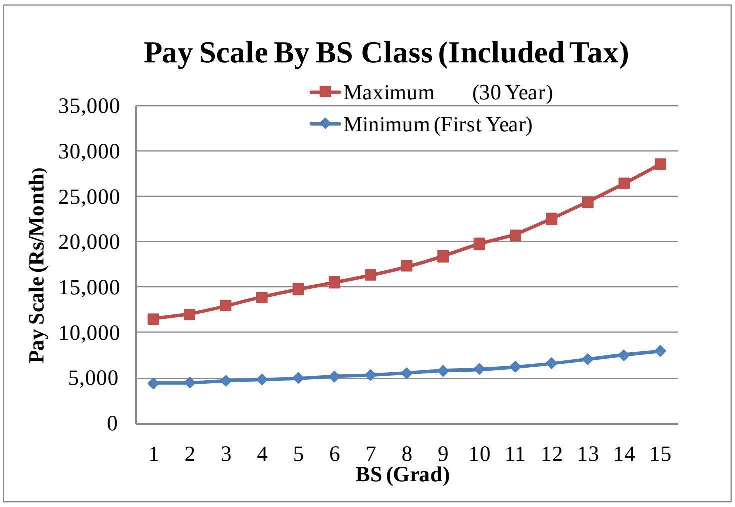


Figure 6.8 Pay Scale for WASA's Employees

Table 6.24 Basic Pay Scale by Official BS (Grade) in 2008

Basic pay Scale by officials BS						
2008-2009					Total Amount Received	
BS (Grad)	Basic Pay (Revised)	INC (Inflation Rate)	Max. Payable	House Rent (BP*45%)	Minimum (First Year)	Maximum (30 Year)
1	2,970	90	5,670	1,337	4,397	7,097
2	3,035	100	6,035	1,366	4,501	7,501
3	3,140	120	6,740	1,423	4,683	8,283
4	3,240	140	7,440	1,458	4,838	9,038
5	3,340	160	8,140	1,503	5,003	9,803
6	3,430	175	8,680	1,544	5,149	10,399
7	3,530	190	9,230	1,589	5,309	11,009
8	3,665	210	9,965	1,649	5,524	11,824
9	3,820	230	10,720	1,719	5,769	12,669
10	3,955	260	11,755	1,780	5,995	13,795
11	4,120	275	12,370	1,854	6,249	14,499
12	4,355	310	13,655	1,960	6,625	15,925
13	4,645	340	14,845	2,090	7,075	17,275
14	4,920	380	16,320	2,214	7,514	18,914
15	5,220	420	17,820	2,349	7,989	20,589

Source: Financial Det. April, 2009

(6) Promotion Criteria

There exist two (2) kinds of promotion criteria as below.

a) Recommendation by supervisor

Particularly, Elderly employees over 45-year old because of difficulties to engage as a field worker were promoted, with higher-rank based on the supervisor's evaluation. Those promoted employees transferred to coaching job at same department accordance with seniority system.

b) Promotion test

Promotion test (interview and paper test) on sub-engineer was carried out twice a year. In addition, promotion was approved by LDA Chairman.

(7) Employment System

Employment on full-time employees was sought publicly on newspaper ad with the grades and occupational categories. Employment on professional engineer was adopted through paper and interview tests. Interview test was applied only to field employees with lower grades. In addition, the retirement age of 60 is fixed and its extension is unauthorized.

Historically, WASA curbed the recruiting numbers of staff and had a policy to strengthen the ratio on the contract employees. However, the Provincial Government of Punjab positively released the official vacant posts to the public and worked out towards to fill such vacancies according to the newspaper of 21st April 2009. WASA considered the employment of engineers/ directors to fill positions left open and the augmentation of field employee numbers; however, it is difficult to timely ensure the capable personnel due to the low pay level by WASA.

(8) Criteria on Personnel Shifts

There are no criteria on personnel shifts (changes); however, personnel with the tendency to be assigned by grade depending upon the increase & decrease on construction projects, fluctuation on tasks and change on assignments for O&M.

There exist two (2) kinds of notice on personnel shifts as below.

a) Engineers/Technicians

   Notice in writing on personnel shifts is officially announced to the said person by the Director of Planning Evaluation Department.

b) On-site personnel

   Notice in writing on personnel shifts is officially announced to the said person by his (her) superiors.

On the other hand, employees can submit their opinion letter against such order on shifts. So far, any shifts got dissenting pressure from labor union. It may develop up to courtroom confrontation in case that agreement between employee and WASA cannot be reached.

(9) Personnel Evaluation

It is considered that there is no documentary form on personnel evaluation.

Normal personnel evaluation was practically conducted by next three ways on the basis of interview results.

- Control by working hours
- Evaluation by customer after responding the complaint (with or without recomplaint)
- Infringement on penalty regulation

In addition, such as pay raise, pay reduction and advices were conveyed to said employees themselves in accordance with the supervisor’s evaluation.

(10) Penalty Regulations

There exists a regulation of obligation to absolutely control the public facilities in the penalty regulations. However, it is difficult to apply such penalty regulation in case that the reason on the job abandonment of a workshop/strike by the staff themselves was recognized as justifiable in term of occupational health. On the other hand, those employees become the target of dismissal in case that they definitely took private, steal and embezzle the WASA’s properties. Moreover, those employees who are absence without notice will be punished with a pay cut.

(11) Healthcare

Administration Department employs two (2) doctors to carry out the employee’s healthcare.

(12) WASA’s Labor Union

There exist four-five (4-5) organizations on labor union within WASA, and Collection Bargain Agent (CBA: closed to the Communist) is the top union taking over the biggest force. However, this union is under the supervision of Labor Department and had earned recognition as a legal entity in Pakistan. The Union’s objectives are to assist the pressure against WASA for resolving the staff’s rights/dissatisfaction and improvement activities on working conditions (positive introduction on hardware, medical service, and increasing on special allowance etc.) by putting herself in the position of the weak with most staff.

The most common WASA labor union is "ROSE”, and the Union members are consisted of the staff with WASA’s grade of 1-15 by the compulsory participation with tacit understandings. Union is operated by the small union dues (about 10 Rs/head: without legal force on payment) and personal major donations.

(13) Employee’s Age and Job Composition

Average age of employees increased up to roughly forty-three (43) in 2008 from forty-one (41) as of 2003. Average age is forty-seven (47) on engineers of which were aging; therefore, it is absolutely required to immediately promote the fosterage of engineers to shoulder the next generation.

With regard to the staff’s composition, engineers occupy about 3% at large, staff at site and administration respectively account for 85% and 12%.

In addition, aging on life expectancy was resulted from the restraint on natural increment and employment on full-time employees and difficult recruitment on human resources.

Table 6.25 and **Table 6.26** show the transition and composition on average age of employees and the other conditions.

Table 6.25 Change in Average Employee's Age

Range of Employees' age	Number of employee (personnel)					
	2003	2004	2005	2006	2007	2008
Over 20-under 25	265	180	104	64	61	330
Over 25-under 30	589	520	481	478	368	620
Over 30-under 35	868	836	751	627	614	800
Over 35-under 40	877	888	901	953	980	992
Over 40-under 45	813	821	813	812	841	934
Over 45-under 50	570	595	639	685	760	824
Over 50-under 55	330	338	375	425	497	554
Over 55-under 60	196	228	291	252	299	422
Over 60 years	0	0	0	0	0	0
Total (personnel)	4,508	4,406	4,355	4,296	4,420	**5,476**
Average age	41	42	43	43	44	43
% of Incresing Ratio	1.00	0.98	0.97	0.95	0.98	1.21

Source: Administration Dep. May 13, 2009

Table 6.26 Detail of Employee's Age Range in 2008

Range of Employees' age	Administrator / Office workers		Engineers		Technician		Supporting staff		**Total (personnel)**	
	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)
Under 20	0	0%	0	0%	0	0%	0	0%	0	0%
Over 20-under 25	35	5%	3	2%	53	7%	226	6%	317	**6%**
Over 25-under 30	38	6%	17	10%	84	12%	481	12%	620	**11%**
Over 30-under 35	35	5%	27	16%	94	13%	644	16%	800	**15%**
Over 35-under 40	89	14%	10	6%	99	14%	794	20%	992	**18%**
Over 40-under 45	139	22%	11	6%	100	14%	675	17%	934	**17%**
Over 45-under 50	113	18%	39	23%	119	17%	553	14%	824	**15%**
Over 50-under 55	117	18%	42	24%	101	14%	294	7%	554	**10%**
Over 55-under 60	74	12%	24	14%	65	9%	259	7%	422	**8%**
Total (personnel)	640	100%	173	100%	715	100%	3,926	100%	**5,463**	100%
Average age	**46**	-	**47**	-	**43**	-	**42**	-	**43**	-
% of Employee by Occupation	**12%**	-	**3%**	-	**13%**	-	**72%**	-	**100%**	-

Source: Administration Dep. 13 May, 2009

(14) Employee's Service Years

As shown in **Table 6.27**, the Service years by the administration and engineer were more than twenty (20) years and approximately seventeen (17) years are as counted the average service years for the staff at site.

Table 6.27 Detail of Employee's Age Range in 2008

Detail Of Service Years	**Administrator / Office workers**		**Engineers**		Technician		Supporting staff		Total (personnel)	
	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)
Under 5 years	113	17.7%	47	27.2%	216	30.2%	924	23.5%	1,300	23.8%
Over 5-under 10	27	4.2%	11	6.4%	102	14.3%	592	15.1%	732	13.4%
Over 10^under 15	20	3.1%	11	6.4%	7	1.0%	599	15.3%	637	11.7%
Over 15- under 20	188	29.4%	19	11.0%	150	21.0%	852	21.7%	1,209	22.2%
Over 20-under 25	65	10.2%	12	6.9%	85	11.9%	430	11.0%	592	10.9%
Over 25- under 30	121	18.9%	48	27.7%	97	13.6%	337	8.6%	603	11.1%
Over 30-under 35	78	12.2%	21	12.1%	51	7.1%	160	4.1%	310	5.7%
Over 35yeras	28	4.4%	4	2.3%	7	1.0%	32	0.8%	71	1.3%
Total	640	100.0%	173	100.0%	715	100.0%	3,926	100.0%	**5,454**	100.0%
Average service years(year/months)	**22**	-	**21**	-	18	-	17	-	18	-

Source: Administration Dep. May 13, 2009

(15) Employee's Education Level

Only one qualified expert with a doctor's degree works for WASA. Acquirer with a master's degree are some seventy-three (73) persons, and college graduates are two hundred fifty-one (251) persons; however, the information on the respective backyard was not available. On the other hand, low level educated employees account as some 80% as high.

WASA’s operators should positively carry out the manpower assignment and employment system taking the technical know-how into consideration.

Appendix 6.3.1 shows the details of employee’s education level in 2008.

(16) Employee’s Training

WASA Training Center (compound area: about 3acres including two buildings) built in 1978 with assistance of World Bank is to aim at the improvement the operating know-how level on pumps useful to the field targeting the persons in charge of Facilities’ O&M. With regard to targeted trainee so far, staff (employees at site) with grade of 1-16 are currently trained.

Existing training curses follow the cleanup procedures on sewer pipes (including safety control), and DMD of O&M selected the personnel to participate the training. No more powerful effects can be expected by WASA training education on the staff above grade 17 due to the shortage of instructor. However, participation to the international training was actively carried out. In addition, WASA’s chief executive decided the personnel selection for such participation.

“WASA Academy Vision” was studied as a way to accelerate the existing effects by WASA’s training. WASA Academy Vision is that the Urban Unit raises the level on instructors/facilities, enriches the training courses and is aiming at other WASA employee’s training including Punjab WASA through the tech support by JICA with a vision which WASA training center becomes an independent educational institution in the future.

The improvement schemes on the existing WASA’s training center (see **Appendix 6.3.2**) are shown as below.

- Reconstruction on the existing brick-built structure facilities for major education (roughly 134 ft × 35 ft = 4,690 ft^2)
- To extend 1-story indoor training portion by 2-story (roughly 70ft × 35ft)
- To enrich the training furnishings including OA
- To bring JICA’s backup into view as a improvement measure on technological level

That the person in charge of education will be selected from the Development Authorities (Lahore Department Authority, Faisalabad Division Authority, Rawalpindi Department Authority, Gujnwara Department Authority, Multan Department Authority) was reviewed.

Moreover, WASA shall study the introduction on proposal/bonus system and upgrading/ training on O&M by patrolling/visiting professional engineers in addition to the level up on employees by skill-training system.

Table 6.28 shows the details of previous training courses.

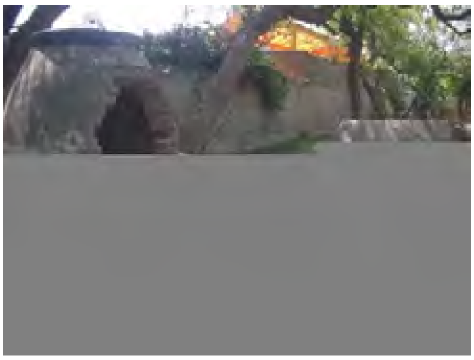
Table 6.28 Detail of Previous Training Courses with WASA

S.NO.	CATEGORY	NATURE OF TRAINING	PERIOD FROM-TO	TOTAL NOMINATIONS(Nos.	TOTAL BATCH
1	Pipe Fitters, APF, Sewer man, SPC, Zaildar, Mechanical Helper	Dewatering Sets	21.06.2004 to 29.06.2004	95	7
2	Officials working as Sub Engineers on their pay and scale	Copy of Programme is attached	20.10.2004 to 11.11.2004	15	-
3	Mechanical Helper	Refresher Course	07.07.2004 to 13.07.2004	28	6
4	SDO/ Sub Engineer	Just to avoid excessive billing by WAPDA	01.03.2006 to 28.04.2006	127	12
5	Sewer man	Training for safety measures	04.07.2006 to 27.07.2006	154	8
6	Electrician / Mechanical Staff	To have grasp knowledge on electricity WASA installation	10.04.2007 to 03.05.2007	48	4
7	Directors/ XENs/ SDOs	Quality & Quantity of water supply to people	09.05.2007	48	1
8	Asstt:/ Junior clerk	Tendering Procedure	20.12.2007 to 21.12.2007	9	2
9	Sewer man Training for safety measures	Training for safety measures	10.12.2007 to 27.02.2008	963	7
10	Tube well operator	Training of chlorination at Tube well	01.09.2008 to 23.12.2008	650	32
	Total	–	145	2,137	79

Source: Urban Unit Aril 2009, Local training held at tanning center WASA (2004 to 2008)

Main Training Building

Training Activity as of 30th April 2009



Outdoor Display

Indoor Workshop (Pipe Connection)

(17) Methodology to reduce the number of employees

The following methods can be considered as part of slimming of the organization.

a) Promotion of an early-retirement program

- Early retirement will result in reduction of WASA's overall payroll burden.

- It will result in slimming of the organization leading to batter efficiency.
- By retiring executive personnel at an early stage, promotion posts for junior and younger staff will be available.

b) Promotion of sending WASA staff elsewhere on deputation.

- By seeking deputation positions for WASA staff in other departments/companies the payroll burden of WASA will be reduced.

(18) Adequate posting

It is necessary to carry out swift promotion for staff showing extraordinary competence and efficiency. This will cause motivation in other employees also. Although WASA is carrying out the personnel evaluation system aiming at improvement of WASA staff through training and facilitation of the self-development, the effect is not fully demonstrated.

Table 6.29 Number of employment applicants

			As of May, 2009	
No.	Positions for Vacancy	B.S(Grade)	NO. of Vacancy	Applicant
1	Assistant Field Inspectors	5	5	1,286
2	Jn. Lab Assistant	5	2	224
3	Vehicle Drivers	5	11	192
4	Observers	5	1	55
5	Drawing Tracers	5	4	76
6	Dark Roomer (Post men)	4	2	72
7	Assistant Supervisors	3	7	215
8	Book Binders	2	1	33
9	Naib Qasid (Tea boys)	1	6	760
10	S. Guard Chowk (S. securitys)	1	32	410
11	Mali (Gardeners)	1	7	100
12	S. Khalasi (surveyors)	1	9	234
13	Sewer man	1	63	531
Total		39	150	4,188

Source : Finance Dep. September 2, 2009

(19) Employment of Recruitment

1) Recruitment of Experts

As part of the operating efficiency of WASA, the employment of real experts is required. Salary based should be in accordance with market rates. Salary range of Rs: 20,000-50,000 per month, even though it is without pension administration plan, will be satisfactory. The main cause that WASA cannot recruit the experts with regular committee is that it cannot allow salaries beyond the regular pay scales limits.

The WASA Basic Pay Scale for WASA's Permanent Employee, and proposed WASA specials Pay Scales for Recruited employee, are shown in **Table 6.30** and **Table 6.31**.

A Reemployment or Short-term policy Emplyee, Scheme is shown in **Figure 6.9** respectively.

Table 6.30 Basic Pay Scale by Official BS (Grade 1-20) in 2009

2009-2010							Total Amount Received	
BS	Basic Pay	INC(Infulation rate)	Fixed Over Time Allowance	Others	Max. Payable	House Rent	Min Total Salary(1st Y)	Max Total Salary(30Y)
1	2,970	90	515	2,567	5,670	1,337	6,935	10,175
2	3,035	100	527		6,035	1,366	7,054	10,654
3	3,140	120			6,740	1,413	6,700	11,020
4	3,240	140	560		7,440	1,458	7,425	12,465
5	3,340	160	578		8,140	1,503	7,509	13,269
6	3,430	175	593		8,680	1,544	7,673	13,973
7	3,530	190	611		9,230	1,589	7,856	14,696
8	3,665	210	634		9,965	1,649	8,101	15,661
9	3,820	230	661		10,720	1,719	8,384	16,664
10	3,955	260	684		11,755	1,780	8,630	17,990
11	4,120	275	713		12,370	1,854	9,371	19,271
12	4,355	310	753		13,655	1,960	9,799	20,959
13	4,645	340	804		14,845	2,090	10,328	22,568
14	4,920	380	851		16,320	2,214	10,829	24,509
15	5,220	420	903		17,820	2,349	11,376	26,496
16	6,060	470	-		20,160	2,727	12,479	29,399
17	9,850	740	-		24,650	4,433	18,241	35,261
18	12,910	930	-		31,510	5,810	23,137	44,527
19	19,680	970	-		39,080	8,856	33,968	56,278
20	23,345	1,510	-		41,485	10,505	39,832	60,693

Table 6.31 Proposed WASA Special Pay Scales in 2008

S.No.	Name of Post	Salary package (p/M)
20	Deputy Managing Director	90,000
19	Director Eng.	75,000
18	Deputy Director (Eng/XEN)	50,000
17	Junior Eng./SDO	30,000
11	Sub Eng.	15,000

Source: Financial Det. April, 2009

1) Ordinary employment (for Grade 1-15 staff)

Since the dredge maintenance works by human power is in unhygienic conditions, it is necessary to improve the workability by use of mechanical facilities. As of May, 2009, the scale factor of applications for the Grade 1-5 is about 28. Actual track record of employment is "0" (Refer to **Table 6.30**). The number of vacancy of a field management job, an SDO is 22 persons and a Sub Engineer is 25 persons. Nobody is employed yet. In addition, the dredge work staffs (Grade: 1 & 2) is demanding increase of a washing allowance.

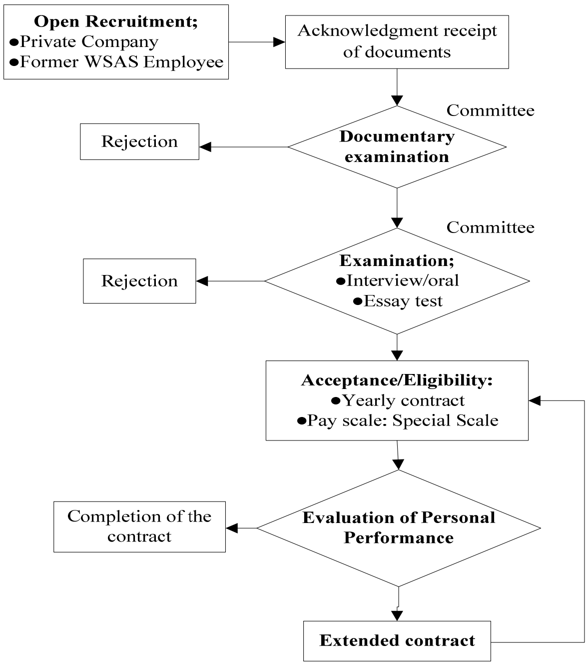


Figure 6.9 Procedure of Recruitment Scheme

(20) Problem Analysis

1) Employee's graying

Employees were counted as approximately 5,700 in total, and about 98% of employees were engaged in the fieldwork. On the other hand, average age on the whole employees is some forty-three (43) years old (retirement age: 60 years old). Particularly, aging on employees at site (cleanup on water conduits and waste pipelines) was progressing, and thus tasks on O&M were depending upon the contract employees. Furthermore, transfer of technology to the engineers/technicians to be responsible for the next generation behind time because the age of engineers and specialists were also higher.

The cause by which aging advanced can consider the following.

-Implementation of the plan of a change of generation of the personnel is behind.

-Required talented people's reservation is behind.

- Delay of an early-retirement program.

-The age which the personnel resign is high.

(The age of retirement of a neighboring country is shown as reference.)

Table 6.32 Employee's age

As of 2007	Age of retirement	Average life Expectancy
Pakistan	60-year old	63~65
Nepal	55-year old	61-year old
India	60-year old	64-year old
Japan	60-year old	79~84-year old

Source: Country introduction on Internet.

2) Securement on human resources

WASA publicly seeks human resources who have the specialized knowledge on finance/management/design; however, such personnel cannot be secured due to the low payroll. Correspondingly, appropriate head-counts also cannot be secured due to the reason of "insalubrious undertakings" and "low payroll" regarding the contract field employees

3) Employee's education

Employee's education still remains at the level for field workers (work safety education) due to insufficient equipment contents and instructors to be provided by WASA Training Center.

Consequently, it caused the following problems.

- Operational efficiency by WASA is decreased.
- Human resources on the next generation become short.
- Recruitment on specialists and professional managerial-level staff become difficult.
- Quality by education is decreased.
- Excess personnel is increased.

As the countermeasures, review on pay system for employing external specialists, positive utilization on WASA Academy and improvement on employees' personal data are indispensible.

4) Raise in pay

Many personnel in WASA complain that motivation is not created due to low salaries of technically trained staff. The wage structure of the present WASA is low as compared to the nature of work its staff is preforming. This should be given due concentration.

6.4 Customer Relations

6.4.1 Customer Complaint Response System

(1) Complaint Response Contact

The operation of complaint reception counters is classified as follows:

- Contact on O&M related
- Contact on water tariff and Revenue

Complaints on O&M related were registered by either 24-hour exclusive telephone line or the direct response from the contact. Complaints were responded by both of "Complaint Monitoring Cell" of WASA Head Office and twenty five (25) Sub-division contacts.

Complaints on regarding water tariff and revenue are registered by each district contact, 6 Towns, within the office hours.

(2) Complaint Response Unit

Persons in charge O&M at the local level (SDO) and persons in charge of water tariff by each department (DD) responded the complaints. The registered complaints were immediately responded and the response results were reported to the superior of respective organization. If serious complaints/accidents were to be happened, such matters were promptly report to the responsible official of each department and WASA's executive officers, and WASA responded with coalition to governmental organizations concerned.

These complaint cases were recorded into the ledger, and were immediately communicated with the responsible department from the window staff and subsequently the implementation on field verification/survey, repair work, and modification on water utility ledger/change of bill etc. were carried out.

1) O/M Complaint

a) WASA Head Office

Complaint Monitoring Cell, counter at Head Office of WASA responded the complaint on O&M. Director of Planning & Evaluation Department is the responsible official. This cell was operated by a total of eight (8) persons (3-shift working for 24-hour system) and one (1) unit UHF communication apparatus to instruct four (4) exclusive phone lines and relevant organizations. The complaint was recorded into the ledger, and was also immediately communicated with each O&M department to request the information on the result.

Complaint Monitoring Cell for O&M **Desk of Complaint Monitoring Cell**

b) Window Responsible Official for 6 Towns (25 Sub-division Offices)

Director of each Sub-division Office is responsible for the complaint measures on O&M assembled from the area within the jurisdiction of WASA.

Desk of O&M Complaint in Town

2) Water tariff and Revenue Complaint (Revenue Complaint)

Director of Revenue Department "outpost" of each town is in charge of the complaint measures on the Revenue. At local agency, each DD (Deputy Director) is carrying out for resolution according to the Complaint ledger.

a) Complaint contents to response window/counter (Example for Gunj Buksh Town)

Staff are always preoccupied with responses to those numerous customers who visited for the next two reasons: i) reissue requests caused by posting mistake and missing/not yet delivered bills; and ii) complain/inquiry on paperwork mistake, tariff/charge amounts, water consumption, duplicate billing, and recording mistake on registered number etc because the paperwork checking system on water tariff was poor.

However, it can be considered that such example was not registered as complaint statistics. **Table 6.33** shows the responded results at 12th May 2009.

Table 6.33 Complaint Breakdown at Response Window (GBT)

Nos. of Visitors	Part Bill	Duplicate Billing	Exempted	Total
	31	24	3	58

Tariff /Revenue Complaint Counter in Town

(3) Estimation Method

It was difficult to obtain the information on annual complaint cases in term of O&M and water tariff/billing occurred within the area under the control of WASA.

Total complaint cases were estimated by the following methods.

- With regard to the complaint on O&M related, hearing investigation was conducted to 25 SDOs.
- With regard to complaint cases on water tariff revenue related, 2 ways were conducted. One was hearing investigation was conducted to 25 SDOs and Second was the analysis on the past 4-year information was carried out obtained from the Revenue Department.
- With regard to complaint cases on Water Quality was checked the ledger at the Complaint Monitoring Cell-1, only January 2009 (Dry Season) and July 2008 (Rainy Season).

6.4.2 Estimation of Number of Complaints

(1) Regarding O/M

1) Accrual number

The claim number of item of O/M is about 1,500 affairs per day. About 1000 of affairs per day of this is caused by a stopping sewer. Moreover, a deficient water supply is about 170 affairs per day. In addition, the double claim is predicted to be 10 to 20%. Therefore, the actual number of sewer occlusion is predicted in about 850 affairs per day. The main obstructers are the earth and sand and all kind of garbage which flows in from damaged sewer pipes and damaged manholes.

2) Occlusion Trend of each Town

The connection per occlusion complaints numbers in Gunji Buksh Town is about 400 connections. However, Shalimar Town is about 818 connections more. Shalimar Town has only a few existing cleaning equipment, although population is as large as about 79,342 connections. As a result of updating a superannuation pipe positively, there are few complaint numbers compared with other Towns.

The summary of the complaint number is shown in **Table 6.34** and the tendency of the complaint in Sub division base is shown in **Table 6.35**.

Table 6.34 Numbers of Complaints Received Daily

Sr. No.	Name of Town	Population	Number of Connection	b) Average Receving Complaints of Revenue				a) Average Receving Complaints of Sewer Line (O/M)					
				Revenue/day	Population/Complaint/day	Connection/Complaint/day	Ratio of Complaint	Block	Lack of Water Supply	Sub total	Population/Complaint/day	Connection/Complaint/day	Ratio of Complaint
1	Ravi Town	1,493,390	152,605	8	182,961	18,696	23%	237	19	256	5,834	596	21%
2	Shalmar Town	1,220,659	79,342	3	359,742	23,383	10%	67	30	97	12,584	818	8%
3	Gunj Buksh Town	1,231,553	122,143	9	131,717	13,063	26%	255	52	307	4,012	398	25%
4	Aziz Bhatti Town	273,200	26,968	1	187,088	18,468	4%	40	4	44	6,209	613	4%
5	Allama Iqbal Town	1,636,339	96,962	9	173,977	10,309	27%	280	36	316	5,178	307	25%
6	Nishtar Town	927,784	78,870	4	261,600	22,238	10%	195	28	223	4,160	354	18%
Total		6,782,925	556,890	35	192,054	15,768	100%	1,074	169	1,243	5,457	448	100%
Remarks				Source: WASA Revenue Dep. May 9, 2009				Source: O/M SDO, September 10, 2009					

Remark: Revenue Complaint shows in 2007, (12,891 cases/year=35 /day)

Table 6.35 Generating Situation of Complaints in O/M

30

Sr. No.	Location: Description of Area/ Sub Divisions	Population (2009)	Number of Average receving Complaints (O/M)						Number of detail Complaints received (O/M)						% of Sewre block	% of Water shortage
			Sewer pipe/day	Water Supply /day	Sewer pipe/Month	Water Supply /Month	Total /Month	Population /Complaints /D	Sewer Block/day	Lack of Water supply/day	Sewer Block/Month	Lack of Water supply/Month	Total /Month	Population /Complaints /D		
1	**RAVI TOWN**															
1	City	280,000	12	17	360	510	870	9,655	12	2	360	60	420	**20,000**	100%	12%
2	Shahdra	220,000	35	10	1,050	300	1,350	4,889	35	2	1,050	60	1,110	5,946	100%	20%
2	Farakhabad	215,000	35	15	1,050	450	1,500	4,300	35	2	1,050	60	1,110	5,811	100%	13%
3	Data Nagar	288,500	80	10	2,400	300	2,700	3,206	80	10	2,400	300	2,700	3,206	100%	100%
4	Misri Shah	259,670	40	15	1,200	450	1,650	4,721	35	2	1,050	60	1,110	7,018	88%	13%
3	Shadbagh	230,220	40	8	1,200	240	1,440	4,796	40	1	1,200	30	1,230	5,615	100%	13%
	Sub total	**1,493,390**	**242**	**75**	**7,260**	**2,250**	**9,510**	4,711	**237**	**19**	**7,110**	**570**	**7,680**	**5,834**	98%	25%
2	**SHALIMAR TOWN**															
6	Mughal Pura	683,420	27	12	810	360	1,170	17,524	27	10	810	300	1,110	**18,471**	100%	83%
7	Baghban Pura	537,239	40	12	1,200	360	1,560	10,332	40	20	1,200	600	1,800	8,954	100%	167%
	Sub total	**1,220,659**	**67**	**12**	**2,010**	**360**	**2,370**	15,451	**67**	**30**	**2,010**	**900**	**2,910**	**12,584**	100%	250%
3	**GUNJ BUKSH TOWN**															
4	Krishan Nagar	406,825	55	17	1,650	510	2,160	5,650	55	10	1,650	300	1,950	6,259	100%	59%
9	Ravi Road	304,888	50	10	1,500	300	1,800	5,081	50	8	1,500	240	1,740	5,257	100%	80%
10	Mozang	121,707	75	22	2,250	660	2,910	1,255	55	10	1,650	300	1,950	1,872	73%	45%
11	Anarkali	150,700	50	25	1,500	750	2,250	2,009	50	10	1,500	300	1,800	2,512	100%	40%
12	Gulberg	133,560	25	10	750	300	1,050	3,816	20	5	600	150	750	5,342	80%	50%
13	Shimla Hill	113,873	25	12	750	360	1,110	3,078	25	9	750	270	1,020	3,349	100%	75%
	Sub total	**1,231,553**	**280**	**96**	**8,400**	**2,880**	**11,280**	3,275	**255**	**52**	**7,650**	**1,560**	**9,210**	4,012	91%	54%
4	**AZIZ BHATTI TOWN**															
14	Mustafabad	99,200	20	5	600	150	750	3,968	20	2	600	60	660	4,509	100%	40%
15	Tajpura	174,000	20	10	600	300	900	5,800	20	2	600	60	660	7,909	100%	20%
	Sub total	**273,200**	**40**	**15**	**1,200**	**450**	**1,650**	4,967	**40**	**4**	**1,200**	**120**	**1,320**	6,209	100%	27%
5	**ALLAMA IQBAL TOWN**															
17	Iqbal Town	311576	85	30	2,550	900	3,450	2,709	80	10	2,400	300	2,700	3,462	94%	33%
18	Samanabad	425763	85	30	2,550	900	3,450	3,702	80	15	2,400	450	2,850	4,482	94%	50%
19	Sabazar	150000	85	25	2,550	750	3,300	1,364	80	9	2,400	270	2,670	1,685	94%	36%
20	Ichra	389,000	40	5	1,200	150	1,350	8,644	40	2	1,200	60	1,260	9,262	100%	40%
21	Johar Town	360,000	25	8	750	240	990	10,909	25	4	750	120	870	12,414	100%	50%
	Sub total	**1,636,339**	**320**	**98**	**9,600**	**2,940**	**12,540**	3,915	**305**	**40**	**9,150**	**1,200**	**10,350**	4,743	95%	41%
6	**NISHTAR TOWN**															
22	Industrial Area	315,500	100	35	3,000	1,050	4,050	2,337	80	10	2,400	300	2,700	3,506	80%	29%
23	Green Town	200,918	100	35	3,000	1,050	4,050	1,488	80	9	2,400	270	2,670	2,258	80%	26%
24	Garden Town	211,000	15	7	450	210	660	9,591	15	7	450	210	660	9,591	100%	100%
25	Town Ship	200,366	20	2	600	60	660	9,108	20	2	600	60	660	9,108	100%	100%
	Sub total	**927,784**	**235**	**79**	**7,050**	**2,370**	**9,420**	2,955	**195**	**28**	**5,850**	**840**	**6,690**	4,160	83%	35%
G.Total (WASA)		**6,782,925**	**1,184**	**375**	**35,520**	**11,250**	**46,770**	**4,351**	**1,099**	**173**	**32,970**	**5,190**	**38,160**	**5,332**	**93%**	**46%**

Source; Interview with all SDOs on September 9 and 10, 2009

(1) Regarding Revenue

1) Accrual number

The complaint number about the revenue is about 35 affairs per day. Among this, the complaint resulting from a water meter and the amount billed occupies about 70 to 80%.

2) Occlusion Trend of each Town

The population per complaint numbers in Gunji Buksh Town is about 13,063 connections and Shalimar Town is about 23,383 connections. The tendency shows the same tendency as a sewer pipe as shown in **Table 6.34**. The cause of the main complaints is a delay in the modification of the ledgers by the delay in an office automation improvement.

(2) Regarding Water quality

Complaint cases obtained from Water Chemical Laboratory on January, 2009 and July 2008 were analyzed. As a result, estimated complaint cases to be occurred were about 50 per month.

Table 6.36 shows the received Number of water quality complaint.

Table 6.36 Details of Water Quality Complaint Received at Complaint Monitoring Cell

Complaint Contents	January 2009 (Dry Season)		July 2008 (Rainy Season)		Remarks (Estimate: cases/year)
	Nos. of Case	Rating	Nos. of Case	Rating	
Water Quality	39 (by WASA: 27)	19, Positive, Other test OK (portion analyzed by WASA)	71 (by WASA: 61)	37, Positive, Other test OK (portion analyzed by WASA)	110 (55month) Inspected by WASA: 91

6.4.3 Present Correspondence Situation

(1) O/M

a) Complaint Receptionist

The procedure of the complaint receptionist which each SD (Sub Division) is carrying out, and repair work is shown below.

i) Complaints from a citizen have phoned to the complaint reception located in all Sub divisions and /or WASA Head Office, Complaint Monitoring Cell called.

ii) The received complaints have record in the SD's ledger in handwriting immediately. Immediately, the WASA personnel investigate the spot, and then, by the report, SDO (Sub division officer) determines arrangements of required equipments, and the repair method as well as the priority of repair work. The article indicated in the existing ledger is shown below.

- The date and time of a receptionist.

- A name, an address, a telephone number.
- Description of a claim.
- The completing date of repair work, the comment on the field work.

The form of the existing ledger is shown in **Table 6.37**.

Table 6.37 Form of Existing Ledger

COMPLAINT REGISTER
WATER AND SANITATION AGENCY (LDA) LAHORE
COMPLAINT MONITORING CELL (MISRI SHAH , RAVI TOWN)

S.No of CMC	Date	Name of complainant and telephone no.	Address	Nature of Complaint	Concerned Sub Division	Sub Division's complaint no.	Action taken

iii) SDO issues a Slip of Three-sheet impression, for construction directions.
One sheet is for site supervisor to implement the repair work, one sheet is for XEN to arrange the vehicles, and one sheet is for SD's reception Center to keep the original record. Repair work is carried out according to directions of this Slip. Article indicated in the existing Slip is shown below.

- Date of issue, time, job #,
- Name, an address, a telephone number.
- Description of a claim.
- The completing date of repair work, the comment on the field work.
- A customer sign, others

The form of the existing Slip is shown in **Figure 6.10**.

SLIP FROM SUB DIVISION OFFICE (Misri Shah in Ravi Town)

Date: ________________ Name of Sub Division: ______________ Complaint Book

Time: ________________ Division: ________________________

Name & Address of Complainant: _____________________________

Book Number: ______________ Complaint Number: ______________

Action taken:	Complaint Description
Name and Signature of Complaint Recipient	Name of Worker (WASA): Time to Start Departure Work Name of Person Preparing Complaint Slip

Figure 6.10 Existing Slip Form (Three-Sheet Impression)

b) Example of Repair Work

The repair work is carried out by the following methods according to the issued Slip.

i) The basic organization of repair work

- Vacuum cars + Jetting Unit (water pressure of 15-20 kg/cm2) + Water tankers + bamboo pole + by human power.

ii) Team arrangement

- Supervisor (one person) + vehicle driver and the auxiliary (two persons) respectively + worker (three persons).

iii) Repair method

- Small-scale

  When small diameter of sewer pipe and/or choking distance is short, repair work removes a choking location by the Jetting Unit with a bamboo pole, and human power. The typical repair work of the small-scale repair work is shown below.


September 12, 2009, Krishan Nagar Gunji Buksh Town

- Large-scale

  With the sewer pipe of 300 or more and /or a choking distance is longer, repair work removes a choking location using the Vacuum car, the Jetting Unit with a bamboo pole, and human power. The typical repair work of the large- scale repair work is shown below.


September 14, 2009, Misri Shah, Ravi Town

vi) Measure against a delay of repair work

In principle, the repair work against a complaint is completed in one to two days. However, when more repair works are accumulated and /or large-scale repair work is required, and /or shortage of equipment, the day for rectify may be needed for about one week. The countermeasures in which equipments are insufficient are as follows.

- SDO requests aid from PMU (Vacuum Car & Jetting Unit).
- SDO requests borrowing of the vehicle from the neighborhood DO.
- SDO attempts extension of working hours, and strengthening of human power.
- SDO carries out holiday labor (included Sunday and national holiday).

The procedure of the present receiving complaints and implementation of repair works by Sub Division Base is shown in **Figure 6.11**.

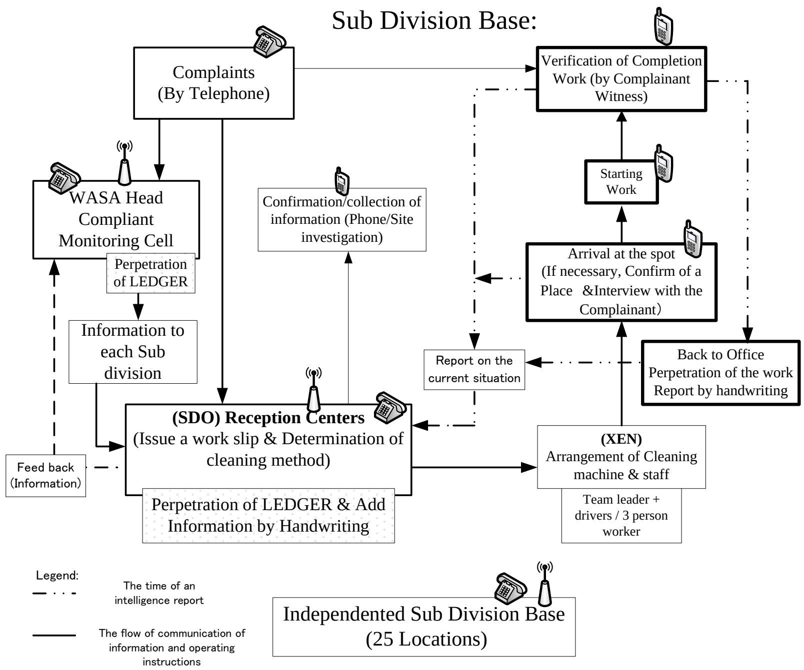


Figure 6.11 Procedure of Complaint Receptionist and Measure by Sub Division Base

<u>Case Study of Complaint Records received (At Complaint Monitoring Cell in WASA Head Office)</u>

Analysis results on the complaint ledger of Complaint Monitoring Cell are stated as below.

1) Complaint on O&M

Monthly average occurrence ratio per connection on complaint by item gathered by Complaint Monitoring Cell-1 at Gunj Buksh Town was estimated as roughly 100 connections per case.

Especially, occurrence cases on wastewater overflow by wastewater pipes are counted as high as 141 connections per case.

Major complaint items were shown as follows.

- Overflow by storm water (about 70%)

  Factors: Clogging of wastewater/storm water pipeline by the inflow of deposits/sediments resulted and thus decreasing on flow area, increasing of drainage discharge, decreasing of drainage capacity, and illegal waste disposal etc.

- Movement and missing on Manhole's cover occurred frequently, especially during rainy season (about 10.5%).

  Factors: Amount of storm water exceeded the drainage capacity and theft etc.

- Short amount of water supply (about 8.6%) and leakage (about 5.4%) during dry season.

  Factors: due to the rising of demand on tap water, critical water source, blackout, and duration extension on temporal water supply etc.

Table 6.38 shows the detail of complaints and received numbers at Complaint Monitoring Cell in WASA Head Office

Table 6.38 Complaint Records Regarding O/M Related

Descriptions	NATURE OF COMPLAINT(Received at Head Office in Gunj Buksh Town)								
2008/July	**Overflow (Sewerage Blocked)**	Water Shortage	**Manhole Cover Missing**	Manhole Ring Missing	**Water Quality**	Overflow (Drain Blocked)	**Water Supply Leakage**	Others	Total
No of Complaints(Qty)	1,206	78	176	20	71	15	80	26	1,672
% of Nature of Complaints	**72.1%**	4.7%	**10.5%**	1.2%	**4.2%**	0.9%	4.8%	1.6%	100.0%
2009/Jan	**Overflow (Sewerage Blocked)**	**Water Shortage**	**Manhole Cover Missing**	Manhole Ring Missing	**Water Quality**	Overflow (Drain Blocked)	**Water Supply Leakage**	Others	Total
No of Complaints(Qty)	524	66	63	14	39	6	41	11	764
% of Nature of Complaints	**68.6%**	**8.6%**	8.2%	1.8%	**5.1%**	0.8%	5.4%	1.4%	100.0%
Total of Complaints per 2 Months (2008 & 2009)	1,730	144	239	34	110	21	121	37	2,436
Ave. Number of Complaints per Month	865	72	120	17	55	11	61	19	1,218
Ave. % of Nature of Complaints per Month	**71.0%**	5.9%	**9.8%**	1.4%	**4.5%**	0.9%	5.0%	1.5%	100.0%
Total No. of Connections (Qty)	**122,143**								
Ave. Complaints Received per Connection per Month	**141**	**1,696**	**1,022**	**7,185**	**2,221**	**11,633**	**2,019**	**6,602**	**100**

Source: Complaints Monitoring Cell WASA Head Office, May, 2009

(2) Water tariff and Revenue

1) Breakdown on complaint

<u>Complaint items were classified as below.</u>

a) Misunderstanding on water consumption due to shortage of water meter
b) Insufficient management on water utility ledger
c) Office process mistake on water utility ledger
d) Office process mistake from meter reading up to billing
e) Insufficient communication between customers and WASA

<u>Major causes were stated as below.</u>

a) Computerized slow-up on complaint response ledger and insufficient analysis on causes

b) Determination and insufficient units of automated office (AO) managing water service ledger

c) Computerized slow-up on meter reading/billing system

d) Slow-up on installation and improvement of water meters

e) Insufficient representation on written-down items of service connections application/water tariff bill

f) Poor relationship between the item on water tariff and service connections application

g) Insufficient disclosure/public relations on information

Table 6.39 shows the details of complaint records (see **Appendix 6.4.2** for details).

Table 6.39 Details of Complaint Records

Sr. No.	Descriptions	% of Items complained
1	Adjustment of Incorrect Debit	1.5%
2	**Adjustment of Surcharge**	**6.9%**
3	Change of ARV(Annual Rental Value) & Plot size	0.6%
4	**Change of Connection / Category**	**4.7%**
5	**Change of Name/Address/Property #**	6.7%
6	Consumer Receive more than one bill	0.5%
7	**Conversion (Un-meter to Metered)**	**17.1%**
8	Correction of Name /Address / property #	2.5%
9	Disconnection on Request	3.9%
10	**Incorrect Ave. Charge**	**13.5%**
11	**Incorrect Credit Charged**	**9.1%**
12	**Installation/Charge of Meter (Charge)**	**13.1%**
13	Installation/Charge of Meter (No Charge)	0.1%
14	Installation of Test meter	2.4%
15	No Sewer/Connection at Site	3.6%
16	Payment not Accounted for double-Payment)	1.3%
17	**Payment of Wrong Bill (Wrong Mailing Addrr)**	**6.4%**
18	**Reconnection on Request**	**5.2%**
19	Revision of Bill on Actual Read	0.6%
20	Wrong Meter Reading	0.1%
21	Wrong Meter Size & Type	0.0%
Grand Total		100.0%

(3) Water quality

1) Complaint of Tap water quality

Major complaint items were stated as below.

- Water quality contamination (about 4.5%)

  Factors: damage on distribution pipe, wastewater reverse-flow, occurrence of turbidity and abnormal odor etc.

- Complaint cases increased roughly 1.8 times of the same during dry season.

  Factors: Water quality contamination caused by increase of leakage place where water pipe intersects with wastewater/storm water pipes due to inundation flooding and the wastewater reverse-flow from the leakage place at the joint of distribution pipe and service pipe during the suspension on water supply hours (while service pipe under negative pressure or low pressure).

2) Laboratory results s on tap water quality

Complaint occurrence time

Water quality abnormality to be noticed from odor/color and complaint was thus reported. Occurrence time-zone is always concentrated after the suspension of water supply at night and the time-zone (4:00-5:00 a.m.) to resume the water supply in the early morning.

Water sampling of specimen

Water quality inspection based on the complaint information to be carried out by sampling the specimens from the on-the-spot water tap around 10:00-11:00 am together with the confirmation tasks on sampling sites due to the shortage of sampling vehicles within the normal office hours of WASA. The specimen was immediately analyzed by the water quality laboratory of WASA.

In addition, the water quality may differ from the same occurred at that time because the sampling of specimen lagged behind the complaint occurrence time.

Result of analysis

With regard to the analyzed results by laboratory, abnormality on major items was not found except Coliform. The inspection results on Coliform by WASA's laboratory are clear with positive of 70% and 61% during dry and rainy seasons respectively. However, it can be considered that all of the reported cases may potentially cause the waterborne infection taking the time lag on sampling of specimens into account.

With regard to water quality during dry season and rainy season, see **Appendix 6.4.1**.

(4) Problem Analysis

A lot of complaints by phone in term of O&M and water tariff/billing occurred. However, complaint response request to the relevant O&M organizations was orally instructed by phone or radio because the response ledgers utilized handwritten note for registry. On the other hand, valuable voice from town people was not processed statistically.

Consequently, it caused the following problems.

- Customer's complaints/needs cannot be grasped by figures.
- Complaints made nothing for operation judgment data due to without statistical processing on complaints.
- It took time to grasp the fact relevance on complaints.
- Mistake/misunderstanding/transmit miss etc. by oral instructions occurred.
- Confidential relationship between customer and WASA may detract if the response was behind time.
- Background on repair results, response methods and response results were unclear.

As a countermeasure, promotion on information-sharing by personal computer processing system for the complaint ledgers within each office is required. In addition, telephone is fundamental for information verification if an emergency arises.

6.5 Public Relations

Public relations officer of Planning & Evaluation Department and other two staff are in charge of public relations. In addition, Director of Planning & Evaluation Department is an official spokesperson of WASA.

(1) Past Campaign Theme

The respective theme on campaign were mostly relevant cases such as water quality contamination prevention, water saving, restriction on O&M, environmental pollution prevention, improvement on collection ration of water tariff and customer's service, disasters prevention, and improvement of WASA image etc.

Champaign contents, for example, were the prevention on discharge of untreated effluent/leakage of waterworks, garbage disposal into the waterway, 30% discount on water tariff, installation of charge-free public water taps to thirty (30) tube-wells, cleanup of domestic water tanks, accidental prevention caused by unimproved sewerage manhole, and notice on illegal pumping-up by booster pump from service pipe etc.

The next two campaigns were implemented because the tap water contamination became serious due to the damage of service pipeline network and leakage especially to be concentrated in the period from March till September.

a) To boil the domestic tap water with two (2) minutes
b) To positively inject the chlorine agents

(2) Media

Champaign was implemented by media at a frequency of three (3) times per year.

- Announcement by newspaper ad
- Announcement by FM broadcast
- Air of video by TV

(3) Internet website

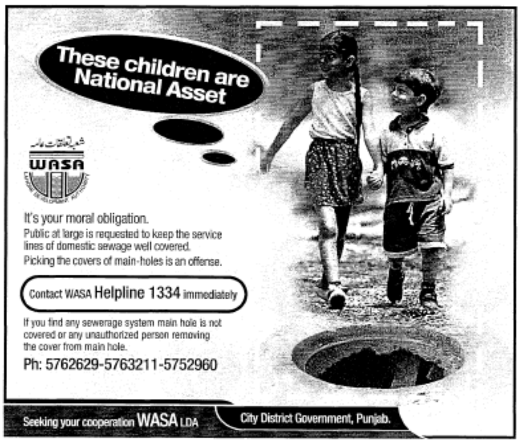
The status of information disclosure, such as management and a financial situation, and water quality, is a future subject.

(4) Enforcement of a questionnaire

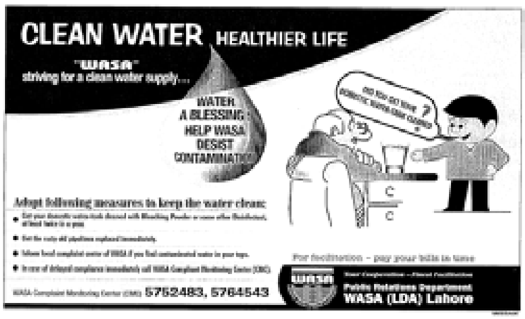
WASA in particular is not carrying out the customer satisfaction survey.

(5) The promotion plan of campaign

WASA intended to aim at the efficiency on public relations to the schools and small-scale organizations through the assistance of one mobile graphic monitor together with WASA Education Center. In addition, enrollment to the textbooks, facilities visit, regular release on water quality information, and utilization of NGO were challenges of the future.



Don't Pick the Manhole Covers



Cleaning Domestic Water-Tank

(6) Problem Analysis

A few of staff conducted public relations activities for WASA through radio station and poster drawing up/campaign. Selection on topics reflected the information of complaints. However, the requests on improvement from town people (including the young) were not reflected to business judgment.

Consequently, it caused the following problems.

- Voice (Request) of town people for business judgment was not reflected.
- Results by discussion with town people and their requests were not statistically processed.
- Trusting relationship between town people and WASA was still tenuous.
- Numerous and various complaints by town people reached.

As the countermeasures, implementation on customer's questionnaire survey, introduction on monitoring system and promotion on education to the youth are required.

6.6 Information Management

(1) Information Disclosure

Some of activity conditions by WASA were posted on the website. In addition, the improvement on management index by means of "Benchmark Indicator" was starting from 2007 as an efficient measure on management. Such values on management index were not open yet and reviewed to allow the disclosure of information in the future.

(2) Communication facilities within WASA

The correspondence procedures between Head Office and branch office were still dominated by land line. Internet was presently improved within the rooms of management level covering each district and Head Office; however, installation on office automation (OA) was still insufficient. Head Office was already equipped with internet; therefore, internet was utilized as a communication measure with governmental agencies related.

(3) Emergency Communication Equipment (UHF)

WASA's communication equipment utilized the Ultra High Frequency (UHF) line (maximum distance of calls with 10kms) of police station. Such UHF line was ensured as a communication measure to efficiently implement the storm water measures/actions and emergency situations. In addition, communication devices were equipped within the major locations (11 places) of WASA respective Town Office and the responsible official (MD, DMD, Dir. and XEN) vehicles.

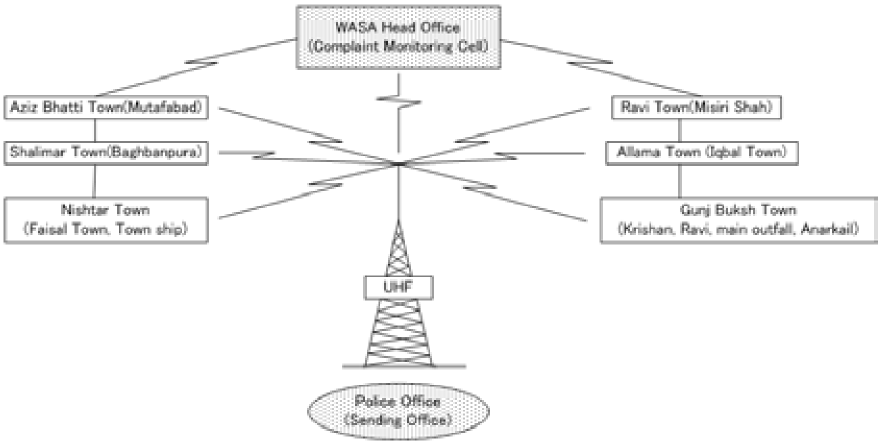


Figure 6.12 UHF Communication System

Communication Device in Office

Communication Device in Vehicles

6.7 Financial Conditions

6.7.1 Accounting/Auditing System

For preparing accounting processing system on water & wastewater, WASA prepares the financial evaluation reports including balance sheet (B/S), profit and loss statement (P/L), and cash flow sheet (C/S) for each fiscal year (1st July – 30th June) with commercial auditor (firm of chartered accounts).

(1) Accounting Standard

The point on accounting statements by WASA was completed by traditional and independent audit form. The accounting standard is mostly pursuant to International accounting standards (IAS). In addition, the above-mentioned post method which is alien to IAS was slowly improved following the pointing out by Chartered Accountants.

(2) Auditing Reporting

"Financial Statements with Attachments" prepared by WASA consist of "Auditors Report to WASA Management Signed by Chartered Accountants for Three Years Contract Basis", B/L, P/L and C/S (joint signature with three persons by MD, DMD (FA&R) and Director Finance of WASA), and the detailed financial report.

Audit documents and drawings are submitted in accordance with the request/instruction from the superior organization of WASA and approved by the WASA Management. In addition; the audit report for the fiscal year of 2004 is under discussion now-a-days, because appointment of commercial auditors under contract of 3-year was delayed in 2004.

The annual audit report of WASA accounts is approved by MD WASA and is not sent to LDA or any other office for approval as shown in **Figure 6.13**.

"Financial Statement with Accompanying Information in 2004" to the inter-agency under the application for review was cooperatively completed by Chartered Accountants and WASA. Chartered Accountants pointed out the following issues within those documents and drawings submitted for approval especially regarding such items deviated from International accounting standards. All of the points mentioned below have already been posted by WASA.

- Impairment assets were not posted yet.
- Items on inventories and current asset value were not written down.
- Among of the revenue items, recorded items on drainage income differed (Currently no Drainage charge is levied).
- Others

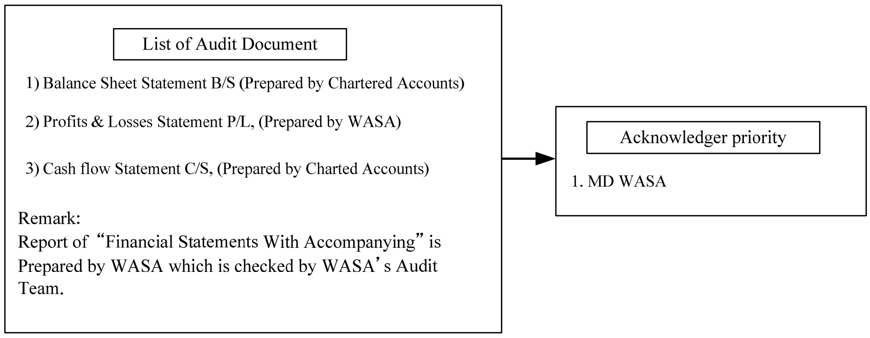


Figure 6.13 Audit Procedure

(3) Annual Budget Document

Preparation of Annual budget on projects is started approximately two months before the fiscal year starting to obtain the pre-authorization on implementation plan from the higher organization LDA/WASA until the fiscal year starting.

Figure 6.14 illustrates the procedures on approval of annual budgeting schedule.

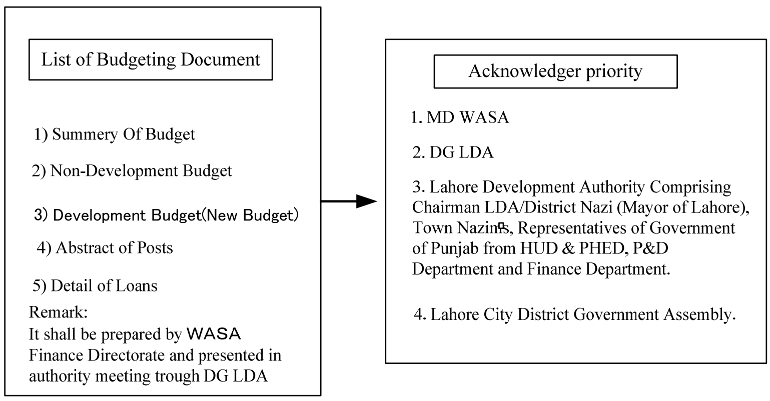


Figure 6.14 Annual Budgeting Schedule

(4) Budgeted and Financing

The approved cost of Annual Development Scheme Works are transferred into the account of WASA from the Finance Department of the Provincial Government of Punjab. The allocated budget was transferred by three methods as below.

- Money (Grant) received from the Financial Department of the Government of Punjab following the request of HUD & PHED of the Government of Punjab.
- With regard to the projects involving the private undertaking, money was directly transferred into WASA's account as the advance payment "Deposit Works".
- With regard to the insufficient amounts on O&M costs, subsidy and/or loan (no warranty, unlimited duration, and free of interest) were regularly paid to WASA from the Government of Punjab.

In addition, construction funds were transferred from the organizations related to WASA's account at the commencing time.

Figure 6.15 illustrates the flow on construction funds.

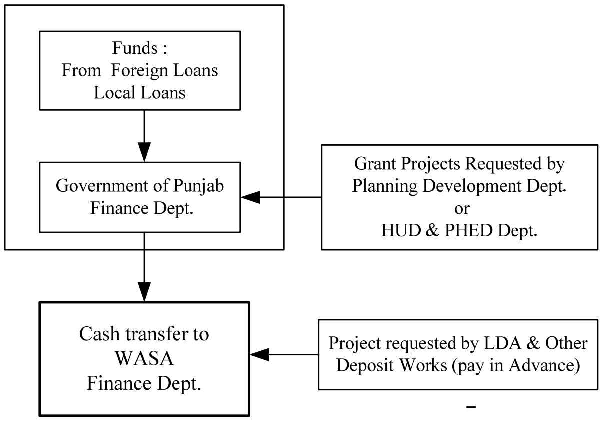


Figure 6.15 Construction Funds Schedule

6.7.2 Financial Statements

Analyzed results on the available audit financial statements by WASA were stated as follows.

(1) Balance Sheet (B/S)

Analyzed results on the available audit financial statements by WASA were stated as follows.

- Both of assets and debts in 2008 shows stable conditions with the growth of about 1.4 times in comparison to the same in 2004
- Fixed assets on water & wastewater facilities were as counted with some 65% and floating assets such as non-collecting bills and cashes etc. occupied the remaining 35%.
- Current liability and fixed liability were in the proportion of about 75%.
- Actual conditions on the governmental loan to deal with financing deficits were equivalent to those subsidies by free of interest and unlimited duration.
- Major long-term fixed liabilities were roughly counted as 20-30% including the severance indemnities.
- Current liabilities occupy approximately 40% of indebtedness and were almost the governmental loan with preferential treatment of account item.
- Assets were as estimated with about 10BRs. The risk of asset deficiency is low because of existence of existence of bounty system even the ratio on current liabilities is less than 50%.

Table 6.40 shows the change in balance sheet form presently used by WASA's financial audit (see **Appendix 6.7.1**).

Table 6.40 Change in Balance Statement Status form used by WASA's Financial Audit

WASA's Financial Audit Form(April 25, 2009)							Remarks
Description		AUDITED		PROVISIONLY/BUDGETED			2007-2008
		2003-04	2004-05	2005-06	2006-07	2007-08	% of Item of Busyness
Assets	**A Fixed Capital Expenditure**						
	Fixed Assets	4,629.15	4,820.78	4,956.51	5,120.20	5,283.89	-
	C.W.I.P	213.32	166.43	450.91	569.71	688.51	-
	Store held for Capital expense	17.12	15.41	22.82	25.67	28.51	-
	Advance for Acquisition for Land	29.49	26.19	30.14	30.47	30.80	-
	Subtotal	**4,889.07**	**5,028.81**	**5,460.38**	**5,746.04**	**6,031.70**	**59%**
	Long Term Investment	477.07	502.46	897.03	1,367.62	647.15	-
	Long Term Loan to Employees	10.75	11.03	42.64	55.11	67.58	-
	Long Term Security Deposit	14.79	15.37	15.02	15.14	15.26	-
	Deferred Expenditure	3.69	4.34	3.91	4.02	4.13	-
	Subtotal	**506.30**	**533.20**	**958.60**	**1,441.88**	**734.11**	**7%**
	B. Current Assets						
	Stores & Spare	15.40	14.72	22.48	26.02	29.57	-
	Consumers Receivables	1,078.03	1,378.68	1,361.76	1,503.63	1,645.50	-
	Current Portion of Long Term Investments	1.85	67.97	-	-	-	-
	Loans & Advances to Employees	6.95	4.55	-	-	-	-
	Prepayments & Other Receivables	146.26	283.88	148.79	150.06	151.33	-
	Bank Balances	459.01	101.01	1,052.69	2,190.63	1,571.07	-
	Subtotal	**1,707.48**	**1,850.80**	**2,585.73**	**3,870.34**	**3,397.46**	**33%**
	G.Total	**7,102.85**	**7,412.82**	**9,004.71**	**11,058.26**	**10,163.28**	**100%**
Liability/Capital	**C. Liabilities**						
	Capital Contribution	1,319.56	1,332.47	2,879.96	4,258.50	4,862.50	-
	Accumulated Loss	(5,004.21)	(5,538.27)	(6,203.21)	(6,874.74)	(7,810.62)	-
	Subtotal	**(3,684.65)**	**(4,205.80)**	**(3,323.25)**	**(2,616.24)**	**(2,948.13)**	-
	Grant	319.41	285.77	875.37	1,982.77	1,371.17	-
	Deferred Credit	380.33	512.78	385.41	387.96	390.50	-
	Subtotal	(2,984.92)	(3,407.25)	(2,062.46)	(245.52)	(1,186.46)	-12%
	D. Long Term Liabilities						
	Long Term Loans	3,569.66	3,373.67	5,436.78	5,513.07	5,589.36	**55%**
	Employees Benefits	992.89	877.16	992.88	992.88	992.88	**10%**
	Consumers & Plumbers Deposits	20.60	21.11	21.62	22.13	22.65	**0.2%**
	Subtotal	**4,583.15**	**4,271.94**	**6,451.28**	**6,528.08**	**6,604.89**	
	E. Current Liabilities						
	Current portion of long term loans	1,714.53	1,930.58	-	-	-	-
	D.W.I.P	15.24	64.43	509.52	503.56	306.95	-
	Creditors accrued & other liabilities	3,774.85	4,553.12	4,106.37	4,272.14	4,437.90	-
	Subtotal	**5,504.62**	**6,548.12**	**4,615.89**	**4,775.70**	**4,744.85**	**47%**
	G.Total	**7,102.85**	**7,412.82**	**9,004.71**	**11,058.26**	**10,163.28**	**100%**
	Source: F.A.R dep. DMD, April 25, 2009						

Remark: "Liabilities" which WASA displayed is the same word as "Capital". Here, it is displayed by "Liabilities."

For reference, **Table 6.41** shows the status fixed asset for audit of WASA.

Table 6.41 Operating Fixed Assets Status form used by 2004 Government of Punjab Financial Audit

OPERATING FIXED ASSETS (2004)

DESCRIPTION	COST			DEPRECIATION			BOOK VALUE	DEPRECIATION
	As at 01 July 2003	Additions	As at 30 June 2004	As at 01 July 2003	Charge for the year	As at 30 June 2004	As at 30 June 2004	Rate %
Freehold land	243,155,819	3,710,406	246,866,225	-		-	246,866,225	-
Building on freehold land	79,043,201	4,247,519	83,290,720	20,947,182	1,658,616	22,605,798	60,684,922	2 (50 years)
Tube wells	900,802,555	67,831,382	968,633,937	448,720,860	52,096,177	500,817,037	467,816,900	6.7
Sewerage pump stations	919,069,393	39,461,786	958,531,179	424,998,394	50,207,712	475,206,106	483,325,073	6.7
Drains	1,291,539,103	52,803,138	1,344,342,241	119,809,457	17,382,146	137,191,603	1,207,150,638	1.3
Pipelines:								
Water	757,167,073	123,710,253	880,877,326	273,349,465	22,686,803	296,036,268	584,841,058	2.5
Sewerage	1,706,670,359	197,231,198	1,903,901,557	370,549,442	38,892,778	409,442,220	1,494,459,337	2
Mobile equipment	183,141,450	12,639,500	195,780,950	127,014,488	12,990,799	140,005,287	55,775,663	10
Office furniture and equipment	26,443,824	403,767	26,847,591	20,699,578	1,499,258	22,198,836	4,648,755	10
Vehicles	80,166,505	19,108,850	99,275,355	80,166,505	-	80,166,505	19,108,850	20
Computer equipment	9,189,389	536,180	9,725,569	3,920,371	1,336,420	5,256,791	4,468,778	20
2004 Rupees	6,196,388,671	521,683,979	6,718,072,650	1,890,175,742	198,750,709	2,088,926,451	4,629,146,199	
2003 Rupees	5,774,942,323	421,446,348	6,196,388,671	1,706,747,265	183,428,477	1,890,175,742	4,306,212,929	

(2) Profit-and-Loss Statement (P/L)

1) Balance Statement

Analyzed results on the available audit financial statements by WASA were stated as follows.

- As a result of water & wastewater tariff revision (some are raised with 40%) on May 2004, operating revenue (including non-operating revenue and special profit) in 2008 increased with approximately 1.4 times (1.7BRs) of the same in 2004, and thus operating revenue was temporarily improved. However, the balance of revenue with expense got worse due to the escalation on prices and payrolls as of 2008.
- Expenses rose with roughly 1.2-1.3 times of the same in 2004 due to the regular pay raise of staff (10-15%), increase on repair cost, and rising on electricity and fuel expenses.
- Interest payment shortage was counted as "Zero" because the project costs were provided free by the Government.
- The profits and costs in 2009 were 3.676BRs and 5.02BRs respectively shown in **Appendix 6.7.2**, and thus the accumulated deficits were reached 1.34BRs as shown in profit-and-loss financial statements by the fiscal year shown in **Table 6.37**.
- There exist grants-in-aid from the Provincial Government of Punjab (GOP) for the insufficient amounts if required.
- Major items by grants-in-aid mentioned above, were preferential treatment on receiving payments by grant or loan, immunity from depreciation, and reaping the

tax's allocation with about 42% (is equivalent to local allocation tax) among the Urban Immovable Property (UIP) Tax as a governmental revenue on fixed asset tax etc.

That the insufficient amounts on operating revenue were supplemented by these finances was the present situation.

In addition, the expenses budget in 2009 with the same level of project budget document in 2008 was already submitted and started from 1st July.

Table 6.42 shows the change in operating revenue after revised water tariff

Table 6.42 Change in Operating Revenue after Revised Water Tariff

Rs: in Million

Description		2003-2004		2003-2004		2005-2006		2006-2007		2007-2008		2008-2009	
		Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Revenue	Water Sales (Incl. Con. Fee)	730.1	61	987.2	60	954.0	60	985.1	60	956.5	58	1,013.0	58
	Sewerage & Drainage	457.9	39	650.7	40	637.0	40	654.4	40	689.0	42	723.0	42
	Subtotal	1,188.0	100	1,638	100	1,591	100	1,639	100	1,646	100	1,736	100
	% of Income increased	1.0	-	1.38	-	1.34	-	1.38	-	1.39	-	1.46	-

Source; Data Reviewed by Revenue Dep. April 25,2009 & May 17, 2009

Consumer receivable

Consumer receivable of rupees 1645.50 Million as mentioned in the profit and loss account table is the amount accumulated which was recoverable from defaulters.

Approximate percentages of different categories of receivables are:-

Commercial	10%
Government Organization	5%
Domestic and Others	85%

Remedy:

Major reason of accumulation of receivables is that disconnection of water of the defaulter consumers is not an effective penalty/punishment for them because unauthorized restoration of water is easier as compared to cases of other utilities like electricity and gas etc.

Among many remedial actions, stooping/blocking of sewer connections of the defaulter consumers can prove effective punishment to force them to pay the outstanding arrears but the resultant in-sanitary/unhygienic conditions are a prohibitive element.

One of the most effective remedies is to run special recovery campaigns after regular intervals and strict monitoring of the achievements of the recovery campaigns. It is, however, considered that metering of all consumers will prove to be the most fruitful method.

Table 6.43 shows the profit and loss status by fiscal year (also see **Appendix 6.7.2**).

Table 6.43 Change in Profit-and-Loss Status by Fiscal Year

(Rs.in Million)

Profit & Loss Account as on June 30, 2009					
Description (Non-Development Budget)				2007-2008 Revised	2008-2009 Budget
	-Opening Balance		(1)	0.830	(424.450)
Receipts:	Operating Revenue	- Water Sales	(2)	956.500	1,013.000
		- Sewerage Charges	(3)	689.000	723.000
		Subtotal	4=(1+2+3)	1,645.500	1,736.000
	Nonoperting Revenue	- Miscellaneous	(5)	173.750	174.300
		Subtotal	6=(4+5)	1819.250	1910.300
		- UIP Tax Share	(7)	360.300	365.000
		- Payment by FD for Power bills	(8)	102.270	-
	RECEIPTS DURING THE YEAR		9=(6..8)	2,281.820	2,275.300
	TOTAL RECEIPTS		**10=(1-9)**	**2,282.650**	**1,850.850**
Expenditure:	Operating	- Payroll & Payroll burden	(11)	860.800	1,015.500
		- Repair & Maintenance	(12)	577.000	663.500
		- Lighting, Power & Energy	(13)	1,175.200	1,411.200
		- Other Expenses	(14)	94.100	106.000
	TOTAL OPERATING EXPENDITURE:		**15=(11..14)**	**2,707.100**	**3,196.200**
SURPLUS / (DEFICIT) BEFORE DEBT SERVICE			16=(10-15)	(424.450)	(1,345.350)
DEBT SERVICE:			(17)	0.000	0.000
Loss B/F			18=(16-17)	**(424.450)**	**(1,345.350)**
Accumulated Loss			-	**-424**	**-1,770**

Source: Finance Administration /Revenue Det DMD May 15, 2009

- The project operation with chronic deficits continued because the revision on water tariffs from 2004 up to nowadays was unacceptable. Accordingly, it was anticipated that approach for debt write-offs may be carried out in the same way as previous case in due time.

Major further causes may press against the finances in the future were stated as below.

- The condition that the expenditures cannot be complemented by the amounts of revenue may continue if fare hike were not made true.
- Appreciation on O&M cost
- Cost increasing on naturalistic environment and securement of water sources and deterioration on raw water quality because the natural/social condition surrounding the waterworks projects was getting worse year after year.
- Furthermore, water supply cost may rise suddenly in the future by the influence of inefficiency on water service area.

Table 6.44 and **Figure 6.16** show the details and change on the accumulated deficits and the change of loss by fiscal budget, respectively.

Table 6.44 Change in Deficit Status

					Rs. In Million	
Descreption	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Loss for the year	763	534	51	424	921	-
Loss Brought from Last Year	4,241	5,004	5,538	0	424	1,345
Accumulated Deficit	5,004	5,538	5,589	424	1,345	-
Source; Data Reviewed by Revenue Dep. April 25,2009 & May 17, 2009						
Note: 2005-2006 revived Special Assistant from GOP						
WASA received Special Preferential treatment from OGP at 2006 year						

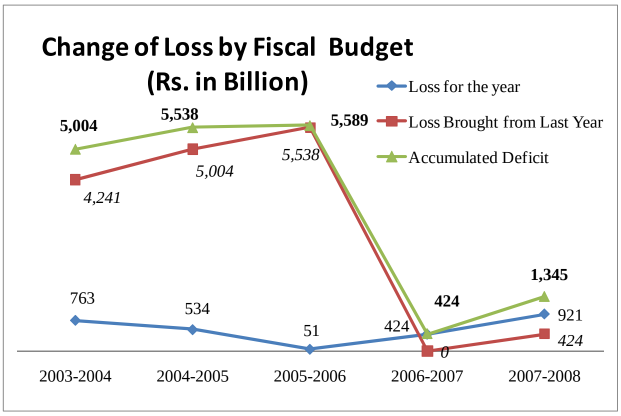


Figure 6.16 Change of Loss by Fiscal Budget

2） Total Revenue and Expenditures

a) Water and Wastewater

The following results were analyzed by the data available obtained from WASA.

Total water works operating revenues to be assumed in the fiscal year of 2007-2008 increased some 10% mainly with the increment of water collecting ratio by contrast with the same in 2006-2007.

Table 6.45 shows the trend on total water operating revenues by fiscal year.

Table 6.45 Trend in Total Water Operating Revenues by Fiscal Year

Sr. No.	Description (Rs.in Million)		2006-07 Actual	2007-2008 Budget Estimates	2007-2008 Actual up to 3/06	2007-2008 Revised Estimates (360MGD)	2008-2009 Budget Estimates (354MGD)
	I. WATER SALES:						
1	- UNMETERED SALES	(Demand)	316.5	303.0	277.7	301.8	295.5
2	- METERED SALES	(Demand)	665.6	680.0	493.7	715.5	750.0
3	WATER SALES FOR THE YEAR	(1+2)	982.1	983.0	771.3	1,017.3	1,045.5
4	- LESS UNCOLLECTABLES:		-225.1	-197.0	-231.4	-228.3	-215.0
5	NET COLLECTION-CURRENT DEMAND	(3-4)	757.0	786.0	539.9	789.0	830.5
6	COLLECTION OUT OF ARREARS		147.5	160.0	72.8	165.0	180.0
7	TOTAL WATER COLLECTION	(5+6)	904.5	946.0	612.7	954.0	1,010.5
8	NEW CONNECTION FEE		3.0	3.0	2.0	2.5	2.5
9	ACQUIFER CHARGES-WATER		0.0	0.0	0.0	0.0	0.0
10	**TOTAL WATER SUPPLY:**	**(7+8+9)**	**907.5**	**949.0**	**614.7**	**956.5**	**1,013.0**
	% of increasing		1.00	1.05	0.68	1.05	1.12
	Source: Revised "Budget 2008-09" WASA/ LDA						

b) Sewerage System

Total sewerage operating revenues to be assumed in the fiscal year of 2008 were the same as the total revenues by water business.

Table 6.46 shows the trend on total sewerage operating revenues by fiscal year.

Table 6.46 Trend in Total Sewerage Operating Revenues by Fiscal Year

Sr. No.	Description (Rs.in Million)		2006-07 Actual	2007-2008 Budget Estimates	2007-2008 Actual up to 3/06	2007-2008 Revised Estimates	2008-2009 Budget Estimates
	II. SEWERAGE CHARGES :						
11	- UNMETERED SALES	(Demand)	215.8	207.0	197.3	208.5	200.0
12	- METERED SALES	(Demand)	438.6	452.0	338.8	472.0	496.0
13	TOTAL SEWERAGE SALES FOR THE YEAR	(11+12)	654.4	659.0	536.0	680.5	696.0
14	- LESS UNCOLLECTABLES:		-150.4	-132.0	-160.8	-149.5	-146.0
15	NET COLLECTION-CURRENT DEMAND	(13-14)	504.0	527.0	375.2	531.0	550.0
16	COLLECTION OUT OF ARREARS		124.5	130.0	51.4	132.0	145.0
17	TOTAL SEWERAGE COLLECTION :	(15+16)	628.5	657.0	426.6	663.0	695.0
18	- ACQUIFER SEWER		26.9	25.0	12.2	23.0	25.0
19	SubTotal	(17+18)	655.4	682.0	438.8	686.0	720.0
20	SEWER CONNECTION FEE		4.2	4.5	3.2	3.0	3.0
21	**TOTAL SEWERAGE :**	**(19+20)**	**659.6**	**686.5**	**441.9**	**689.0**	**723.0**
	% of increasing		1.0	1.0	0.7	1.0	1.1
	Source: Revised "Budget 2008-09" WASA/ LDA						

c) Major Costs

Analyzed results on the data available from WASA were stated as follows.

The items on major costs were consisted of payroll, repair costs on vehicles, tube-wells, and sewage pumps, and electricity charge.

- Electricity charge and payroll occupied over 43% and 30% of the total costs respectively for each fiscal year.
- Power consumption during rainy season was 1.5 times of the same during dry season owing to the wastewater pumps were running at capacity.

In addition, appreciation on electric power costs was considered to be caused by the decreasing on efficiency of facilities and increasing on wastewater/storm water volumes.

Table 6.47 shows the details on O&M costs by fiscal year (see **Appendix 6.7.3**).

Table 6.47 Details on O&M Costs by Fiscal Year

				Rs in Million
Non-Development Expenditure	2007-2008		2008-2009	
Description	Amount	% of Change	Amount	% of Change
Power and Enegy	**1,175.20**	**43.4%**	**1,411.20**	**44.2%**
Payroll & Burden	860.8	31.8%	1,015.50	31.8%
Repair & Maintenance	577	21.3%	663.5	20.8%
Other Expenses	94.1	3.5%	106	3.3%
Total Expenditure	2,707.10	100.0%	3,196.20	100.0%

4) Breakdown on Cost Indexes

Analyzed results on the data available from WASA were stated as follows.

Rise ratio on cost for the fiscal year of 2007-2008 was estimated roughly 17%.

Fluctuation ranges on each subject were shown as below.

- Electricity cost raised with about 20% (variable cost)
- Payroll raised with about 16% (fixed cost)
- repair cost raised with about 15% (variable cost)
- Business equipment/materials risen with some 10-30%
- Average on other costs raised with about 13%

Especially, payroll of fixed cost went increase roughly 20% in comparison to the same of previous fiscal year.

Appendix 6.7.4 shows the details on O&M costs by fiscal year.

(3) Cash Flow (C/S)

The format that can indicate the change on monthly revenue and expense to necessarily investigate the status cash flow was not available.

Cash flow by WASA was evaluated from the WASA's audit format and year-end cash conditions on the respective project.

Present situation was stated as below.

- With regard to the insufficient amounts on O&M Costs, special funds such as loan (free of interest) and subsidy were supplied/extended to WASA.
- The insufficient amounts on construction costs can be made ends meet at the end of the fiscal year through the reviewing on budget in the middle of year because there exists the assistance by GOP such as subsidy in view of the course of the year.
- Countermeasure against cash flow deterioration caused by account cash shortage was postponed due to the increasing on sum of money owing such as fuel and electricity bills.
- Insufficient amounts on O&M costs were by finally appropriated subsidy.
- Some cash will be saved and kept for contingencies to the balance of bank account.

Table 6.48 shows the cash flow used by the Provincial Government of Punjab financial audit in 2004.

Table 6.48 Cash Flow Status Used by 2004 Punjab Government Financial Audit

WATER AND SANITATION AGENCY
LAHORE DEVELOPMENT AUTHORITY
CASH FLOW STATEMENT FOR THE YEAR ENDED 30 JUNE 2004

	2004 Rupees	2003 Rupees
CASH FLOWS FROM OPERATING ACTIVITIES		
Net loss for the year	(763,208,745)	(1,301,148,877)
Adjustments of non-cash and other items:		
Depreciation	198,750,709	183,428,477
Amortization of deferred cost	587,087	547,791
Amortization of deferred credit and grant	(20,816,274)	(16,361,944)
Interest accrued on provident fund contribution	-	15,463,241
Provision for staff retirement benefits	28,000,000	834,405,738
Allowances for uncollectible	25,738,871	82,452,110
Amortization of investments	(77,633,703)	(79,213,258)
Provision for receivable against robbery case	1,353,687	-
Provision for slow moving items	-	9,494,096
Financial charges	529,407,138	434,001,179
Gain on sale of fixed assets	-	(748,000)
	685,387,515	1,463,469,430
OPERATING PROFITS BEFORE WORKING CAPITAL CHANGES	(77,821,230)	162,320,553
(Increase) / Decrease in current assets		
Stores and spares	13,349,533	(16,862,950)
Consumer receivables	(220,004,558)	(181,616,656)
Loans and advances to employee	(3,031,718)	2,547,077
Prepayments and other receivable	(92,179,153)	(47,243,852)
	(301,865,896)	(243,176,381)
Increase / (Decrease) in current liabilities		
Creditors, accrued and other liabilities	550,406,003	56,846,448
Deposit work-in-progress - Net	19,593,567	(10,680,968)
	569,999,570	46,165,480
NET CASH FLOW FROM THE CHANGES IN WORKING CAPITAL	268,133,674	(197,010,900)
CASH GENERATED FROM OPERATION	190,312,444	(34,690,347)
Financial charges paid	(712,439)	(782,895)
Consumers and plumbers deposits	442,101	303,899
Retirement benefits paid - net	(16,959,834)	(19,024,018)
NET CASH FLOW FROM OPERATING ACTIVITIES	173,082,273	(54,193,361)
CASH FLOWS FROM INVESTING ACTIVITIES		
Long term investments - net	4,349,536	-
Long term security deposits	(818,935)	(490,601)
Capital expenditure incurred	(488,699,273)	(553,254,229)
Long term loans to employees	(500,300)	(903,709)
Deferred expenditure	(392,562)	(2,764,306)
Proceeds from sale of fixed assets	-	748,000
NET CASH USED IN INVESTING ACTIVITIES	(486,061,934)	(556,664,845)
CASH FLOWS FROM FINANCING ACTIVITIES		
Receipt for capital contribution	17,705,397	5,381,682
Grant received during the year	92,483,809	191,637,382
Deferred credit	-	57,327,704
Long term borrowings - obtained	347,000,000	377,000,000
NET CASH FLOW FROM FINANCING ACTIVITIES	457,189,206	631,346,768
NET INCREASE IN CASH EQUIVALENT	144,209,545	20,488,562
CASH AND CASH EQUIVALENT AT THE BEGINNING OF THE YEAR	314,795,783	294,307,221
CASH AND CASH EQUIVALENT AT THE END OF THE YEAR	459,005,328	314,795,783

The annexed notes form an integral part of these financial statements

MANAGING DIRECTOR	DEPUTY MANAGING DIRECTOR (F A & R)	DIRECTOR FINANCE

(4) Business Conditions

Financial conditions on water & wastewater utilities were shown with common concepts as below because water system, wastewater system, and cleanup business on water conduits were not respectively managed.

Managing conditions in the fiscal year of 2007-2008 were shown as below.

- Water supply costs (7.58Rs/m^3) were about 1.5 times of unit price of water supply (5.09Rs/m^3).
- Expenditures exceeded amount revenue, and accumulated deficits show upward trend.
- Ineffective water volume showed gradual downward trend. On the other hand, accounted-for water demonstrated a modest upward trend.

- Accounted-for water was as estimated roughly 312m^3/head/day to the employees (2,925 persons) in charge of waterworks concerned in the fiscal year of 2006-2007.

Table 6.49 and **Table 6.50** show the variation in management indexes and water loss respectively.

Table 6.49 Variation in Management Indexes

Description	2006-2007	2007-2008	2008-2009 Assumption	Remarks
Cost of Water supply per Revenue Water (Rs/m3)給水原価	7.20	7.58	9.13	-
Unit Price of Water Supply per Revenue Water (Rs/m3)供給単価	5.02	5.09	5.46	-
Ratio of Cost of Water Supply per Unit price of Water Supply(Times)	1.4	1.5	1.7	-
Total Operating Expenditure (MRs/year)	2281.82	1,850.85	1,850.85	-
Total Operating Receipts (MRs/year)	2,707.10	3,196.20	3,196.20	-
Operational Loss(MRs)	-425.28	-1,345.35	-1,345.35	-
Accumulated Loss(MRs)	-425.28	-1,770.63	-3,115.98	-
Total (NonDeve. & Development) Receipts(MRs/Year)	4,983.49	3,676.31	-	-
Total (NonDeve. & Development) Expenditure(MRs/Year)	5,078.37	5,021.66	-	-
Surplus/Shortfall(MBs)	-94.9	-1,345.4	-	-
Change of Total No. of Water Connection per Employee(m3/Employee/d)	82	94	97	Poor
Unit Revenue Water per Water's Employee(m^3/Employee/d)	312	-	-	Poor
Water Production per Water's Employee(m3/Employee/d)	544	-	-	Poor
Water Connections per Water's Employee(Nos./Employee)	183	-	-	Poor

Source: Selected the Benchmark Indicator, WASA's Planning & Evaluation Dep April 30, 2009 and Updated

Table 6.50 Variation in Water Loss

S.No.	Rate of water utilization	INDICATOR(Financial Year)		
		2006-2007	2007-2008	2008-2009 Assumption
10-1	Unaccounted for Water(UFW),MGD	125.2	120.7	112.0
	Unaccounted for Water(UFW), Mm^3/d	0.569	0.549	0.509
10-2	**Revenue Water(RW),MGD**	**200.9**	**215.3**	**211.0**
	Revenue Water(RW), Mm^3/d	**0.913**	**0.979**	**0.959**
10-3	Non Revenue Water(NRW),MGD	24.0	24.0	31.0
	Non Revenue Water(NRW), Mm^3/d	0.109	0.109	0.141
10-4	Accounted for Water(AFW), MGD	(201)	(223.5)	(211)
	Accounted for Water(AFW), Mm^3/d	0.913	0.979	0.959
Total	Water Production, MGD	350.0	360.0	354.0
	Water Production, Mm^3/d	1.591	1.637	1.609
10-5	**% of UFW**	35.8	33.5	31.6
10-6	% of AFW	64.2	66.5	68.4
10-7	% of NRW	42.6	40.2	40.4
10-8	**% of RW**	**57.4**	**59.8**	**59.6**

Source: Selected the Benchmark Indicator, WASA's Planning & Evaluation Dep April 30, 2009 and Updated

(8) Problem Analysis

Existing financial statements were being slimed on water & wastewater system.

Consequently, it caused the following problems.

- Expenses bring pressure to bear on the operation by sector was unaccounted-for.

As a countermeasure, enforcement on expense control is required through preparing the expense breakdown by waterworks sector, wastewater sector and storm water/wastewater sector respectively.

6.7.3 Water Tariff

Sewerage charge was defined in accordance with the water consumption on waterworks following the beneficiary-to-pay principle and was charged to the user together with water tariff. Tariffs were paid by fixed charge (old district: area without installation obligation on water meter) in combination with commodity charge (water consumption: water meters).

Charge list on water and sewerage by WASA was revised (Registered No.L-7532, 1st May 2004) in eight (8) years on April 2004 since 1998 (Registered No.L-7532, 1st January 1998). Government of Punjab always takes a cautious attitude to the price-raising on tariff by water supply as the backbone infrastructure and places emphasis on measures to purposefully hold down such charge comparing the raised range on other public utility charges (gas and electricity). As a result, approved tariff raising ratio was on the order of roughly 40% against the 100% raising request by WASA.

WASA applied the revision application on tariff to LDA ever year; however, GOP (LCD) does not approve such application. In addition, tariff revision by rising with 70% on July 2008 was also applied to LDA; however, such application was not approved yet.

In addition, background on tariff hike request by WASA was as shown on **Table 6.51** according to interview.

Table 6.51 Change on Requested Charge Water Tariff

Date	Increase in Price Rate (WASA's proposal)	Approved Price Rate
April 2004	70% Up	40%
June 2006	70% Up	Rejected
June 2007	70% Up	Rejected
June 2008	70% Up	Rejected

Tariff was revised by the following procedures.

- WASA completed the solicitation document on tariff hike.
- In this regard, WASA obtained the figures of ARV from Ministry of Excise & Taxation.
- Application on tariff hike with an approval of WASA's DM will be submitted to LDA.
- LDA negotiates with PDD and HUD&PHED on the said tariff hike solicitation documents.
- Final approval will be determined by the Government of Punjab (LCD)..

Figure 6.17 illustrates the flow on approval/documents to revise water tariff.

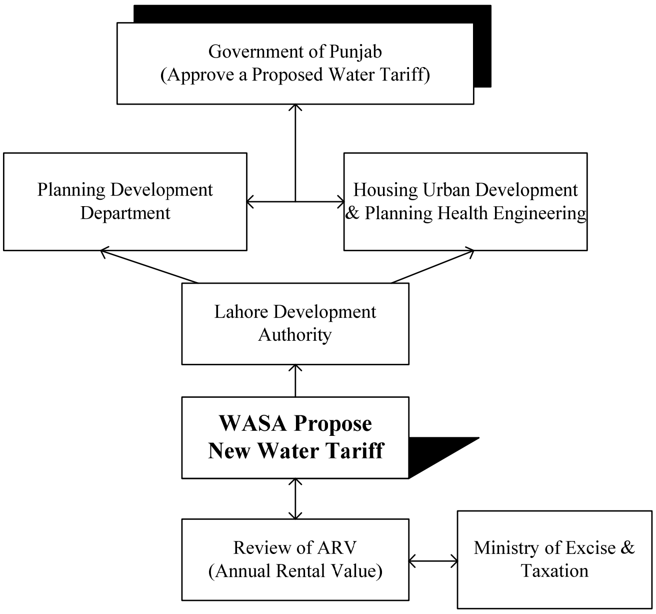


Figure 6.17 Approval Schedule of Water Tariff

The following major items were added and revised to the water tariff approved in 2004 by imitating the version in the fiscal of 1998.

- Aquifer charge was abandoned.
- Connection fees for Quaid-E-Azam Town were added.
- Some tariffs increased with some 40%.
- Meter connections of commercial water was segmented into A, B, C, D, and E.

In addition, for tariff see **Appendix 6.7.5** (1998) and **Appendix 6.7.6** (2004).

(1) Composition of Water Tariff (see **Appendix 6.7.7**)

(2) Estimate Method on Billed Amounts of User Charge (see **Appendix 6.7.8**)

(3) Terminology Definition on Tariff (see **Appendix 6.7.9**)

(4) Problem Analysis

Connection application items and unit price were not specified in the regulation on water tariff. In addition, presentment and term’s definition on water tariff were ambiguous.

Consequently, it caused the following problems.

- Customers cannot verify the breakdown on water tariff bill by themselves.
- Customers cannot estimate the connection expenses beforehand.
- A lot of complaint/inquiry cases on water tariff occurred.
- Tasks on compliant response window were congested due to the deficient knowledge by employees
- Paperwork was not in time.

As the countermeasures, updating on water tariff bill, reinforcement on employee education and enhancement on paperwork computerized are required.

6.7.4 Revenues by User

(1) Revenues by User

With regard to water consumption by users, it was estimated that domestic water occupied roughly 85% and commercial water occupied the remaining 15% among the collected water volume (about 1,900,000m3/day) including the water used by WASA and other well water. In addition, Average revenues per meter by users were as estimated with 3,474Rs to be collected from domestic water and 8,620Rs to be collected from commercial water respectively.

Collection ratio on the tariff amounts against the amounts billed was approximately 83%.

Table 6.52 shows the water consumption and revenues per connection by users.

Table 6.52 Water Revenues per Connection by Users (2008-2009)

Name of Towns	Un-Meter	Metered			Total
		Domestic	Commercial	Total	
4) Amount of water for Billing (m3/day)	567,000	1,074,000	300,000	1,374,000	1,941,000
% of User	29%	55%	15%	-	100%
5) Amount of Revenue(Rs)	470,000,000	891,400,000	249,000,000	1,140,400,000	1,610,400,000
6) Ave. Revenue per Meter(Connection)(Rs/meter or connection)	**1,731**	**3,474**	**8,620**	**3,995**	**2,892**
7) Ave. Revenue from total of working Meters(Rs)	-	214,350,574	96,303,677	310,654,250	-
8) Ave. Revenue from total of Not working Meter(Rs)	-	677,049,426	152,696,323	829,745,750	-
9) % of Ave. Revenue from Not working Meter	-	**81.6%**	**18.4%**	100.0%	-
Source: WASA Finacial Dep, 22 April, 2009					

(2) Problem Analysis

It is difficult to figure out the accurate water consumption on respective utilization due to insufficient service water meters. In addition, water consumption on industrial use cannot be counted because operation was sometimes halted caused by the influence of economy. Furthermore, the estimation basis also differed accompanying the inhabitant’s emigration/ migration (change-of-residence).

Consequently, it caused the following problems.

- Accurate water consumption cannot be figured out.
- Equitable tariff liability was lacking.
- Fundamental data to study the water tariff hike were insufficient.
- Revision/updating on administrative data were behind time.
- A lot of complaint cases occurred.

As the countermeasures, installation on water meters and enhancement on processing by personal computer for the administrative data are required.

6.7.5 Meter Reading and Tariff Collecting

(1) Numbers on Meter Reading

Numbers on meter reading with connected pipes in the area under jurisdiction of WASA were as estimated with about 285,500 (see **Table 6.9**: with connecting pipes only). Among of these figures, water meters of 72,900 in proper working order were the major targets for meter reading.

Meter reading was carried out bimonthly and numbers of billing reached some 556,900 by piecing together the numbers of unmetered connections.

(2) Meter Reading Method

Meter reading jobs were respectively carried out by each town. Working hours were from 8:00 till 15:00 for six (6) days a week and twenty-four (24) days a month. Hand-written records on meter reading were delivered to the office once a week and were transferred into the personal computer (PC) for billing within a couple of days.

With regard to the WASA staff's numbers engaged in meter reading and tariff collecting, persons in charge of meter reading were roughly 100, persons in charge of billing were some 20-30 and persons in charge of bill delivery were 150 respectively. Bills will be directly delivered to each customer's residence bimonthly. The portable on-the-spot device "Handy-terminal" ordinarily used by developing countries for issuing the meter reading list was not utilized yet.

Figure 6.18 illustrates the work procedure on usual meter reading and billing.

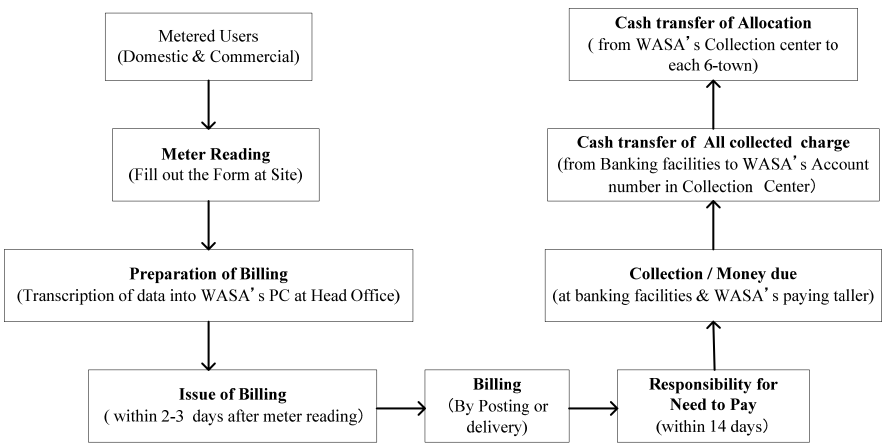


Figure 6.18 Work Procedure on Meter Reading and Billing

(3) Billing on Water Tariff and Sewer Charge

With regard to the task on water tariff, Department of Administration/Revenue of WASA conducts the meter readings, adjusting, billing, and management on money received for six (6) towns. In addition, application on water tariff will be carried out bimonthly and water tariff (including wastewater charges) bills were issued to some 556,900 households including those metered customers with approximately 286,000. **Appendix 6.7.10** shows the example of domestic water bill

(4) Collection Method on Tariff/Charge

Customers can present themselves directly to pay the bimonthly water tariffs/sewer charges to the Governmental Post Office and financial institutions such as national Bank Pakistan (NBP), Alliance Bank Ltd. (ABL), and Bank of Punjab (BOP) or via deputy-financial institution “National Database and Registration Authority (NADRA)”.

Payment should be conducted before due date, that is, within the periods (within 14 calendar days) was explicitly stated in bill. If the payment is delayed, 10% of surcharge added on it automatically.

Average revenue ratios on collection method by respective financial institution within the period of July 2008 - March 2009 were 65.5% from the banks including NADRA and 25.5% were via post offices against the total amounts with 1,198 MRs within the period of nine (9) months (270 calendar days) including commission fees.

The numbers of days to be counted on the paperwork mistakes by user’s payment and document recordings by the financial institutions were 96 calendar days (roughly 35.5%) on the average of nine (9) months mentioned above in total as shown in **Appendix 6.7.11** for any payment agencies.

Especially, the reason on numerous mistakes on paperwork by the financial institutions excluding NBP was unclear. In addition, paperwork mistakes by the financial institutions were revised and such revision on payment was conducted accompanying the results on entry confirmatory work by WASA.

Automatic payment from bank account is still not applied within the jurisdiction of WASA by reason that customers want to confirm the bill-payment receipt by themselves.

Table 6.53 shows the performance of commissioned banking facilities and number of mistakes in operation in 2008.

There are many office work mistakes on the water-bill payment collection and handling system among commission payment facilities

Figure 6.19 illustrates ratio of utilization of banking facilities.

Table 6.53 Performance and Mistakes of Commissioned Banking Facilities (2008)

Summary (July 2008-Mar 2009)		NBP	ABL (Incd.:NADRA)	BOP	GPO	Total
Status of collection	Actual Collected Revenue(Rs)	234,058,304	416,896,448	241,659,676	305,451,393	1,198,065,821
	Input Billing Amount (rs)	234,084,658	418,610,407	243,278,453	305,021,221	1,200,994,739
	Diff Amount (RS)	-26354	-1713959	-1630777	430172	-2,940,918
	Maximum Busses opening day(days)	224	224	224	224	896
	Times of Diff day (days)	21	204	113	44	382
% of diff Amount Vs Actual Vs Input		100.0%	100.4%	100.7%	99.9%	100.2%

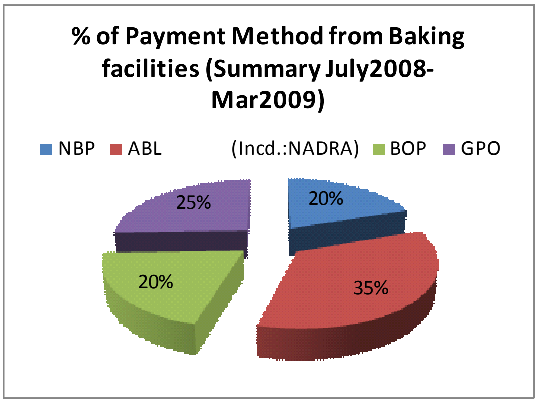


Figure 6.19 Ratios of Utilization by Banking Facilities

Figure 6.20 illustrates the flows on revenue cash flow and status of handling charge.

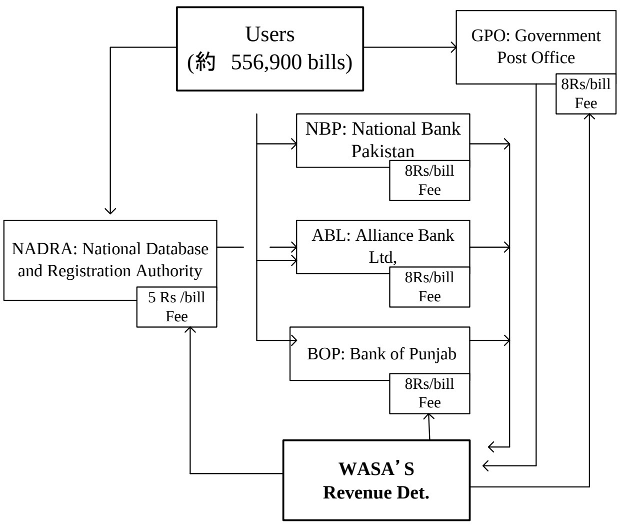


Figure 6.20 Flow of Revenue Cash Flow and status of Handling Charge_

(5) Efficiency on Collection of Tariff/Charge

Table 6.54 shows the efficiency on tariff/charge collection. In addition, efficiency on collection of tariff/charge was gradually improved by making 79.1% for the fiscal year of 2008 in comparison to the same of 77.5% for the fiscal year of 2005 resulted from the effect on pervasion (rise with about 6% estimated on December 2007 - December 2008) of connecting pipes.

Table 6.54 Trend on Efficiency on Tariff/Charge Collection

(Unit: Million Rs)

Description	2005-06	2006-07	2007-08	2008-09
Water Sales	967.973	982.1	1017.3	1045.5
Sewerage Charge	636.182	654.37	680.5	696
Total Demand	1604.155	1636.47	1697.8	1741.5
Collection Against Demand	1243.655	1287.878	1343	1405.5
Collection Efficency	77.5%	78.7%	79.1%	80.7%
Sewerage/Total Demand(%)	39.7%	40.0%	40.1%	40.0%
Water Sales/Total Demand(%)	60.3%	60.0%	59.9%	60.0%

Source: WASA finance Det. April 13, 2009 （Tariff Ratio Water (6) Vs Sewerage (4) ）

(6) Measures against Arrears

The unpaid reason by the customers was just “No money to pay” as the interview results from the person responsible for Revenue Department of WASA. WASA strengthened the collection with a view to the reminder notice forwarding, persuasion, suspension, and trial etc. As a result, improvement on slow-motion collection of arrears can be seen in comparison to the same in 2004.

Table 6.55 shows the trend on improvement of arrears.

Table 6.55 Trend on Arrears’ Ratio

(Unit: Million Rs)

Year	Un-Meter Arrears	Meter Arrears	Total Arrears	Arrears Ratio	
				Un-Meter Arrears	Meter Arrears
1998	125.919	141.652	267.571	47.1%	52.9%
1999	33.291	59.158	92.449	36.0%	64.0%
2000	33.04	53.970	87.010	38.0%	62.0%
2001	30.011	63.347	93.358	32.1%	67.9%
2002	28.708	168.356	197.064	14.6%	85.4%
2003	31.966	126.425	158.391	20.2%	79.8%
2004	30.431	120.967	151.398	20.1%	79.9%
2005	32.887	131.901	164.788	20.0%	80.0%
2006	33.526	139.332	172.858	19.4%	80.6%
2007	33.988	130.911	164.899	20.6%	79.4%
2008	35.009	134.838	169.847	20.6%	**79.4%**
Total	448.776	1270.857	1719.633	26.1%	73.9%

Source: WASA finance Det. April 13, 2009

(7) Penalty by Temporary Suspension of Water Service

Penalty by temporary suspension of water service will be conducted in case that water tariffs/sewer charges were not paid within 4 months from billing (time-limit of payment) and thus the reminder notice was dispatched. In addition, same penalty will also be put into practice on condition that WASA staff discovered the extraordinary leakage from service pipe. Payment for such duration will be monthly added by the actual average tariffs/charges in the past nine (9) months.

(8) Penalty by Suspension of Water Service

Penalty by suspension of water service will be conducted by mandatorily shut down the water tap to suspend feeding water in case that 4-month water tariffs/sewer charges were behind in payment (on the basis of time for payment) and thus the reminder notice was dispatched, and afterward water tariffs was not paid within two months.

With regard to reopen on water service, customers shall apply the reopen and water service reopens after finishing the payment on arrears, connection cost and advance payment by six-month water tariffs.

Appendix 6.7.12 illustrates the typical reminder notice.

In the 2007 and 2008 fiscal year, the number of cases which issued the reminder notice, number of recovery, and number of the suspension of water service are shown in **Table 6.56**.

Table 6.56 Records on Reminder Notice Issued

Year	Total No. of Issued	No. of Recovery		No. of Suspension of Water Service
		(100%)	(Partially)	
2007	37,525	16,486	20,356	683
2008	35,452	12,405	21,741	1,306

(9) Application on Connections with Service/Sewer Pipes

Application on connections with water pipes/sewers is simultaneously accepted by nearly 80 local offices under jurisdiction of WASA. Connection works will be implemented by a constructor under WASA's supervision and/or by WASA's staff within some 6-7 days and such cost shall be paid by beneficiary.

Service pipes were connected with water meter due to no stock on water meters. In addition, connection works on sewer pipes were implemented at the same time. Sewer/effluent was discharged into the adjacent waste pipes/drainage ditches and the final destination to be discharged is River Ravi.

Connection applicants shall purchase the application form attaching the following documents and submit to each reception window.

- Application form (paid: 2Rs)
- Applicant's ID (duplicate with signature)

- Landowner's letter of consent (ID's duplicate with signature)
- Assurance on application contents (to prevent abuse)
- Layout map (Installation location, connection site and discharged destination of waste pipe)
- Others (Payment certificate on water tariff/sewer charge by the customers with water connection within the common compound)

Application contents were consisted of the registered no. of building, caliber of service pipe, breakdown on connection costs (security, sewer connection fee, water connection fee, meter cost, and advance payment) and the consent by the applicant will be identified while applying. In addition, connecting expenses were differed according to the contract terms of connection application. Connecting expenses for domestic use were shown as below.

- Security deposit: 50Rs
- Sewer connection fees: 400Rs
- Water connection fees: 300Rs
- Meter costs: 1,032Rs
- Advance payment: 300Rs
- Total costs: 2,082Rs

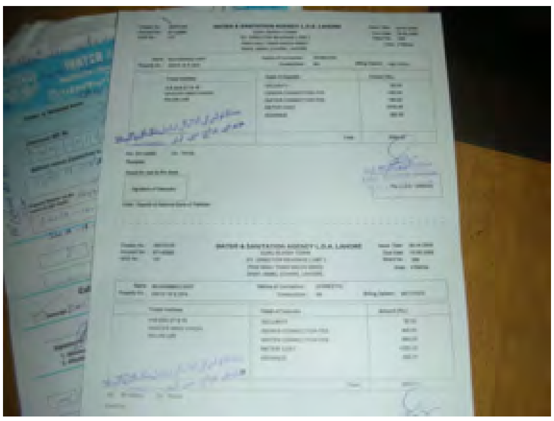
(10) Numbers on New Connections

Numbers on new connections with water service were counted with some 14,750 in the fiscal year of 2008. **Table 6.57** shows the numbers of new connections in 2008.

Table 6.57 Numbers of New Connections in 2008

July 2008-Feb 2009	Un-Metered (Qty)	Metered / Connections (Qty)			G.Total (Qty)
		Domestic	Commercial	Total (Qty)	
2008/7/1(Existing Connections)	274,361	244,954	28,657	273,611	547,972
New Connection (New Houses)	-	11,602	229	11,831	11,831
New Connection	2,914	-	-	-	2,914
Total Remained Connection	271,447	233,352	28,428	261,780	533,227
Total Number of New Connections	**2,914**	**11,602**	**229**	**11,831**	**14,745**

Typical Booking Window/Desk (4 staff)



Typical Application Form

(11) Example on Gunj Buksh Town (March-April 2009)

JICA Study Team visited the Revenue Department at Gunj Buksh Town to grasp the meter reading by WASA.

Organization was constituted by the staff with about 130 and six (6) contracted employees.

1) Numbers on meter reading and billing

Numbers on metered connections on January-February 2009 were counted as 60,409 (Measured numbers by meter in proper running order were 13,113). WASA staff count the numbers on billings and deliver billings bimonthly.

Table 6.58 shows the numbers of meter reading and billing bimonthly.

Table 6.58 Number of water Metering and Number of Billing Bimonthly

Nos.	Nos. by Meter Reading	Nos. by Package Application	Total
	60,409	61,734	122,143

2) Billing/meter reading system

Numbers on meter reading were counted as roughly 60,409 according to the data available on November-December 2008 and January-February 2009.

- Area by meter reading
  Area was divided into fifty-two (52) subareas (No.1 batch subarea-28: 1st month, No.2 batch subarea-24: next month) to conduct meter readings/billings.
- Numbers of person in charge of meter reading: Fourteen (15) persons are in charge of meter reading.
- Working hours: 8:00 - 15:00, six (6) working days a week
- Duty to report: 5-day records on meter reading are submitted to the office once a week and immediately input into PC.
- Numbers of meter reading per person 200-1,500 cases a week, on foot or by motorbike

Application A6.7.13 illustrates the typical meter reading sheet.

3) Billing on water tariff/sewer charge

- Two persons transferred the hand-written records by meter reading sheet into PC.
- Billing date/time: Bill will be delivered within a couple of days after receiving the meter reading records.
- Transferred records in PC were printed out by printer and one auditor will verify the contents.
- WASA staff of some sixty (60) directly deliver the bill to the respective customer's resident every day. Bills will be dropped into either mailbox or entrance door.

WASA's Delivery Vehicles

Reading Meters at Site with the data sheet

4) Monitoring on un-authorized connections

WASA investigates promptly on condition that the person in charge of meter readings discovered the un-authorized connections while meter reading visit and/or any un-authorized connections reported by town people. Particularly, serviced pipe to be connected with booster pump is under the ban. With regard to such un-authorized connections, booster pump was forfeited by WASA.

Booster Pump Connected to Service Pipe

Appendix 6.7.14 illustrated the typical check sheet for survey of unauthorized connection/misuse.

5) Meter reading impediment

Numbers on meter reading in proper working order occupy about 20% and the remaining 80% means the meter reading impediment caused. Among the meter reading impediment caused, some 70% were "without installation of water meters", and the remaining 2.2% resulted from the customers by "premise and absence from home" occupied roughly 70%.

Table 6.59 shows numbers on meter reading disturbance caused by meter and customers.

Table 6.59 Numbers on Meter Reading Impediment Caused by Meter and Users

Descriptions	Jan-Feb 2009(Domestic)			Jan-Feb 2009 (Commercial)		
	Number of routine work done	% of allocation	% of Cause	Number of routine work done	% of allocation	% of Cause
1. Broken Meters	37	-	0.1%	11	-	0.2%
2.Dead Meters	10,507	-	27.6%	3,043	-	43.6%
3.Dial not clear	324	-	0.8%	127	-	1.8%
4.Missing Reading	0	-	0.0%	0	-	0.0%
5. No Meter installed	27,261	-	71.5%	3,800	-	54.4%
Subtotal	38,129	79.1%	100.0%	6,981	60.1%	100.0%
6.Meter Underground (Buried etc)	94	-	8.7%	39	-	6.5%
7. Dater Not Entered	8	-	0.7%	0	-	0.0%
8.Property Locked	469	-	43.6%	74	-	12.3%
9. Provisional (One Time)	279	-	25.9%	144	-	23.9%
10.Temporary Disconnection	226	-	21.0%	345	-	57.3%
Subtotal	1,076	2.2%	100.0%	602	5.2%	100.0%
Total	39,205	-	-	7,583	-	-
G. Total	48,188	100.0%	-	11,620	100.0%	-
Ave. Number of Disturbance by Month	24,094	-	-	5,810	-	-

Source: WASA Revenue Office , April 25, 2009

Complaint Response Window's Inside/Outside ain Gunj Buksh Town

(12) Problem Analysis

Meter readings, billing and bill delivery were conducted by the branch office of Revenue Department in each town. However, water utility revenues (cash) of each town were collected from the consignment financial institutions (four banks) and then summarized by Revenue Department in Gunj Buksh Town. Meter readings were written into the form by hand, and then were added and updated into water service ledger by the obsolete personal computers within the office. Subsequently, bills on water tariff were delivered to the customer's house by the delivery person of WASA.

Consequently, it caused the following problems.

- Numerous employees were engaged in the task up to billing.
- A lot of complaint cases on paperwork mistakes.
- Processing power on personal computers was poor.

- Updating on customer’s database was not in time.
- Statistical data on business cannot be timely sorted out and submit for someone's inspection
- Documents were piled up within the office.
- A lot of paper mistakes were caused by financial institutions.

As the countermeasures, improvement on the renewal of office automation (OA) equipment, updating of on-line system, review of meter readings and tariff collection methods are required.

6.8 Financial Management

6.8.1 Outline on Fiscal Plan

Fiscal plan shall be formulated as the plan expressed by the amounts as the finance and its handling to cover the required expenditure for water & wastewater project operation and in the aim of internal supervision or external reporting on budgetary control or investment plan decision and determination on water tariff.

Fiscal plan is consisted of comprehensive plan, individual plan, master plan and operational plan. In addition, it is necessary to formulate the plan by respective target fiscal year in accordance with the following classification according to the difference among the planned periods.

- Long-term plan (approximately more than five years)
- Medium-term plan (approximately three years)
- Short-term plan (approximately within one year)

(1) Plans

Information on the “Medium-term and Long-term Fiscal Plan” that shall indicate the management/operation by WASA was not available.

The following financial conditions (improvement item Phase-1) were clear resulted from the available short-term fiscal plan “BUDGET 2008-2009 Version, WASA (Lahore)”.

- To promote the pervasion on water service meter
- To promote the outsourcing on tariff collection/ receiving
- To reduce the unaccounted-for water (To promote the installation on medium water meter and leak detection)
- To reduce the electric power costs
- To promote the simplification on connection approval procedures
- To reinforce the customer service center
- To statistically process the data

(2) Master Plan and Operational Plan

Master Plan is a core plan in relation to the business management including the revolution on business structure of water & wastewater project; therefore, it is consisted of expansion plan on water & wastewater facilities and/or augmentation plan to expand/widen the water and wastewater systems.

The following schemes are continually implemented according to the WASA's construction plans for the single fiscal year of 2008-2009.

- Laying by water conduit/waste pipe and rehabilitation/construction projects on tube-wells mostly occupied.
- Purchase plan on water meters (water service/BF meters) was not counted.
- Renewal plan on chlorine feeding facility was not counted.
- Renewal plan on tube-wells with some seventy (70) existed.
- Removal plan on deposits with the same scale as the previous fiscal year
- Operational plan with same water tariff and meter readings/billing as of 2007

Operational plan to be recurrently conducted is consisted of O&M tasks on deposits removal in the open/drainage channel, water conduits and waste pipes, O&M tasks on facilities and collection tasks on water tariffs/sewer charges base on Master Plan.

Appendix 6.8.1 shows the project list recorded by above-mentioned "Fiscal Plans by Single Fiscal year of 2007-2008". In addition, project budget were totally estimated as 2,778.268 MRs.

(3) Problem Analysis

There exists financial plany by single fiscal year; however, medium-term and long-term financial plans were not consolidated yet.

Consequently, it caused the following problems.

- Goals on financial plan and achieved plan were unclear.
- Expenses bring pressure to bear on the operation by sector was unaccounted-for.
- Investment plan was unclear.
- Summing up and calculation on deficits were unclear.
- Revision time on water tariff was unclear.

As the countermeasures, employment on expert staff, improvement on financial plan, completion of financial statements by sectors, and study on revision of water tariffs are required.

6.9 Management

6.9.1 Project Operation Policy

Management/operation on water & wastewater project shall be effectively implemented aiming at the policy specified in the superior plan "Vision 2030, National Drinking Water Policy etc."

It was considered that Policy reviewed within the interior of WASA (Lahore) was being engaged on the needs by town people and/or business environments.

However, achievements on such policy were considerably behind the time due to the difficult budget and lagging employee’s training/education/personnel training.

In addition, managerial goals were summarized in **Appendix 6.9.1** as below according to the speech from MD/DMD/Director.

6.9.2 Augmentation on Operation Organization

Operation objectives on water and wastewater utility are returning water supply finance more sound consequent upon the effective organized management.

Existing organization was established following the system around 1991 as a fundamental form. Furthermore, the jurisdiction on O&M was segmented into six (6) towns from two (2) areas by the leading of military regime in those days around 2002. Each town respectively conducted the water & wastewater facilities and cleanup on waterways.

Business implementation status by existing organization was shown as below.

- Preparation tasks on financial control, revenue/cost management and auditing information were directly carried out.
- Tasks on service water meter reading and computer processing such as billing, delivery and credit control were directly carried out.
- Approval tasks and construction supervision were directly carried out.
- O&M on water & wastewater facilities and water quality inspection were directly carried out.
- Removal task on deposits was partially carried out by outsourcing.
- Tasks on storm water/drainage were partially carried out by outsourcing.
- Maintenance on equipment/materials and vehicles were cared by outsourcing.

6.9.3 Completion on Operational Management Indicator

WASA completed the benchmark indicators from 2007-2008 as a part of reform on management. However, the establishment on benchmark as an operating policy is the challenges for the future.

Table 6.60 indicates the major benchmark indicators by WASA

Table 6.60 WASA's Benchmarks

S.No.	DESCRIPTION	UNIT	Calculation	INDICATOR(Financial Year) 2006-2007	2007-2008	2008-2009 Assumption	REMAKS
1	**Basic Data**						
1-1	Total Area for O/M works	km^2	-	338	338	338	-
	Service Area (Water Supply)	km^2	-	-	-	-	-
	Service Area (Sewerage)	km^2	-	-	-	-	-
1-2	Population of Lahore District	Nos.	-	8,092,000	8,318,000	-	-
	Population of WASA Area	Nos.	-	5,548,000	5,671,000	-	-
	Population Served with Water Supply	Nos.	-	4,826,760	4,933,770	-	-
	Population Served with Sewerage pipeline	Nos.	-	4,576,000	4,764,000	-	-
	Population served by Sewage treatment system	%					
1-3	Water coverage	%	-	87	87	-	-
	Sewerage Coverage	%	-	82.5	84.0	-	-
	Treated wastewater Coverage	%	-	-	-	-	-
1-4	Impact of Food Controal	%	-	-	-	-	-
1-5	Continuity of Service Hours per day in Winter	Hr/day	-	14	14.0	14.0	-
1-6	Continuity of Service Hours per day in Summer	Hr/day	-	18	18.0	18.0	-
1-7	Ratio of groundwater source	%	Pump displacement/Reserves	-	-	-	-
1-8	Intake amount	MGD	-	-	-	-	-
1-9	Reservoir Storage Capacity	Day	-	-	-	-	-
2	**Water Production**						
2-1	Daily Ave. Water Production	MGD	-	350	360	354	-
		Mm^3/D	MGD*4.546（liter/Gallons）	1.59	1.64	1.61	-
2-2	Daily Ave. Water Production per Population	GPCD	-	73	73	-	-
		LPCD	-	330	332	-	-
2-3	Daily Maximum Water Production	MGD	-	-	-	-	-
		Mm^3/D	MGD*4.546（liter/Gallons）	-	-	-	-
2-4	Daily Maximum Water Production per Population	GPCD	-	-	-	-	-
		LPCD	-	-	-	-	-
2-5	Rate of Loading (water supply Facilities)	%	Daily ave W.P./Daily Maximum W.P.*100	-	-	-	-
	Rate of Loading (Sewerage Facilities)	%		-	-	-	-
2-6	Daily Ave. Wastewater Flow	MGD	-	-	-	-	-
		Mm^3/D	MGD*4.546（liter/Gallons）	-	-	-	-
2-7	Daily Maximum WasteWater Flow	MGD	-	-	-	-	-
		Mm^3/D	MGD*4.546（liter/Gallons）	-	-	-	-
2-8	Rainwater Flow	MGD	-				
		Mm^3/D	MGD*4.546（liter/Gallons）				
3	**Metered & Unmetered Consumption**						
3-1	**Total Metered Consumption**	**MGD**	-	**88.36**	**96.88**	-	-
3-2	No. of Metered Connection	Nos.	-	259,514	267,912	285,443	-
3-3	Total No. of working meters	Nos.	-	-	-		-
3-4	Person /House	-	-	9.03	9.03	Person/house (WASA's Estimatio	
3-5	Per House Consumption	Gall/House/D	-	340	362	-	-
	Per Person Consumption	GPCD	-	38	40	-	-
		LPCD	-	171	182	-	-
4	**Un-metered Consumption**						
4-1	Total Un-metered Consumption	MGD	-	112	118	-	Assumed
4-2	No. of Un-Metered Connection	Nos.	-	275,304	272,838	-	-
4-3	Per Connection Consumption	Gall/Connection/D	-	409	434	-	1.2
5	Other Consumption	MGD	-	24	24	-	-
6	**Total Consumption、AFW**	**MGD**	(3-1)+(4-1)+(5)=	**225**	**239.3**		-
7	**Total No. of Connection**	Nos.	(3-2)+(4-2)=	**534,818**	**535,824**	**556,890**	-
8-1	Per Total connection Consumption	Gall/T.Connection/D	-	420	447	-	-
8-2	Per Person Consumption(Including All use application)	GPCD	-	47	49	-	-
8-3		LPCD	-	212	225	-	-
9	Total Sewerage Connection Year End.	No.		507,000	528,825	-	-
10	**Rate of water utilization**						
10-1	Unaccounted for Water(UFW)	MGD	(2-1)-(10-2)-(10-3)	125	121	112	-
10-2	**Revenue Water(RW)**	**MGD**	-	**201**	**215.30**	**211**	-
		Mm^3/D	**MGD*4.546（liter/Gallons）**	**0.913**	**0.979**	**0.959**	
10-3	Non Revenue Water(NRW)	MGD	-	24	24	31	-
10-4	Account for Water(AFW)	MGD	(13-1)+(13-2)=	**(201)**	(223.5)	(211)	-
	Water Production	MGD	-	**350.0**	**360.0**	**354.0**	
10-5	**% of UFW**	**%**	**UFW/(7)**	**35.8**	**33.5**	**31.6**	-
10-6	% of AFW	%	RW+NRW/(7)	64.2	66.5	68.4	-
10-7	% of NRW	%	NRW+UFW/(7)	42.6	40.2	40.4	-
10-8	**% of RW**	**%**	AFW／(7)	**57.4**	**59.8**	**59.6**	-

Source: BanchMark Indicators, WASA's Planing & Evaluation Dep April 30, 2009 and Updated

S.No.	DESCRIPTION	UNIT	Calculation	INDICATOR(Finacial Year)			REMAKS
				2006-2007	2007-2008	2008-2009 Assumption	
11	**Water Supply Connection**						
11-1	Total No. of water supply connection	Nos.	-	534,818	535,824	556,890	-
11-2	Total No. of Functional Water Meters	Nos.	-	64,178	66,442	72,865	
11-3	Functional Meters Ratio of Total Connection	%	-	12.0	12.4	13.1	-
11-4	Total No. of Metered Connection	Nos.	-	259,514	273,611	285,443	-
11-5	Functional meters Ratio of Total metered Connection	%	-	24.73	24.28	25.53	-
11-6	Total Amount of Metered Water sold	MGD	-	88.4	102	211	-
11-7	Metered water sold Ratio	%	-	39.3	42.6	-	-
12	**Operation and Maintenance Works**						
12-1	Pipe Breaks per Km per year	km/year	Frequency/km	2.1	2.1	-	–
	Total Water Services Length	km	-	3,350	3,380	-	–
	Total No. of pipe breaks per year	Frequency	-	7,013	7,150	-	–
12-2	Water Supply pipe Breaks per Km per year	km/year	Frequency/km	-	-	-	–
	Toatl Water main length	km	-	-	-	-	-
	Total Diistribution pipe Length	km	-	-	-	-	-
	Total Service line Length	km	-	-	-	-	-
	Total No. of pipe breaks per year	Frequency	-	-	-	-	-
	Total Steel pipe Length	km	-	-	-	-	-
	Total CIP pipe Length	km	-	-	-	-	-
	Total PVC/PE pipe Length	km	-	-	-	-	-
	Total Lead pipe Length	km	-	-	-	-	-
	Total Asbest pipe Length	km	-	-	-	-	-
12-3	Amount of Leakage Water Loss	m^3/year	-	-	-	-	-
12-4	Sewerage Blockages per km per year	km/year	Frequency/km	35.5	37.0	-	–
	Total Wastewater length	km	-	3,780	3,780	-	–
	Total No. of Sewer Blockage per year	Frequency	-	134,081	140,000	-	–
	Total CIP pipe Length	km	-	-	-	-	-
	Total CR pipe Length	km	-	-	-	-	-
	Total Clay pipe Length	km	-	-	-	-	-
12-5	Dranage repaier per km per year	km/year	-	-	-	-	-
12-6	Amount of Desilt	m^3/year	-	-	-	-	-
	Total Dranage Length	km	-	-	-	-	-
13	**Unit Coat**						
13-1	Ratio of Operational Revenue per Cost	-	Revenue/Cost	0.70	0.67	0.60	-
13-2	Change of Water Supply Unit Cost	Times	-	1.00	1.10	1.31	-
	Cost of Water supply per Water production	Rs/m^3	Operation Cost/((7)*365)	4.13	4.53	5.4	1.67
	Cost of Water supply per RW	Rs/m^3	Operation Cost/((13-2)*366)	7.20	7.58	9.13	1.67
	Water production	Mm^3/D	-	1.59	1.64	1.6	-
	Revenue Water(RW)	Mm^3/D	-	0.91	0.98	0.96	-
	Operation Cost per Water production	MRs/y	-	2,399	**2,707**	**3,196**	-
13-3	Change of Unit price of Water Supply	Times	-	1.00	1.06	1.13	-
	Unit price of Water supply per Water production	Rs/m^3	Operation Revenue/Water production	2.88	3.05	3.25	-
	Unit price of Water supply per RW	**Rs/m^3**	**Operation Revenue/RW**	**5.02**	**5.09**	**5.46**	-
	Operation Revenue(Including Miscellaneous)	MRs/y	-	1,673	**1,819**	**1,910**	-
13-4	Total Receipts	MRs/y	-	-	**4,983.49**	**3,676.31**	-
13-5	Total Expenditure	MRs/y	-	-	**5,078.37**	**5,022**	-
13-6	Change of Total No. of Water Connection per Employee	Nos./Employee	-	82	94	97	-
13-7	Revenue Water per Water's Employee	m^3/Employee/d	RW/Emplyees	312	-	-	-
13-8	Water Production per Water's Employee	m^3/Employee/d	Water production/Emplyees	544	-	-	-
13-9	Water Connections per Water's Employee	m^3/Employee/d	Water connections/Employees	183	-	-	-
14	WASA'sEmployees						
14-1	Total No. of WASA's Employees	Nos.		6,560	5,729	5,729	-
14-2	Staff on water supply	No.		2,925	-	-	
14-3	Staff on sewerage	No.		2,682	-	-	
14-4	staff on Drainage	No.		953	-	-	
15	**Total No. of Staff on Sew. & drainage (Contract Basis)**	No.		3,635	3,664	3,664	
16	**Ratio of Operation Cost**						
16-1	Proportion of Power /Electricity per Operation Cost	%	-	31.2	31.8	31.5	-
16-2	Proportion of Salary per Operation Cost	%	-	47.5	43.4	44.3	-
16-3	Proportion of Repair & Maintenance per Operation Cost	%	-	-	21.3	20.9	-
16-4	Operation cost per Water production	MRs/y	-	2,399	2,707	3,182	
16-5	Salary	MRs/y	-	749	861	1,001	-
16-6	Power	MRs/y	-	1,141	1,175	1,411	-
16-7	Repair & Maintenance	MRs/y	-	-	577	664	-
16-8	Other Expenses	MRs/y	-	-	94	106	-
17	**Complaints**						
17-1	% of Total No. of Water Supply Complaints per Connections	%	-	6.9	6.9	-	-
17-2	% of Total No. of Sewerage/Drainage Complaints per Connections	%	-	-	-	-	-
17-3	% of Total No. of Water Quality Complaints per Connections	%	-	-	-	-	-
17-4	% of Total No. of Billing /Revenue Complaints per Connections	%	-	-	-	-	-
17-5	No. of Water Supply Complaints per year	Nos.	-	37,029	37,000		-
17-6	No. of Sewerage/Drainage Complaints per year	Nos.	-	-	-	-	-
17-7	No. of Water Quality Complaints per year	Nos.	-	-	-	-	-
17-8	No. of Billing / Revenue Complaints per year	Nos.	-	-	-	-	-

Source: BanchMark Indicators, WASA's Planing & Evaluation Dep April 30, 2009 and Updated

6.9.4 Information Disclosure

Information disclosure in term of management was behind schedule. The objective on information disclosure is to establish the partnership with customers, absorb the customer's satisfaction and demand. In the future, information on management control indicators must be disclosed. Customer's needs and information obtained are useful for selection on project priority and activation on organization

6.9.5 Political Goal of WASA

The policy of the water service enterprise which WASA aims at is shown below.
The degree of achievement of the policy is at monetary difficulties and the shortage of talented people, and is behind.

A policy is shown below.

a) Policy-1: Cooperative operation and coexistence with community

Policy 1-1: To enforce precise business operation

- To promote the setup on business management goal
- To promote the completion on fiscal plan
- To promote the improvement on benchmark
- Business undertaking based on management goal
- To promote the formulation on management index monitoring system
- To promote the enforcement on operating efficiency based on intensive reform plan
- To promote the enforcement on customer's questionnaire

Policy 1-2: To reform organization

- To promote the study on organization's simplification
- To promote the clarification on responsibility/role/tasks burden
- To promote the balance on employee deployment
- To promote the reconfirmation on command structure
- To promote the study on employee grade allocation
- To promote the study on organization's activation
- To promote the realization on gradual alternation of generations
- To promote the study on reemployment of excellent retired employees
- To promote the employment on supervisory personnel, treasurer/ manager/general clerk and engineer with work experience/ knowledge

Policy 1-3: To formulate partnership with customers

- To promote the enforcement on public relations
- To promote the arrangement on exemption measures for the weak
- To disclose information on management index etc.

- To promote the study on making water & wastewater facilities tours
- To promote the study on water tariff presentation meeting
- To promote the accountability for challenges before WASA to town people and communization with these challenges
- To respond the complaint in term of tariffs/charges by upstanding town people with soft considerations
- To promote the provision on malicious illegal information from town people
- To promote the enforcement on testimonial events for excellent proposals
- To promote the customer service

b) Policy-2: To improve revenue/benefit by effective operation

Policy 2-1: To study the reduction on unaccounted-for water

- To promote the study on water balance
- To promote the study on augmentation measure of accounted-for water

Policy 2-2: To collect water tariff by water consumption

- To promote the improvement on growth/augmentation of water meter’s number to be installed
- To promote the study on water tariff by water consumption
- To promote the securement on water consumption by users
- To promote the progress on numbers of sewer connections

Policy 2-3: To promote effective O&M

- To promote the payroll reduction
- To upgrade the quality of employee experience/education level
- To promote the private consignment on O&M tasks
- To promote the study on prolongation of retirement year for excellent employees

Policy 2-4: Efficiency on water meter readings/billing

- To promote the study on payroll reduction by partial mechanization to water reading/billing/delivery tasks
- To promote the improvement on water tariff payment system
- To promote the replacement on aging computer system for paperwork
- To promote the complaint case reduction measures in term of paperwork mistakes and tariffs/charges

Policy 2-5: To complete financial report by business

- To promote the studying on financial/management reports for respective water & wastewater project

Policy 2-6: To strengthen penalty

- To enforce the strengthening on penalty/publication to malicious illegal connections

c) Policy-3: To supply stable water

- To promote the study on replacement of asbestos pipes

- To promote the securement on laying distance service and wastewater pipes
- To promote the study on reinforcing service pipes crossing wastewater pipes
- To promote the study on leakage/breakage investigation to service pipes
- To promote the rehabilitation on chlorine feeding facility by pump pressure method
- To promote the study on making installation of inspection appliance obligatory to chlorine concentration of tube-well's discharge side
- To promote the study on installation by automatic water quality monitoring apparatus to the outlet of wastewater/effluent
- To promote the improvement on chlorine feeding ledger

c) Policy-4: To service stable water

Policy 4-1: To secure water sources
- To promote the study on alternative water sources
- To promote the study on whole quantity to groundwater sources
- To promote the study on water table fluctuation
- To promote the investigation on groundwater quality
- To promote the investigation on location & scale to aquifer/impermeable layer
- To promote the investigation on quantity/quality for recharge/flowage/storage of groundwater
- To promote the formulation on preservation plan
- To promote the reuse on treated sewage

Policy 4-2: To reduce temporal water supply
- To promote the improvement by second incoming circuit
- To promote the improvement on optimum private power generation for pump capacity
- To promote the reinforcement on O&M system for failure prevention

Policy 4-3: To rehabilitate/improve creaky facilities
- To promote the rehabilitation/improvement on tube-wells
- To promote the improvement on chlorine feeding facilities
- To promote the improvement on wastewater pump and screen equipment
- To promote the improvement on replacement works of electric facilities
- To promote the improvement on replacement works of wastewater pump station house
- To promote the improvement on improvement works of tube-well floor crack parts
- To promote the improvement on facility monitoring system by aggregated operation

Policy 4-4: To replace/improve water meter
- To promote the replacement/improvement on BFM
- To promote the replacement/improvement on service water meter
- To promote the improvement on intermediate water meter

Policy 4-5: To rehabilitate/improve pipeline network

- To promote the enforcement on replacement laying works for aging pipes such as service water pipes
- To promote the enforcement on replacement works of service pipe materials
- To promote the acceleration on water supply system

Policy 4-6: To improve leakage measures on water pipes

- To promote the enhancement on leak detection equipment
- To promote the enhancement on leak detection
- To promote the enhancement on employees in charge of leak detection
- To promote the enhancement on securing leakage volume

Policy 4-7: To reduce complaint cases

- To promote the study on computerized processing for complaint response ledger
- To promote the study on computerized processing for debrief report by complaint processing
- To promote the study on filling/statistics for complaint contents
- To promote the establishment on reduction plan for complaint cases
- To promote the improvement on vehicles used for complaint measures

e) Policy-5: Too improve equipment/materials for O&M

Policy 5-1: To promote the improvement on water meter workshop

- To promote the augmentation on repair technicians
- To promote the improvement on workplace
- To promote the improvement on sourcing/stock status
- To promote the improvement on calibration apparatus

Policy 5-2: To promote the improvement on workshop for inundation measure equipment/materials

- To promote the replacement on aging small pumps
- To promote the replacement on aging trucks and augmenting numbers of truck
- To promote the improvement on portable lighting tower with engine
- To promote the improvement on portable private power generator
- To promote the improvement on handy machine tools

Policy 5-3: To promote the improvement on heavy machine to remove deposits within water conduits/waste pipes

- To promote the replacement on aging equipment & materials
- To promote the enrichment on small bulldozer
- To promote the enrichment on bucket crane with long boom
- To promote the replacement on aging trucks and augmenting numbers of truck
- To promote the improvement on downsized two-wheel vehicle
- To promote the improvement on toxic gas detector appliance and safety musk etc.
- To promote the improvement on fall prevention appliance, helmet, safety glasses and glove etc.

Policy 5-4: To promote the improvement on water quality analysis function

- To promote the replacement on aging analysis equipment/materials
- To promote the replacement on analysis equipment/materials
- To promote the replacement on aging vehicles for sampling and augmenting numbers of vehicle
- To promote the improvement on wastewater analysis equipment/materials
- To promote the augmentation on employee in charge of analysis
- To promote the computerized processing on analyzed data

Policy 5-5: Inventory control

- To promote the computerized processing on warehousing ledger
- To promote the computerized processing on delivery ledger
- To promote the centralization on inventory control

f) Policy-6: To upgrade employee

Policy 6-1: To prepare training plan

- To promote the setup on training benchmark/effect
- To promote the reinforcement on employee personal information
- To promote the upgrading on management/application capacity of supervisory personnel
- To promote the upgrading on technological level of managerial engineer
- To promote the upgrading on employee level for labor health/safety education
- To promote the preparation on training benchmark by trainee
- To promote the preparation on training menu
- To promote the reinforcement/improvement on instructor
- To promote the review on instructor's qualification /payroll system

Policy 6-2: Promotion on changes in the consciousness of employee

- To promote the issuance on training certification of termination
- To promote the review on pay raise/payroll system
- To promote the studying on bonus system for working improvement proposals

Policy 6-3: Improvement on training facilities

- To promote the improvement on training equipment/materials in WASA's Training Center
- To promote the improvement on training room
- To promote the improvement on lodging/canteen facilities

Policy 6-4: Improvement on appraisal method of outcome

- To promote the appraisal on benchmark achievement/review reports by trainee
- To promote the appraisal on working improvement (safety, efficiency and improvement) proposal by trainee
- To promote the enforcement on training termination test (written, orally)
- To promote the verification on training attended days

- To promote the appraisal on performance before and after training
- To promote the appraisal on special technology/knowledge before and after training
- To promote the appraisal on application ability/problem-solving skill on duty

g) Policy-7: To secure the pleasant and safe living environment

Policy 7-1: To promote the improvement on wastewater

- To promote the improvement by separate system
- To promote the improvement on sanitary sewer
- To promote the functional strengthening on wastewater and storm water pump stations
- To promote the improvement on odor measures
- To promote the improvement on manhole

Policy 7-2: Favorable maintenance on facilities

- To promote the replacement on aging tube-wells
- To promote the replacement on aging pump stations
- To promote the computerize processing on tube-well O&M records
- To promote the computerize processing on pump station O&M records

Policy 7-3: To promote the inundation measures

- To promote the completion/publication on inundation-prone hazard maps
- To promote the improvement on aqueducts

Policy 7-4: Favorable maintenance on aqueducts/waste pipes

- To promote the enforcement on clearing/removal of deposits/sediments

h) Policy-8: To create clean rivers

Policy 8-1: To promote the water quality in public waters

- To promote the screen installation to storm water outlet chamber
- To promote the regulation/monitoring on industrial wastewater
- To promote the monitoring on disposal by illegally-dumped items
- To promote the improvement on storm water drainage system
- To promote the strengthening on offender’s penalty and publication on offender/blacklist

i) Policy-9: Educational campaign on town people

Policy 9-1: Saving water

- To promote the leakage measures resulted from water tanks
- To promote the leakage measures resulted from service pipes
- To promote the effective utilization of water

Policy 9-2: Water quality contamination measures

- To promote the waterborne infectious disease measures caused by broken water pipes

- To promote the cleanup roof/underground tanks

Policy 9-3: Environmental preservation

- To promote the reduction on uncollected volume of wastes

Policy 9-4: Inhabitant’s manners

- To promote the prohibition on garbage (domestic, industrial wastes) dumping to rivers/drainage channels
- To promote the reduction on illegal garbage disposal to manholes
- To promote the education on garbage collection manners
- To promote the prohibition on booster pump installation directly from service pipes

Policy 9-5: PR on WASA’s activities

- To promote the publication on amount of water supply
- To promote the publication on financial condition
- To promote the publication on WASA’s tasks

6.9.6 Problem Analysis

Business scheme (basic policy) indicates “entire management” should correspond the variation of business environment was not consolidated yet. On the other hand, construction budget was yearly continued; however, “Improvement Items on Management” rosen by WASA in 2008 were not effectuated because the budget allotment was not enough. WASA improved the benchmark on O&M from AD2007; however, WASA had not yet to setting up the objectives.

Consequently, it caused the following problems.

- Vitality and tension in organization turned down.
- Efficiency in organization declined.
- Employees become chronic on lagging policy implementation.
- Employees are satisfied with chronic deficits.
- Customer’s needs were not accurately grasped for business judgment.

As a countermeasure, formulation on management policy by employing expert staff, establishing the project and setting up on business administration goals is required.

CHAPTER 7 REVIEW OF EXISTING STUDIES AND DEVELOPMENT PLANS

7.1 Existing Studies and Development Plans

Table 7.1 shows a list of existing studies and development plans of water supply, sewerage and drainage for Lahore. Many of these reports have been prepared since 2000.

Table 7.1 Existing Reports and Development Plans

	Year	Consultants	Reports and Development Plans
(1)	Sep. 1975	Camp Dresser & Mckee Ltd. (CDM)	Lahore Water Supply, Sewerage and Drainage Project
(2)	Oct. 1986	NESPAK	Lahore Water Supply System Computer Study and Design of New Tubewells
(3)	Sep. 1987	Balfour Consulting Engineers	Lahore Wastewater Treatment Project
(4)	Jun. 1991	NESPAK	Groundwater Resources Evaluation and Study of Aquifer under Lahore
(5)	Feb. 1992	Mott MacDonald International Limited & ACE (Pvt.) Limited	Lahore Urban Drainage - Design Report
(6)	Jul. 1993	Balfour Maunsell & Engineering Consultants	Punjab Urban Development Project Lahore Wastewater Treatment Plants and Sewage Pumping Stations
(7)	Oct. 1994	Balfour Maunsell	Punjab Urban Environmental Project Lahore Southwest Wastewater Treatment Plant
(8)	Nov. 2002	NESPAK	Integrated Master Plan for Lahore – 2021
(9)	Aug. 2005	NESPAK	Master Plan for Improvement of Sewerage and Drainage System of Central Zone, Lahore – Detailed Engineering Design Report
(10)	Nov. 2005	NESPAK	Preparation of Comprehensive Sewerage & Drainage Scheme for South Lahore – Feasibility Report
(11)	Nov. 2006	NESPAK	Preparation of Comprehensive Sewerage & Drainage Scheme for South Lahore – Preliminary Design Report
(12)	Aug. 2007	Seueca	Identification Study for Provision of Water Supply and Sewerage Services in Lahore City
(13)	Jun. 2008	NESPAK	Laying of Trunk Sewer along Cantonment Drain Lahore

NESPAK: National Engineering Services Pakistan (Pvt.) Limited

7.2 Review of Existing Studies and Development Plans

The most important report in **Table 7.1** is the "**Lahore Water Supply, Sewerage and Drainage Project"** of 1975, the contents of which include a master plan for water supply, sewerage and drainage facilities. The proposals in this report form the basis for the provision of water supply, sewerage and drainage facilities in Lahore. The report presented two important conclusions, namely, (1) the basic water supply will continue to be from groundwater even in the long term, and (2) the system is presently a partially combined system and capacity is needed for a separate sanitary sewer system with special allowance for some storm water flow which may be desirable in highly congested city districts, subject to further study in each case.

Since this report, subsequent reports have handled plans for special fields like water supply, sewerage and drainage or referred to specific areas. The "**Integrated Master Plan for Lahore – 2021"** (2002) include consideration of water supply, sewerage and drainage facilities, but it was originally a plan of the entire urban facilities composed of many components and the study levels on water supply, sewerage and drainage facilities are not very detailed or exhaustive.

(1) Water Supply

"Groundwater Resources Evaluation and Study of Aquifer under Lahore" (1991) was the first full-scale study on groundwater resources conducted after the **"Lahore Water Supply, Sewerage and Drainage Project"** (1975) and it includes the development of an aquifer mathematical model. However, this model is no longer used in WASA.

"**Integrated Master Plan for Lahore - 2021"** (2002) proposed to reduce the per capita water consumption from the present 80 gallons to 50 gallons by the target year and to take at least 300 MGD water from the northeastern surface water source for water supply.
This report indicates the future status of water supply, sewerage system, drainage system and solid waste management under the sub-section of "Infrastructure Development". Although this sub-section is elaborated under a variety of subjects such as (1)Key Issues and Guidelines, (2)Gross components, (3)Development Potentials, Constraints and City Growth, (4)Urban Growth Strategy, (5)Housing, (6)Transportation, (7)Community Facilities, (8)Infrastructure Development, (9)Public Utilities, (10)Flood Management and Growth Possibilities across the Ravi River, (11)Urban Environment, (12)Institutional Framework, (13)Financing Proposals and Options, (14)Zoning Regulations, and(15)Sub-division Regulations: the technical treatment and studies therein seem to be rather superfical. The ideas for population projections found in this report is referred to in the present study

"**Identification Study for Provision of Water Supply and Sewerage Services in Lahore City"** (2008) conducted a detailed unaccounted-for-water (UFW) survey at Johar Town with 1,500 connections and a 30 km long distribution network and, based on its results, proposed an eight-year action plan for unaccounted-for-water (UFW) reduction.
The elaborate survey carried out to checked on the actual status of UFW in the pilot area. As the area selected is the newly developed residential area of Johar Town, the water supply facilities seem to be in the better condition than those existing in the old towns. Therefore it is necessary to interpret the result with some reservations. However, in the event that there is no data exactly measured in a complete water supply system due to problems of lack of both bulk

flow meters at the tube-wells and water meters at the connections, the results obtained by checking the outflow and inflow in a complete water supply system would be both valuable and need to be carefully evaluated.

(2) Sewerage and Drainage

In the field of sewerage, a study on the service area and wastewater treatment plant (WWTP) was conducted for the implementation of the Southwest WWTP in the report ”**Lahore Wastewater Treatment Project”** (1987). Land acquisition for the plant site was completed in February 23, 1992 and design drawings for pumping stations, WWTP and collector channels to the WWTP were prepared in the report ”**Lahore Wastewater Treatment Plants and Sewage Pumping Stations”** in1993. However, construction was prevented due to the lack of funding for the Southwest WWTP and collector channels to the WWTP

The report “**Lahore Urban Drainage”** in 1992 was a study on the design criteria of drainage facilities including the evaluation of different cross-sections of drains, etc.

In 1994 by Balfour Maunsel, accompanying a review of population and sewage flow in Central, South Civil Lines and Southwest Sewerage Districts belonging to the service area of the Southwest WWTP, a review was carried out of the plan proposed in the report “**Lahore Water Supply, Sewerage and Drainage Project”** (1975). The 1975 master plan proposed the dual installation of new trunk sewers along the existing sewers to cope with the capacity shortage of existing sewers and the construction of new disposal stations to discharge wastewater into the Ravi River. In accordance with this plan, the Main Outfall, Gulshan-e-Ravi and Multan disposal Stations were constructed, but almost no improvement was done for trunk sewers. In addition, the comparative study of high-rate activated sludge, high-rate trickling filter, aerated lagoon, and oxidation pond processes composed of anaerobic pond and facultative pond were conducted

The report recommended an area of 549 ha for a design sewage flow of 701,600 m^3/day in 2005 increasing to 684 ha for 892,100 m^3/day in 2017. However, the site already acquired was only 364.2 ha in extent and not enough for the stated requirement, although it did recommended the wastewater stabilization pond process anticipating that any shortage of land would be acquired in future. Nine anionic ponds and forty facultative ponds were densely arranged in the overall layout of the wastewater treatment plant, with the proviso that the earth embankment of the respective ponds would be used as the maintenance roads. Such additional land acquisition has not been realized to date. The proposed design sewage flow will be bigger than that in 1994 and the requirement that 40 % of the pond surface area is additionally required for the circulation roads, incidental facilities and buffer zone of the plant, is indicated in the report ”Master Plan for Urban Wastewater (Municipal and Industrial) Treatment Facilities in Pakistan” prepared in February 2002. If this is introduced into planning, it is obvious that even the 684 ha proposed for the year of 2017 by Balfour will not be enough for the entire plant layout.

The report "**Integrated Master Plan for Lahore - 2021"** (2002) visualises the expansion of the sewered area accompanied with the expansion of the urbanization area and early construction of the land-acquired wastewater treatment plants for sewerage. It also proposes to tackle the elimination of solid waste dumping to drains, removal of existing encroachments, preparation of economical proposals, planning of the rain water disposal with a return period of five years, facilitation of maintenance drains, and self-funding drains. The technical studies are not so detailed as those described previously in "(1) Water Supply" above.

The report "**Master Plan for Improvement of Sewerage and Drainage System of Central Zone"** (2005) include provisional plans for sewerage and drainage facilities in the Central Zone. There is the difference in the serviced areas for sewerage and drainage systems. The Central Zone belongs to the service area of the Southwest WWTP. The project cost is estimated at Rs.614 M for sewerage facilities excluding that of the WWTP and Rs.821 M for Package-A drainage and Rs.817 M for Package-B drainage.
The Report contents include a data book of detailed designs but has no description on the present situation of sewerage and drainage facilities in the Central Zone. Therefore the goals of the detailed designs are not clear.
The Report was prepared at the almost same time and by the same consultant of "2005South Lahore Report" but adopted different design criteria for the per capita daily wastewater flow, allowance for commercial and industrial wastewater flow and limit of velocity in sewers. Its relevance is unknown.

The publication **"Preparation of Comprehensive Sewerage & Drainage Scheme for South Lahore - Feasibility Report"** (2005) provide provisional plans of sewerage and drainage facilities for South Lahore (see **Figure 7.1**). The South WWTP is located at the riverbed near the confluence of the Hudiara Drainand the Ravi River. For this project, a **"Preliminary Design Report"** was prepared in 2006 and estimated the project cost at Rs.12,570 M for sewerage facilities excluding that of the WWTP and Rs.9,988 M for drainage facilities.
In South Lahore which shows rapid development among other regions in Lahore, wastewater is pumped up to the storm water drains elsewhere due to the shortage of carrying capacity of existing trunk sewers and the delays of new trunk sewer provisions. The proposed sewer system envisages laying a new trunk sewer along the canal as much as possible in order to intercept wastewater for conveyance to a wastewater treatment plant and to minimize the number of the existing temporary lift stations by abandoning them. The sanitary wastewater is therefore separated from storm water. The proposed system has the great advantage of improving the O&M of sewerage facilities and water pollution in public water bodies but there is no quantitative evaluation of the system in the report.

The report “**Identification Study for Provision of Water Supply and Sewerage Services in Lahore City”** (2008) by Seueca, the French consultant and a subsidiary of Veolia, proposes (1) separation of sewage from drainage by decommissioning 30 lifting stations and upgrading 16 out of 46 permanent stations, (2) rehabilitation and/or reinforcement of approximately 39 km of trunk sewers (out of 570 km), (3) intensive de-silting and cleaning of sewers, (4) working with solid waste authorities to reduce the amount of solid waste entering the sewerage system, (5) upgrading and rehabilitation of the main pumping stations with pump replacement and installation of mechanical screening, and (6) treatment of wastewater at three locations (North, South-West and South)

The report include a survey conducted on some topics in relation to water supply and sewerage facilities. Although six wastewater treatment plants ware proposed in the master plan for a sewerage system in Lahore, the report made a comparative study of three alternatives, namely for six, three and one wastewater treatment plant(s) based on the size of trunk sewers and pumping heads required for their integration and recommended three wastewater treatment plant alternatives. In addition, for a wastewater treatment process, a simple comparison was made for wastewater stabilization pond and an activated sludge processes and the report recommended the latter.

The report “**Laying of Trunk Sewer along Cantonment Drain Lahore は Cantonment”** (2008) proposes the laying of a new trunk sewer along the Cantonment Drain and the connection of existing sewers to the new trunk sewer to separate wastewater from storm water: and to abandon 18 disposal stations that currently discharge wastewater to the Cantonment Drain. The project cost is estimated at Rs.1,377 M.

In the surrounding area of the Cantonment Drain, wastewater is discharged into the drain through lift stations in many places due to the delay of new trunk sewer provision and the lack of carrying capacity of existing sewers. The report proposes to install a trunk sewer along the drain to separate wastewater from storm water and abandon the existing lift stations. There is no problem in the plan itself, but similar to the “2005 South Lahore Report”, there is no quantitative evaluation on the advantage of O&M and water pollution reduction in public water bodies in the report

The details of the reports mentioned above are presented in **Appendix 7.1**.

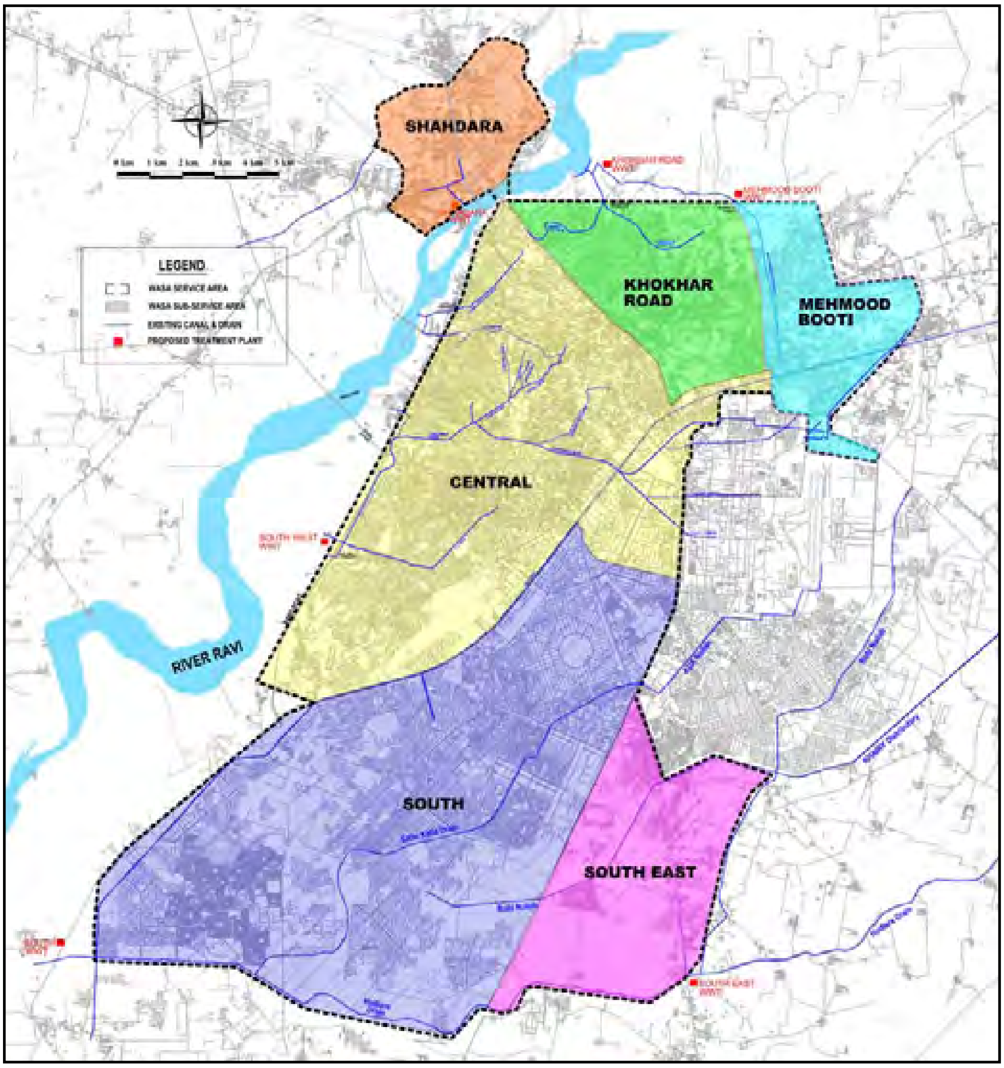


Figure 7.2 Service Areas of Each Proposed WWTP

7.3 Problem Analysis

(1) Need for Formulation of the New Master Plan

As stated earlier, the "1975 CDM's Master Plan" is the basis of the present development of water supply, sewerage and drainage facilities in Lahore. During the thirty-four years that have since elapsed, Lahore has developed continuously and its present population largely exceeds the design population in 1975 and has resulted in a big change in the surrounding conditions. During this period, development plans have been formulated but the study area for facility provision has been limited. It is accordingly recommended to prepare the new Master Plan.

The acquisition of surface water sources is the earnest wish of the people concerned with the water supply service. If agreement to use irrigational water for drinking water proposes can be established among stakeholders, The formulation of the new master plan will be undoubtedly indispensable. When an intake from surface water is realized, facilities for water intake, conveyance, treatment, and transmission are required and the study on how to blend the treated surface water with groundwater in the water distribution system demands a drastic review of the overall water supply plan.

Also in sewerage, wastewater treatment is being considered for implementation and it is timely to review the master plan with a view to sharpen its future direction and to proceed provisionally towards such goals. The WASA has already acquired the sites for the Southwest and Southeast Wastewater Treatment Plants, but it must make a sincere effort to discuss how wastewater treatment in the remaining areas should be carried out and take actions for suitable land acquisition. Treated wastewater utilization has a possibility to become a trump card in securing a surface water source, its reuse plan will be one of a big issues in the sewerage master plan for Lahore.

As a drainage option, pumping has been often used for quick discharge of storm water in Lahore. Another option is the storage and infiltration of storm water, which has been recently highlighted in many countries. Lahore is called “the City of Gardens” and its drinking water source is fully dependent on groundwater. The introduction of such an environmentally friendly system is worthy of study in the course of review of the master plan.

(2) Reports to Be Referred for Phase I Formulation

The sewer and drain networks proposed in the “2005 Central Zone Report”, “2005 South Lahore Report” and “2008 Cantonment Drain Report” are referred to the JICA study for selection of Phase 1 project components. The differences in design criteria found in those reports will be discussed for possible amalgamation with the WASA criteria and their network sizes and routes will be rechecked based on the design population to be served and the amalgamated design criteria.

CHAPTER 8 PROBLEM ANALYSIS

8.1. Facilities

8.1.1 Water Supply

(1) WASA

Historically, Lahore's water supply has relied upon groundwater and tubewells. This system has in the past provided a relatively secure and stable water supply for Lahore. However, recent periods of reduction in flow of Ravi River and rates of consumption have seen groundwater levels falling year by year.

From the standpoint of estimating the capacities of the existing water supply facilities, two aspects should be taken into account. One is quantity of the supplied water, another is quality. Water utilities have to provide a safe and plentiful supply of water that meets safety standards and satisfies the customer's requirements.
The project findings are summarized below:

Table 8.1 Key issues of water supply

Viewpoints	Issues
Water quantity	1) Increasing water demand 2) Decreasing groundwater level 3) Serious Unaccounted for water
Water quality	4) Increasing arsenic concentration 5) Contamination in the pipelines

1) Increasing water demand

Population increase is a major factor affecting the demand on water resources. It is estimated that the population of Lahore is currently growing by around 3.5% per year. People currently consume 341 Liters (75 gallons) of water per capita per day including the rate of unaccounted for water, which is greater than Karachi's consumption and average in the world, details are shown in chapter 8.
Even if WASA commits to reduce the unaccounted for water and consumption per capita (water demand per capita with 75 gcd (gallon/capita/day) in 2009 is expected to be 45 gcd in 2035, and UFW with 34% in 2009 is also expected to be 20% (see **Table 9.6** demand forcast), water demand in 2035 is predicted to be 1.2 times as great as current one in 2009 since population is increasing. In this case, assuming the current average production of tubewells will remain the same, WASA will need 80 more tubewells approximately compared with January in 2009. That will affect a lot on water resources in the aquifer.

Table 8.2 Projected number of tubewells

	Unit	2009	2035
Current water demand	m^3/d	1,609,000	-
Projected water demand	m^3/d	-	1,933,821
Current number of tubewells	nos.	412	-
Projected number of tubewells	nos.	-	495
Average production per tubewells	m^3/d	3,905	3,905

Current water demand & current number of tubewells: Accounted/ Unaccounted for Water and Revenue/ Non Revenue Water for the Period of Jan. & Feb. 2009, WASA
Projected water demand: **Table9.6**, Chapter9, this report
Average production of tubewells: 1,609,000/412=3,905

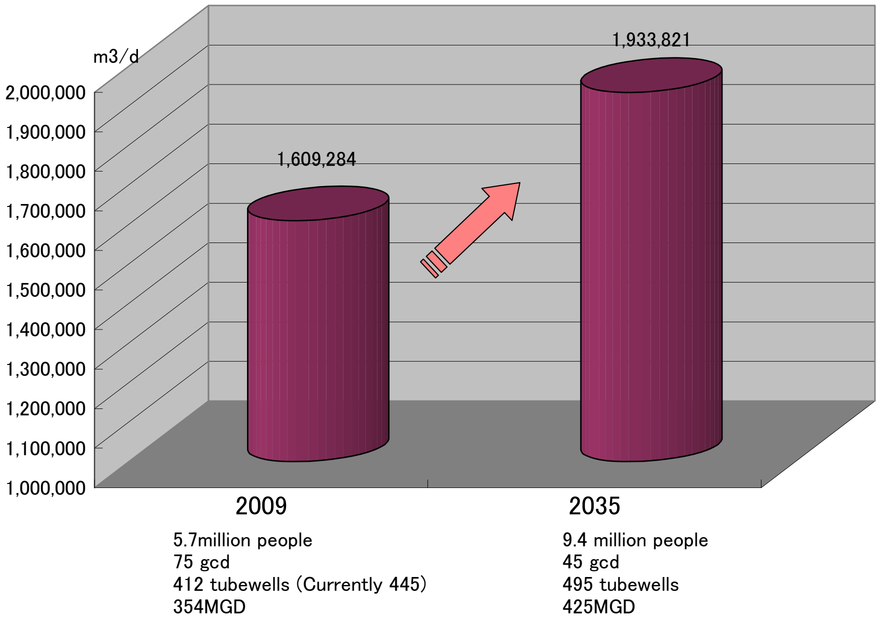


Figure 8.1 Projected water demand growth in WASA

2) Decreasing groundwater level

While the water demand is increasing, the static water level of the aquifer is rapidly going down described in chapter 5.1. The average decline in the ground water level is 0.9m (3 feet) per year. The number of tubewells and groundwater abstraction has been increasing in accordance with the growth of population. WASA is operating around 400 tubewells but other utilities or individuals seem to have 4,000 tubewells in operation in WASA's jurisdiction, as well as 6,000 tubewells are working for irrigation in Lahore. The total number of tubewells is estimated to be more than 10,000. In addition, due to the Thein Dan construction project in India, the flow of water down the Ravi River has been severely curtailed (see **Figure 5.8**). This has in turn led to reduced groundwater because the Ravi River is one of the principal sources of recharge to the aquifer located under Lahore.

Considering the increasing water demand coupled with decreasing ground water, alternative water resources such as surface water for drinking water will be surely needed.

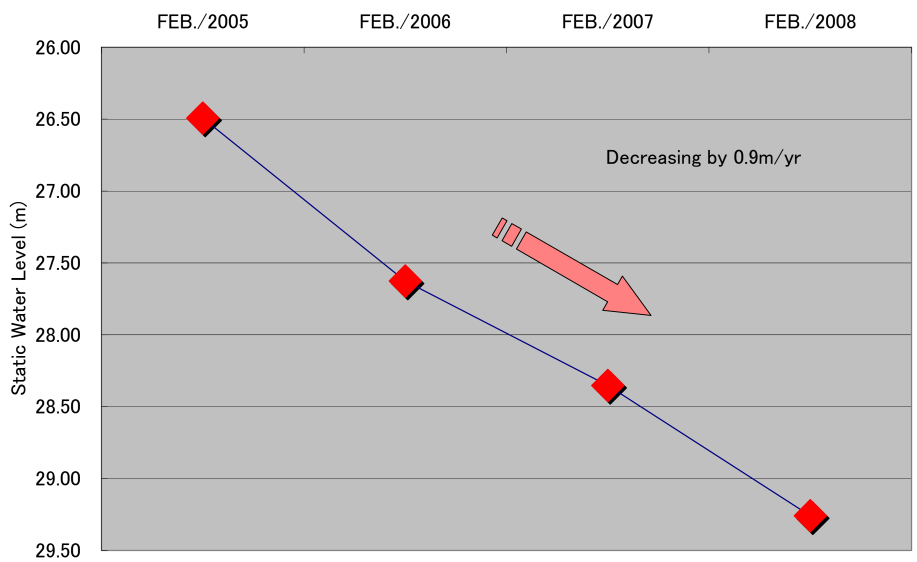


Figure 8.2 Results of monitoring static water level of groundwater

3) Serious unaccounted for water

According to the report by the Leak Detection Cell in WASA, unaccounted for water (UFW) was estimated to be 32% of system input volume in January and February of 2009.

The issues related to the high UFW rates are (i) consumers paying for inefficiencies of water utilities, (ii) a precious and scarce resource being wasted, and (iii) unnecessary investments in production.

The benefits of reducing UFW include:

- Need for less water to be produced, treated, and pumped, translating into the postponement of the expansion of capacity—producing less water also translates immediately into cost savings on O&M, due to savings in energy and treatment costs.
- Reduction in unauthorized consumption and metering inaccuracies, which will result in more water being billed and more revenue for utilities—it has also been shown that water metering and adequate rates reduce wasteful consumption, which will likely decrease total consumption.
- Adequate understanding of consumption patterns, which will allow utilities to optimize distribution systems.
- Better knowledge of real consumption, which will improve demand projections.
- Reduced sewage flows and pollution.

The main findings and recommendations to reduce the UFW are shown in **Table 8.3.**

Table 8.3 Main findings and recommendations to reduce UFW

Findings	Recommendations
• Water balance is still not clear due to the lack and deficiency of meters.	• Install bulk flow meters at tubewells • Install customer meters • Build the water balance
• Most leaks probably occur on service pipelines to customers because they use cheap material and its connection to the main is not properly constructed.	• Establish regulations for material of service pipes • Connect service pipelines to the main in good order
• Pipelines are getting deteriorated.	• Determine the deteriorated pipelines and build a replacement program • Replace deteriorated pipelines
• WASA initiate repairs only from reported leaks that surface above ground.	• Active leakage control

Fisrt, in WASA, only 5% of the tubewells have good bulk flow meters to quantify the flow, and 49% of customers do not have meters; only 13% of customers have meters in good order.

Reliable metering of all water volumes must be an integral component in tackling the main causes of loss as mentioned above, as well as manage water supply, water demand and loss determination. The most important part of determining how much water is being lost in a system is to accurately quantify the volume of water which is entering that system. The metering of source meters for abstraction is essential for water balance calculations.

The primary purpose of customer meters is to generate economic revenue based on metered consumption, but the accuracy of these meters is also a key issue in water balance calculations.

Secondly, it has been reported that most leaks are found in service connections to customers. Often the cheapest priced pipe, which is of inferior quality, is used, resulting in leakage. These pipes should not be approved and must not be used for maintenance, replacement or in construction of new service connections. Regulation for material of service pipes should be established.

In addition, it is also reported that service pipelines are not correctly installed, particularly at the connection to the water main of WASA so that leaks occur at the connection. Contracters should learn the detail to correctly install pipelines.

Thirdly, in WASA, AC pipeline has been mainly laid since the 1970s. Many of the pipelines have become so deteriorated that they should be replaced as pipe breaks have increased over time. Prior to the replacement, the pipeline network should be surveyed and its age, diameter and priority determined. It will enable the replacement program to replace the deteriorated pipelines effectively.

Finally, WASA currently initiate repairs of reported leaks that surface above ground. WASA should undertake active leak control programs to search out unreported leaks and undertake preemptive repairs to minimize losses.
To enhance the capacity of active leak control, the following action steps are needed; 1) increase the number of staff, 2) increase the number of equipment, 3) strengthen the capacity of leak detection and repair, 4) learn the comprehensive method of controlling UFW.

4) Increasing arsenic concentrations
The Pakistan Council of Research in Water Resources (PCRWR) carried out surveys of groundwater arsenic concentrations at 16 tubewells in Lahore from 2002 to 2006. In 2002, 10 tubewells exceeded 10μg/L, and none of them exceeded 50μg/L. The average concentration was 10.3μg/L, however in 2006, all tubewells exceeded 10μg/L and average concentration increased to 36μg/L. Maximum concentrations were up to 71.6μg/L. **Figure 8.3** shows the average concentration of arsenic in 2002 to 2006. These surveys indicate that arsenic concentration is obviously going up.

Due to the carcinogenic nature of arsenic, the World Health Organization (WHO) recommends a maximum permissible concentration for arsenic in drinking water of 10μg/L. Pakistan use the former WHO-recommended concentration of 50μg/L as their national standard to suit their national prorities including economic, technical, social, cultual and political requirements.

Another survey of groundwater arsenic concentrations was carried out in 2009 in this project given in **Table 8.5** and **Figure 8.4**. It is found that all the samples exceeded 10μg/L out of 10 tested tubewells and two samples exceeded 50μg/L. maximum concentration is 81.4μg/L and average concentration is calculated to be 44.8μg/L.

Although there has been a considerable amount of research carried out on the prescence of arsenic in groundwater and the environment over the years, many aspects of the mechanisms of release of arsenic are still poorly understood.
In Lahore, it is probably thought that the decreasing groundwater level might cause the release of arsenic, as most countries have had the same problem in recent years with the growing use of tubewells to tap groundwater for water supply and irrigation.

The dangers associated with long-term exposure to arsenic are now well known. The most prominent health problems in affected populations are skin disorders (melanosis, keratosis, skin cancer) but a large range of other disorders, including internal cancers, cardiovascular diseases, peripheral vascular disorders, respiratory problems, and diabetes, have also been linked to chronic high doses of ingested arsenic.

Now that some initial surveys have been carried out and arsenic problems have been recognized, a program of monitoring tubewells should be undertaken in order to identify the trends of arsenic. Arsenic should be included as a potential risk factor in decision-making about water-related issues.

The two main technological options for arsenic mitigation are (a) switch to alternative, arsenic-free water sources; or (b) remove arsenic from the groundwater source.
Considering the increasing water demand, reducing groundwater as the conventional water resource and mitigation of arsenic contamination, it is recommended that alternative water resource should be found.

There are both short term and long term measures that can be taken to address these issues;

- Acquire an alternative water resource
- Develop a master plan
- Install water treatment plants using for alternative water resource
- Regular monitoring of arsenic concentration

The water supply of Lahore city has always been based on the abstraction of groundwater. It is time to think about an alternative water resource such as surface water. Using surface water and installing water treatment plants will facilitate both meeting customer demand and diluting arsenic concentration from tubewells. In this case, a master plan would be required as the whole water supply scheme will have to be changed significantly.
Using an alternative water source will require significant modifications of the existing water supply system. Firstly, the exisiting network system has been built in order to supply water from more than 400 tubewells scattered throughout the city as its water source, whereas using surface water requires only one or more water treatment plants to feed the city. In other words, the water source will be centralized. This requires big trank mains to supply water to the service areas. Second, even if WASA could obtain the surface water as the alternative water source, the tubewells should be maintained, because the possible intake quantity of water from river or canals would be unstable particularly in winter. In this case, the tubewell supply system should back up the surface water supply system. That is to say, the tubewell and surface water sysytems should be integrated. These kinds of things should be considered in a master plan. The master plan must also include basic designs of intake facilities, water treatment plants, transmission and distribution systems and reservoirs.

Also, the concentration of arsenic in the tubewells should be monitored regularly and continuously. If the arsenic concentration in specific tubewells seriously exceeds the standard, it would be better to abandan those tubewells.

Table 8.4 Results of survey of arsenic concentration

S.No	Location		2002	2003	2004	2005	2006
1	Goharabad Tubewell Shalimar Town (New Bore)	WASA	10.0	21.2	37.0	31.7	45.2
2	Sultanpura TW Near Chah Meeran Shah	WASA	10.0	28.0	31.0	49.5	33.3
3	Ali Park Tubewell-1 Fort Road (New Bore)	WASA	20.0	51.0	55.0	21.8	71.6
4	Old Shahdra Town Centre Tubewell	WASA	0.0	16.5	52.0	23.9	24.6
5	Goal Bagh Tubewell Wahdat Colony	WASA	30.0	34.5	43.0	26.9	28.0
6	Guromanget Tubewell Gulberg-III	WASA	10.0	18.0	28.0	20.1	26.4
7	Tubewell Cantonment Boad Asghari Flats	Non WASA	0.0	19.6	29.0	22.0	29.8
8	Tubewell Tufail Road Saddar Bazar	Non WASA	0.0	28.9	31.0	30.6	35.8
9	TW-12, Ravi Block, Allama Iqbal Town	WASA	0.0	27.0	36.0	35.8	39.0
10	Tubewell Federal Lodge, Chamba House (New Bo	Non WASA	0.0	24.0	29.0	23.4	29.6
11	PCSIR Housing Society, Canal Bank Road	Non WASA	20.0	28.8	34.0	28.9	44.8
12	LDA Flats Opposite Faisal Town, Ghosia Masjid	WASA	20.0	23.1	30.0	23.6	31.4
13	Tubewell Riwaz Garden	WASA	10.0	26.3	32.0	24.2	40.4
14	Farooq Colony, Walton Road, Police Lines	Non WASA	0.0	19.8	31.0	21.8	32.6
15	Punjab Governemnt Co-Operative Housing Societ	Non WASA	25.0	29.3	30.0	26.1	30.6
16	Government Housing Scheme Township A-I	Non WASA	10.0	31.6	29.0	24.7	32.9
	Max.		30.0	51.0	55.0	49.5	71.6
	Min.		0.0	16.5	28.0	20.1	24.6
	Ave.		10.3	26.7	34.8	27.2	36.0

Source: Fifth water quality monitoring report 2005-06 by Pakistan Council of Research in Water Resources

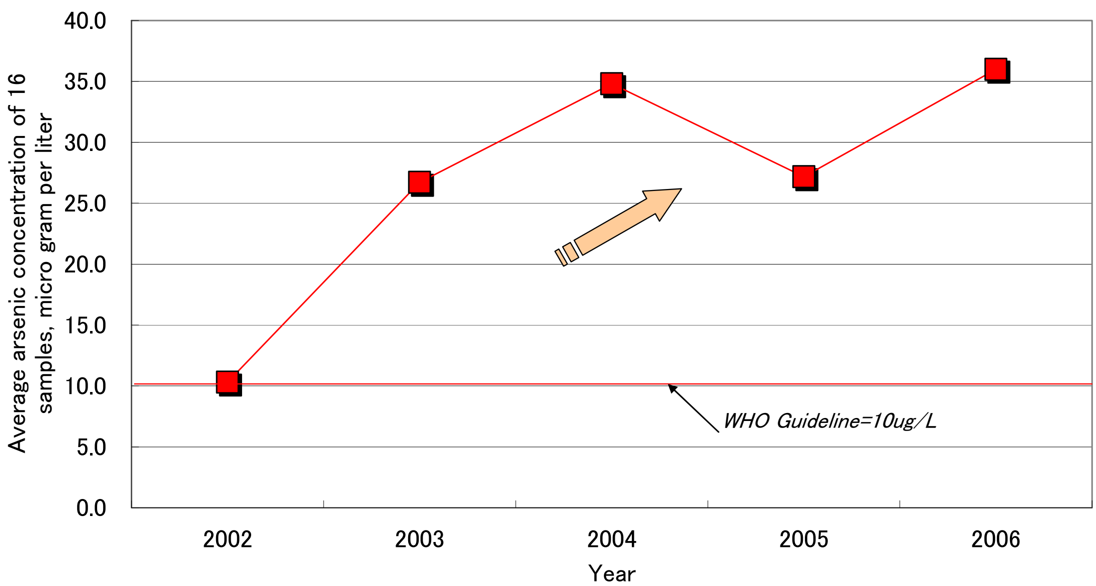


Figure 8.3 Results of monitoring arsenic concentration

Source: Fifth water quality monitoring report 2005-06 by Pakistan Council of Research in Water Resources

Table 8.5 Results of survey of arsenic concentration

Sr. No.	Sampling Point		As μg/l
1	ALI PARK T/W-1 FORT ROAD (NEW BORE) TW NO.)	WASA	81.4
2	GOHARABAD T/W SHALIMAR TOWN (NEW BORE) TW NO.144)	WASA	23.4
3	T/W MOZANG ADDA MAIN BAZAR (TW NO.297)	WASA	48.2
4	T.W TUFAIL ROAD SADDAR BAZAR (TW NO..)	WASA	31.0
5	TW-12, RAVI BLOCK , ALLAMA IQBAL TOWN (TW NO.235)	WASA	44.4
6	T/W CANTONMENT BOAD ASGHARI FLATS TW NO.--)	Non WASA	37.0
7	T.W R-BLOCK, LIQATA-ABAD (TW NO.220)	WASA	38.7
8	PUNJAB GOVT. CO-OPERATITAVE HOUSING SOCIETY (TWNO.)	WASA	40.4
9	SHALLOW WELL IN LDA AVENUE AREA	Non WASA	58.3
10	SHALLOW WELL IN CHONGI AMAR SADHU AREA	Non WASA	44.8
Max.			81.4
Min.			23.4
Ave.			44.8

Source: The water monitoring survey in Lahore under the JICA preparatory study on Lahore water supply, sewerage and drainage improvement project, 2009

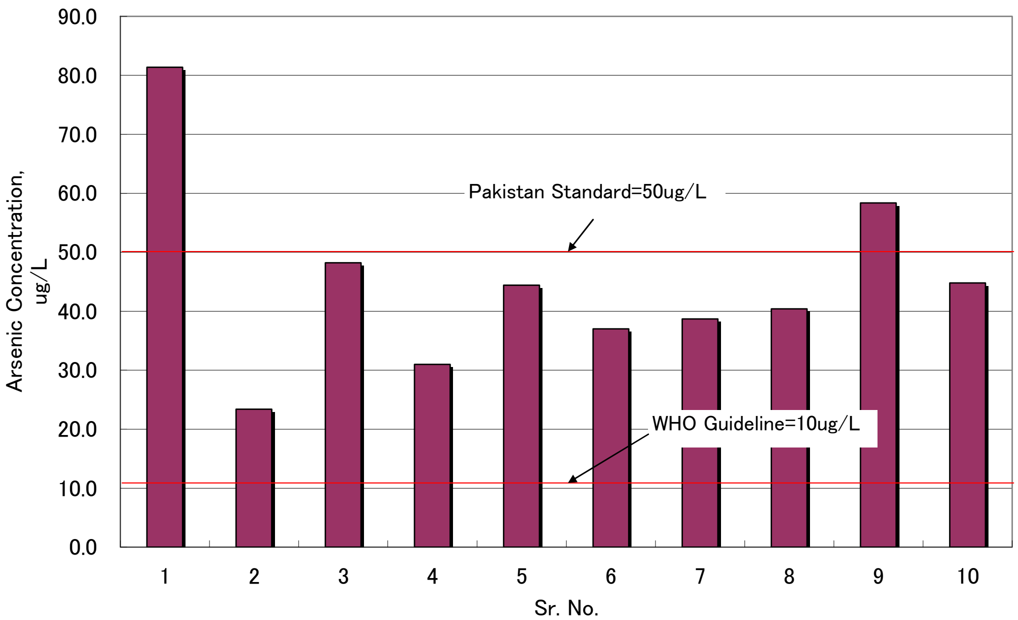


Figure 8.4 Results of monitoring arsenic concentration

Source: The water monitoring survey in Lahore under the JICA preparatory study on Lahore water supply, sewerage and drainage improvement project, 2009

5) Contamination in the pipelines

While arsenic is clearly an important public health threat, it needs to be noted that morbidity and mortality due to other waterborne diseases is also a serious health issue.

Table 8.6 shows the results of the survey of fecal coliform at tubewells and downstream water taps which is served by tested tubewells. There is no fecal coliform positive at any tubewells in WASA while four water taps are positive. Those results indicate that the water has been contaminated somewhere in the pipeline between the tubewell and the water tap.

Contamination in the pipeline can be caused by several factors:

- Negative pressures in the pipelines due to an intermittent water supply
- Cheap inferior service pipes
- Deteriorated distribute pipelines
- Individual pumps which can suck sewage around pipes
- Insufficient chlorine system

Tubewells are operated for 14-18 hours per day on average. To compensate for the intermittent water supply, a lot of customers have installed individual pumps with suction directly from the water main. The material of the water main pipes is mostly AC which was laid in the 1970s. These pipes seem have deteriorated. Also, customers often select the lowest price pipe which is of inferior quality and can easily be broken. When the tubewells are stopped, negative pressure develops in the pipelines which suck the sewage and other injurious material thereby causing water quality problems. WASA has commited to disinfecting abstracted water at tubewells but only 34% of chlorinators are working and the remaining tubewells are disinfected by a dripping system that is not as reliable as a chlorinator.

Table 8.6 results of survey of fecal coliform

Sr. No.	Sampling Point		Tubewell MPN/100ml	Tap Water MPN/100ml
1	ALI PARK T/W-1 FORT ROAD (NE BORE) TW NO.)	WASA	<2	<2
2	GOHARABAD T/W SHALIMAR TOWN (NEW BORE) TW NO.144)	WASA	<2	20
3	T/W MOZANG ADDA MAIN BAZAR (TW NO.297)	WASA	<2	15
4	T.W TUFAIL ROAD SADDAR BAZAR (TW NO..)	WASA	<2	2.2
5	TW-12, RAVI BLOCK , ALLAMA IQBAL TOWN (TW NO.235)	WASA	<2	5
6	T/W CANTONMENT BOAD ASGHARI FLATS TW NO.--)	Non WASA	38	96
7	T.W R-BLOCK, LIQATA-ABAD (TW NO.220)	WASA	<2	<2
8	PUNJAB GOVT. CO-OPERATITAVE HOUSING SOCIETY (TWNO.)	Non WASA	15	38
9	SHALLOW WELL IN LDA AVENUE AREA	Non WASA	<2	<2
10	SHALLOW WELL IN CHONGI AMAR SADHU AREA	Non WASA	5	11
Maximum Concentration			38	96
Minimum Concentration			<2	<2
% Sample Exceeding Permissible Limits			3	7

Source: The water monitoring survey in Lahore under the JICA preparatory study on Lahore water supply, sewerage and drainage improvement project, 2009

To tackle these issues, the following measures are recommended:

- Install chlorinators
- Establish regulations of service pipes and individual pumps
- Replace the deteriorated pipelines

In the long term, the intermittent supply should be revised to keep the system under pressure all the time.

6) Minimum required amount of alternative water

The required amount from the alternative water source is basically as much as the water demand, which is estimated to be 1,934,000m^3/day as stated in **Chapter 9.1.4**. If the total volume of the water demand is not obtained from the alternative water source, WASA will have to continue to use tubewells to meet the water demand in conjunction with water obtained from the alternative water source. In this case, arsenic concentration in the tubewell water must be diluted to less than 50μg/L to comply with the Pakistan water quality standard. In other words, WASA will need at least a certain amount from the alternative water source to dilute the tubewell water.

The arsenic concentration of the tubewell water is estimated to be 188μg/L in 2035 by the approximation given in **Figure 8.5** and **Table 8.7**.

To dilute the tubewell water from 188μg/L to 50μg/L, WASA will need 1,420,000 m^3/day from the alternative water source as calculated below;

Where;

Water demand in 2035:	1,934,000m^3/day
Amount of the alternative water to dilute the tubewell water:	X m^3/day
Amount of the tubewell water:	Y m^3/day

$$X + Y = 1{,}934{,}000\ m^3/day$$

Amount of arsenic in the tubewell water:	A μg
Amount of arsenic in the alternative water:	0 μg
Estimated arsenic concentration in the tubewell water in 2035:	188μg/L

Therefore, amount of arsenic in drinking water in 2035 is;

$$A\ \mu g = Y\ m^3/day * 188 \mu g/L$$

Allowable maximum arsenic concentration:	50 μg/L

Therefore,

$$A\ \mu g / 1{,}934{,}000\ m^3/day = 50\mu g/L$$

$$A\ \mu g = 50\mu g/L * 1{,}934{,}000\ m^3/day$$

$$A\ \mu g = 50\mu g/L * 1{,}934{,}000\ m^3/day = Y\ m^3/day * 188\mu g/L$$

$$Y\ m^3/day = 50/188 * 1{,}934{,}000\ m^3/day = 514{,}000\ m^3/day$$

$$X = 1{,}934{,}000\ m^3/day - Y = 1{,}934{,}000\ m^3/day - 514{,}000\ m^3/day = 1{,}420{,}000\ m^3/day$$

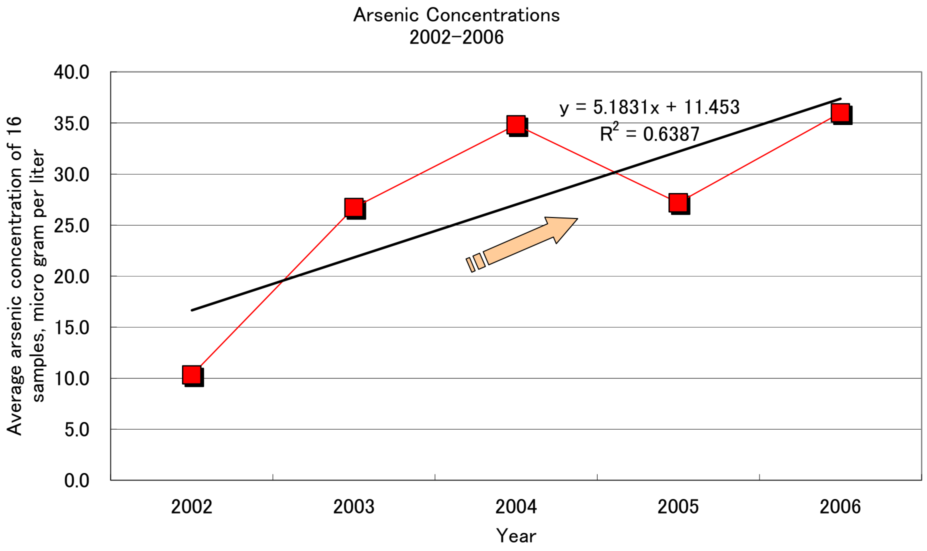


Figure 8.5 Results of monitoring arsenic concentration and approximation

Source of results of monitoring arsenic: Fifth water quality monitoring report 2005-06 by Pakistan Council of Research in Water Resources

	Results of monitoring arsenic ug/l	Projection of arsenic concentration ug/l
2002	10.3	-
2003	26.7	-
2004	34.8	-
2005	27.2	-
2006	36.0	-
2007	-	42.6
2008	-	47.7
2009	-	52.9
2010	-	58.1
2011	-	63.3
2012	-	68.5
2013	-	73.7
2014	-	78.8
2015	-	84.0
2016	-	89.2
2017	-	94.4
2018	-	99.6
2019	-	104.7
2020	-	109.9
2021	-	115.1
2022	-	120.3
2023	-	125.5
2024	-	130.7
2025	-	135.8
2026	-	141.0
2027	-	146.2
2028	-	151.4
2029	-	156.6
2030	-	161.8
2031	-	166.9
2032	-	172.1
2033	-	177.3
2034	-	182.5
2035	-	187.7

Table 8.7 Projection of Arsenic Concentration

Source of results of monitoring arsenic: Fifth water quality monitoring report 2005-06 by Pakistan Council of Research in Water Resources

(2) Non WASA

1) Urban areas served by utilities other than WASA

A part of the urban area is served by utilities other than WASA, such as the Lahore Cantonment Board, the Walton Cantonment Board, the Defense Housing Authority, the Model Town Society, the Pakistan Railway etc.

The key issues of urban areas served by other utilities are as follows:

- Insufficient interest in water quality
- Less chlorination systems
- Lack of respect for the arsenic issue

As per the interviews with the staff from these utilities, they seem to have little interest in water quality, because water quality has not suffered so far. These utilities therefore often supply water without disinfection. Also, they have not yet noticed the issue of arsenic contamination. They should monitor water quality regularly. In particular, a research program should be conducted in order to better determine the extent of the problem.

2) Rural area

Although the research has been conducted, there is still no clear picture of the current situation of the water supply to rural areas. There is no information about it, because there are no pubic utilities taking care of the operation and maintenance of rural water supply systems.

Two key issues were found:

- No public utilities responsible for the operation and maintenance of rural water supply
- Inadequate provision of water and sanitation services in some areas

The PHED has constructed water supply systems for much of the community, however it is not clear how many people can access safe drinking water. The problem is that none of public utilities or professional private companies take care of the water supply systems. After the completion of facilities, the PHED just hands them over to residents. The PHED’s responsibility is limited to the design and construction of the systems. After takeover, the residents have to operate the systems, but they are not qualified to do so due to their lack of knowledge of water supply systems.

In fact, a lot of systems fell apart due to lack of maintenance, although they once had functioned well.

All the water facilities should be operated by public utilities or expert operators to keep them running properly.

As results of the survey, it was found that the community of Samanabad Town, located out of WASA jurisdiction, has serious water issues. It is located on the western side of the

Bund Road, on the Ravi River bed. It is estimated that 50,000-100,000 people live there and most of them cannot access public water except for one section served by WASA. People get water by their individual shallow wells or ask neighbors in WASA's area to share water. They could use hand pumps, but currently prefer motor pumps because the groundwater level has decreased so much that a hand pump cannot lift very much water. The water quality of the individual pumps is often contaminated. Even in the WASA area, customers complain about water quality. It is often contaminated due to the low pressures in distribution and the individual pumps sucking sewage through deteriorated pipelines.

A lot of people in this area are suffering from waterborne diseases associated with the inadequate provision of water and sanitation services. These communities must have sources of clean drinking water.

8.1.2 Sewerage

(1) WASA Area

1) Shahdara Area

(a) Sewers

The majority of trunk sewers in this area are in good condition. However, trunk sewers and branch sewers are inadequate to cater for both present and future sewage flows due to the advanced age of existing sewers.

The existing sewerage system doesn't cover all of this area as yet. The existing system needs to be improved with trunk and branch sewers laid in unserved areas.

(b) Disposal Station

There are a total of 10 pumps in the Farakhabad Disposal Station and all pumps are in working condition. However, out of the 10 pumps, 2 pumps are old pumps which were installed in 1982 and the durability of these pumps have past their effective lifespans therefore, the pumps don't function at full design capacity. Also the total capacity of pumps for this disposal station will be inadequate to cater for future sewage flows.

2) Mehmood Booti Area

(a) Sewers

The majority of trunk sewers in this area are in good condition, however, a few of the sewers in the southern part of this area have already settled and are not in proper working condition. Therefore, sewers from a number of adjoining areas are connected to the Shalimar Escape Channel. The connection of sewers to an open channel, no doubt provides some relief but at the same time it results in a negative impact on the overall environmental conditions. The existing sewerage system doesn't cover all of this area yet, the existing system needs improvement with the development of trunk and branch sewers in formerly unserviced areas.

(b) Disposal Station

In the Mehmood Booti Disposal Station, there are 4 pumps and all pumps are in the working condition, however, the installed 1,000 KVA generator, can operate only 3 pumps so there is a need to provide an additional generator. The present capacity of the pumps will be inadequate to cater for future sewage flows.

3) Khokhar Road Area

(a) Sewers

Most of sewers are in good working condition. However, about 20% of the existing sewers in both the Misri Shar and Baghbanpura areas are egg-shaped brick masonry sewers. It was laid 30 to 40 years back, to cater for the population of that time, therefore, these sewers need to be replaced. The existing sewerage system doesn’t cover all of this area yet, and furthermore the existing system needs improvement with a need for the development of trunk and branch sewers in formerly unserved areas.

(b) Disposal Stations

The Shad Bagh Disposal Station was constructed in 1982 and there are six pumps in total. Out of the 6 pumps, 4 pumps which were installed in 1982 don’t function at full design capacity due to their age and need to be replaced. The existing 1,000 KVA generator, ,can operate only 4 pumps so there is need to provide an additional generator. The present capacity of the pumps will be inadequate to cater for future sewage flows. The Khokher Road Disposal Station has 3 pumps, but one pump is out of order due to mechanical problems. The existing generator (1,000 KVAa) has mechanical problems so it needs to be replaced.

4) Central Area

(a) Sewers

The existing sewerage system in the Central Area was laid 20 to 70 years back. During this period, there has been an immense increase in population making the system inadequate for the present population. Also, most of the sewers in the existing sewerage system have become badly silted up causing operation and maintenance problems. There are various industries in the upper part of the Central Area such as a molding industry, a carpet industry and flow mills. These industries discharge wastewater into the sewers without any treatment thus resulting in the reduction of the capacity of the sewers due to sedimentation and choking. The sewage is collected into the open drains which ultimately convey it to the trunk sewers. In addition to this, sewage is also pumped into storm water drains at a number of locations.

(b) Disposal Stations

The Multan Road Disposal Station was constructed in 1982 and the existing 6 pumps are in working condition. Out of the 6 pumps, 4 pumps which were installed in 1982 needs replacement due to the advanced age of the pumps. The existing capacity of the pumps will be inadequate to cater for future sewage flows.

For the Gulshan-e-Ravi Disposal station, there are 14 pumps all of which are in working condition, however, 8 pumps are old as they were installed in 1982, therefore, these pumps don't function at full design capacity. The present capacity of pumps will be inadequate to cater for future sewage flows.

The Main Outfall No.1 Disposal Station was constructed in 1945; this pumping station is the oldest one in Lahore. This disposal station has 10 pumps and while all pumps are presently in working condition, 2 pumps installed in 1983 and 1990 need replacement due to their age. The Main Outfall No.2 Disposal Station was constructed in 1977 and this disposal station has 4 pumps with all pumps in the working condition. However, 2 of the pumps installed in 1988 need replacement due to their advanced age

5) South Area

(a) Sewers

The old sewerage system in the upper part of the South Area is about 20 to 40 years old. Most of the trunk sewers in the existing system are inadequate to cater for both present and future sewage flows. Existing trunk sewers in most of the areas are in poor condition due to aging.

In the middle part of this area, there is no trunk sewer, therefore waste water is discharged into the nearby storm water drains and where no storm water drains exist, waste water is even discharged into open fields.

In the lower part of the South Area, the sewerage system was constructed in the last 3 to 20 years. Most of trunk sewers are in the good working condition, however, the majority of branch sewers have already settled and are not in proper working condition.

Presently, sewage is being discharged into the Sattu Katla Drain and Hudiara Drain as main carriers, these ultimately discharge into the River Ravi without any treatment, and in some of areas, there are no storm water drains so sewage is disposed of into open fields, thus creating environmental nuisance.

(b) Disposal Station

The LMP Block Disposal Station was constructed in 1985 and the existing 6 pumps are in the working condition, however the existing capacity of pumps is inadequate to cater for the present or future sewage flows.

6) South East Area

(a) Sewers

Most of trunk sewers in the existing sewerage system are in the good working condition. However, as this area has been experiencing very rapid urban growth rate trunk sewers have not been provided at an appropriate rate along suitable routes. On the other hand, the majority of the branch sewers have already settled and are not in the proper working condition due to maintenance problems.

Most of the South East Area, mainly consisting of new developments, have so far had no trunk sewer facilities provided so far by WASA. In these area, wastewater is discharged into the nearby storm water drains and where no storm water drains exist, wastewater is even discharged into open fields, thus creating environmental nuisance.

(2) Cantonment Area

1) Lahore Cantonment Area

Sewage of the Lahore Cantonment Area is finally discharged into the Cantonment Drain and the Rohi Nullah without any treatment which is not an environment friendly option and results in bad smell, breeding of mosquitoes and flies and contamination of ground water.

In this area, there are 11 existing disposal stations in good working condition, however, untreated sewage from these disposal stations are conveyed to storm water drains therefore, some of these drains flow at almost full capacity even during the dry season. Virtually no capacity is left to carry storm water during the rainy season. This results in inundation of catchment areas during the rainy season.

2) Walton Cantonment Area

Sewage from the Walton Cantonment Area is discharged into the ADA Nullah, the Rohi Nullah and the Cantonment Drain without any treatment. There are 14 existing disposal stations present in this area, all of which dispose their sewage into nearby storm water drains, which is a measure of the overall inefficiency of the system and results in environmental nuisance.

(3) TMA Area

As described in **Chapter 5.3.3(page 5-73 ~ 5-74)**, the Public and Health Engineering Department (PHED) has been providing some sewerage and drainage improvement schemes in this area, however, there is no Master Plan on sewerage and drainage improvement and the PHED prepare the implementation schemes for sewerage and drainage systems only on a year by year basis. Therefore, there is a great need to prepare a Master Plan on sewerage and drainage improvement.

8.1.3 Drainage

(1) WASA Area

1) Shahdara Area

As described in Section 5.4.1 (1), the Railway Line is a barrier that has divided the Shahdara Area into eastern and western sides. For the western side, the existing drainage system is primarily dependent on the Shahdara Drain. A number of sewers are connected to the Shahdara Drain so this drain flows at almost full capacity even during the dry season and its original cross-section in some reaches has been greatly reduced due to the dumping of solid wastes. The existing drainage system doesn't cover all of this area yet, and there is need to develop main and secondary drains in unserviced areas.

In the eastern part, presently there are only road drains and house drains. A proper drainage system needs to be planned and constructed in this part.

2) Mehmood Booti Area

The existing drainage system is primarily dependent on the Shalimar Escape Drain. This drain is comparatively better flowing and well maintained, however, its original cross-section in some reaches has been reduced due to encroachment and collapse due to livestock. There are also a number of sewers connected to this drain so it flows at almost full capacity even during the dry season.

The existing drainage system doesn't cover all of this area yet, and there is need to develop the main and secondary drains in unserviced areas.

3) Siddique Pura Area

The existing drainage system is primarily dependent on the Siddique Pura Drain, the Railway Drain and the Upper Chotta Ravi Drain. The Siddique Pura and the Railway Drains are covered drains and are comparatively in better flowing condition. The Upper Chotta Ravi Drain is an uncovered drain and most sections of this drain are still in good flowing condition. However,due to a lot of dumping of solid waste observed just near the pumping station, this section is blocked with much garbage and its original cross-section has been reduced. In the southwest part of this area, main and secondary drains have not been provided so there is a need to develop an appropriate drainage system.

The Siddique Pura Drainage Pumping Station was constructed in 1997 with a total number of 3 pumps. Of the 3 pumps, 1 pump is out of order due to mechanical problems so it will need to be replaced. There are 3 flap gates but all gates are not functioning and is in need of repair.

4) Chotta Ravi Area

The existing drainage system is primarily dependent on the Lower Chotta Ravi Drain. There are residences, buildings and small markets on either sides of the drain almost along the whole of its length, which obstructs cleaning and rehabilitation of the drain by machines. As a result, solid waste accumulation within the drain cross-section observed at several locations has reduced the flow carrying capacity of the drain. As a result, a lot of garbage flows into the Chotta Ravi Drainage Pumping Station.

With a number of sewers connected to this drain it flows at almost full capacity even during the dry season.

The Chotta Ravi Drainage Pumping Station was constructed in 1967 with a total of 7 pumps. Out of the 7 pumps, 5 pumps which were installed in 1967 don't function at full design capacity due to aging and need to be replaced. Also 1 pump which was installed in 1990 is out of order due to mechanical problems so this also needs to be replaced.

5) Central Area

In this area, the existing drainage system is primarily dependent on the Cantonment Drain, the Central Drain and the AIT Drain.

At present, the Central Drain is badly silted up or filled and encroached upon at a number of places. Especially, from Chuburgi Chowk to the beginning point of this drain there are residences and buildings on either sides of the drain, which obstructs cleaning and rehabilitation of the drain by machines. Consequently, solid waste accumulation within the drain at several locations has reduced its cross-section, its flow and carrying capacity. Since a number of sewers are connected to this drain it flows at almost full capacity even during the dry season. As there is virtually no space left to carry the storm water during the rainy season and in addition, since this area is at a relatively low elevation there are many inundation points within this catchment area.

The AIT Drain is also one of the main tributaries of the Cantonment Drain serving the critical areas of the lower part of the Central Area like Milat Chowk, Shabab Chowk, Mansoora, Scheme More and Chungi Multan Road. Upstream of this drain it is in comparatively better flowing condition and is well maintained, however a number of sewers are connected to this drain so it flows at almost full capacity even during the dry season. The stretch from the middle stream to downstream area is badly silted up or filled and encroached upon at the number of places, therefore the obstructed drain cross-section at several locations has reduced the flow and carrying capacity of the drain.. With virtually no space left to carry storm water during the rainy season the catchment areas flood during the rainy season.

The Cantonment Drain is the main drain in the Central Area. The Cantonment Drain is comparatively in better flowing condition and is well maintained. However a number of sewers are connected to this drain so it is flows at almost full capacity even during the dry season. Its original section has been greatly reduced due to dumping of solid wastes and encroachments at a number of locations.

6) Sattu Katla Area

Currently the major portion of the Sattu Katla Area comprises of proposed housing societies which will be developed in the future; whereas some other housing schemes have already been developed. Therefore the drainage system of this huge area will become a major environmental problem when the area becomes fully developed. The reason for this being that the existing drainage system will not be sufficient to cope with the increased run-off caused by the augmented population densities and built up areas of the city. In the absence of adequate facilities for a refuse collection system, solid waste is also disposed of into drains and hence causes blockages. Untreated industrial effluent from industrial estates also enters the Sattu Katla Drain. Untreated wastewater is ultimately discharged into River Ravi and is causing a deteriorating situation for its aquatic life. The connection of sewers to the drains, no doubt provides some relief but at the same time results in a negative impact on the overall environmental condition of the area especially as these drains usually pass through very important residential and commercial areas. It also results in making the operation and maintenance of the drains very difficult. Encroachments and uncontrolled solid waste dumping especially in the Sattu Katla Drain has greatly reduced the original cross-section and is hindering its smooth functioning.

7) Hudiara Area

In this area, there is no drainage pumping station, storm water is discharged into the Hudiara Drain or into nearby storm water drains and where no storm water drains exist it is even discharged into open fields. The Hudiara Drain serves as one of the most important drains of South Lahore. The drain receives industrial and urban/rural wastewater from both India and Pakistan. At present, its original cross-section in some reaches has been greatly reduced due to the dumping of solid wastes. Untreated industrial effluent from industrial estates is entering the Hudiara drain, which is ultimately discharged into River Ravi, therefore it is causing a deteriorating situation for aquatic life in the river.

(2) Cantonment Area

1) Lahore Cantonment Area

The drainage system of Lahore Cantonment is primarily dependent upon three major drains, namely the Cantonment Drain, the ADA Nullah and the Rohi Nullah. Due to the inadequacy of the trunk sewers in this area, these drains are being used as sullage carriers. Main areas along the Rohi Nullah in Lahore cantonment boundary are Bahu Wala village, Park View, Malik Pur, Eden City, Madina Park etc. Sewage from unplanned areas falls into the Rohi Nullah through open drains and pipes at various locations. Growth of vegetation and solid waste dumping has been observed in and along this Nullah at various reaches which reduces the flow velocity and consequently its entire reach has been silted. As a result, the carrying capacity of the Rohi Nullah has been much reduced. For the Cantonment Drain, during the rainy season storm water of the areas along it contributes flow in the drain however as the carrying capacity of the drain has been reduced due to the dumping of solid waste. Storm water of the ADA Nullah finally flows into the Sattu Katla Drain near the LDA quarters. At present, its original cross-section in some reaches has been greatly reduced due to the dumping of solid wastes.

2) Walton Cantonment Area

The drainage system of the Walton Cantonment Area is also dependent upon the Cantonment Drain, the ADA Nullah, the Rohi Nullah and the drain along Ferozpur Road. The drainage system of the Walton Cantonment Area has the same problems as discussed above in the Lahore Cantonment Area section i.e. dumping of solid waste in drains including growth of vegetation etc. Due to an overall inadequacy of the trunk sewers in this area, sewage from a number of adjoining areas are connected to these drains and as such these drains are acting as sullage carriers. Dumping of solid waste and encroachments along the drains have also reduced the cross sectional area.

8.2. Institutional Issues of WASA

(1) Development of Adequate Policy and Regulatory Environment

1-1 Preparation and enactment of Punjab Urban Water Act and WASCO Act (or Lahore WASA Act)

In Pakistan, there is no public service law like the water supply act, sewerage act, etc. and the powers and responsibilities of such service providers are not clear, although WASA has the three bylaws, namely (1) Water Supply Regulations, 1978, (2) Sewerage and Drainage Regulations, 1978 and (3) Licensed Plumbers, concerning the conditions for application for connections, installation and maintenance of services, specification for the laying of water supply pipes and fittings and sanitary sewers, specification for materials, protective measures and tests.. The rights and responsibilities between the service provider and customers are also vague. The present practice is unilateral to customers.

1-2 Establishment of (a) a concrete road map for increasing tariff to the adequate level, (b) a mechanism for adequate tariff revision, and (c) measures of financial supports by the government

Fixed costs increase every year. As a result, it negatively affects management activities. While, the renewal of the old facilities has been delayed and due to their age mechanical efficiency has decreased. As a result, this increases electric power expenses.

Increase in water tariff should be carefully linked with the increase in power tariff. Annual expenditure on electricity is about 43% of WASA's O&M expenditures. So WASA should calculate per unit cost of revenue water on the basis of the burden of power tariff increase. It is further explained by the following example assuming 20% increase in power tariff.

Table 8.8 Influence of Power Tariff Increase on O&M Expenditures

Expenditure (MRs)	Annual Cost		% of Total Cost		For example: 20% up on	Revised % of Tatal Budget
	2007-2008	2008-2009	2007-2008	2008-2009	2008-2009	
Payroll & Payroll burden	860.82	1,015.50	32%	32%	1,015.50	29%
Repair & Maintenance	577	663.5	21%	21%	663.50	19%
Lighting Power & Energy	1,175.20	1,411.20	43%	44%	1,693.44	49%
Other Expenses	94.1	106	3%	3%	106.00	3%
Total	2707.12	3196.2	100%	100%	3,478.44	100%
Refer to Table 6.43 Change in Profit and Loss Status by Fiscal Year				**Difference**	**282.24**	**9%**

$Cost(Rs/m^3)$	Total Cost (Rs/m^3)		Electric power expense Cost		For example: 20% up on	Revised % of Tatal Budget
	2007-2008	2008-2009	2007-2008	2008-2009	2008-2009	
Cost of Water Supply (RW)	7.2	7.58	3.13	3.35	4.02	8.25
Unit price of Water Supply (RW)	5.02	5.09	2.18	2.25	2.70	5.54
Refer to Table 6.60 WASA's Benchmarks (13-2 & 13-3)				**Difference**	**0.45**	**20%**

However, with respect to the revision of the water rates, a price hike is difficult due to the resistance from the Government of the Punjab. As a result, the operating revenues cannot be increased.

It requires to establishment of a concrete road map for increasing tariff to the adequate level.

(2) Timely Data Acquisition and Preparation of Definitive Vision and Strategies

2-1 Regular preparation of mid-term and annual business plans

A mid-term and annual business planning exercise is unfinished. As a result, improvement to management has been delayed and the deficiencies increase every year because financial targets and time schedules are uncertain,

At present financial processing takes place through batch processing of costs. These costs involve water works and sewerage works. The causes and the investigations of these which face the management have been experiencing considerable difficulties. As a result, effective cost reduction measures cannot be implemented.

2-2 Establishment of performance monitoring indicators and regular monitoring system

Performance monitoring indicators has been calculated in WASA, but no target is given to them. They should be established as the target for improvement throughout one year activities to keep the motivation of employees.

2-3 Implementation of comprehensive asset survey and preparation of asset inventories and drawings

Corrections to, and additional work on, the water pipeline network and associated facilities have been delayed. As a result, there are no technical drawings showing the current status to serve as basic data, hence an effective scheme for any updating efforts would be difficult to provide.

(3) Reduction of Unaccounted-for-water and Non-revenue-water

3-1 Clarification of rights and responsibilities in relations with customers

Currently, rights and responsibilities for service connections are mostly described in WASA's application and agreement form with customers. This agreement looks like being weighed against customers, because customers have to pay and be responsible for everything of service connections, however all the equipment is considered the property of WASA.

3-2 Installation of meters in 40% of connections

The investigation of unaccounted-for water has not been attempted because of the lack of available technical drawings of the water pipeline network, lack of the water meters at customers and bulk flow meters at tube-wells, the lack of numbers of investigators as well as the measurement equipment which has not improved. As a result, action on reducing the unaccounted-for water losses has been delayed.

The billing of the amount of the water supplied is dependent on fixed charges where no water supply meters are installed. As a result, the revenue from operations doesn't increase and it is not possible to measure the amount of water supplied or control wasted water. While bulk flow meters (BFMs) installed on delivery pipe lines of tube-wells are either experiencing breakdowns or are unfinished. As a result, the amounts of water supplied cannot be measured.

3-3 Establishment of leakage detection teams

Activities to reduce water leaks is inadequate because of missing technical drawings/information on the pipe line route, rehabilitation work done, the materials used, the existing dimensions, and flow quantities. As a result, the amount of the water leakage and the points of leakage have not been confirmed.

3-4 Implementation of distribution network improvement in the priority area in the central Lahore within agreed loan amount and period, based on asset study and subsequently-prepared distribution network improvement plan in the entire WASA area

Under the project of "Identification study of water supply and sewerage services in Lahore city" by France, a pilot area which consists of 1,500 connections and 30km of pipelines was selected in a newly developed residential area of Johar Town. As a result of the project, the level of UFW reduced 15% to 10%. This indicates that the pilot area approach is a good way to reduce UFW effectively. So it is recommend that this approach should be continuously rolled out area by area in the whole city.

3-5 Implementation of stringent measures against defaulters and illegal connections and phasing-out of uncharged public stand posts

Under the project mentioned-above, this report says that 3% of connections were found to be illegal. This figure is lower compared to the estimated number of illegal connections in the city more around 5% according WASA officials.

3-6 Entrustment of metering and billing to private companies

A lot of paperwork mistakes are generated within the system of metering- billing-delivery due to human errors. Moreover, there is much confirmation work of documents taking place. As a result, a lot of the staff is over-burdened with work in addition to attending to the many complaints received as well.

(4) Human Resource Development and Organizational Streamlining

4-1 Organizational restructuring

Reshuffling the organization appropriately or organizational reform has not been tried although the business has expanded and it is progressively aging. As a result, the functional efficiency of the organization has decreased, with insufficient operation and maintenance. This has also resulted in a number of citizen complaints as well.

4-2 Improvement of personnel management and human resource development

Employment conditions have not improved with recruitment of staff including contract employees being hired for low wages, involving unhygienic working conditions and heavy labour. Moreover, employment of professionals has been experiencing delays because of the low wages offered. As a result, incentives for activation and rejuvenation of the organization have not been emerged.

WASA publicly seeks human resources with specialized knowledge on finance/management/design; however, such personnel cannot be secured due to low payroll. Correspondingly, appropriate head-counts also cannot be secured due to insalubrious undertakings and low payroll regarding the contract field employees.

Employee's education still remains at the level for field workers (work safety education) due to insufficient equipment contents and instructors to be provided by WASA Training Center.

4-3 Entrustment of certain facilities to private companies

For the reduction of management cost, to control declining in efficiency of management, and for dispensing with insufficiently talented people, it is considered necessary to examine whether outsourcing of WASA (in part) is possible or not.

4-4 Establishment of Management Information System

The report that shows the transition of management is unfinished. As a result, it is difficult to observe WASA's official management record, for example the change of the work content, the financial status, the business data, the O/M situation, and the numbers of staff, etc.

Because available material on numerical values is insufficient, managerial judgment becomes totally experience based, and, as a result, might lose its validity with time.

Since the operation and maintenance ledgers on tube-well data have not been effective in most cases because data is only handwritten, the use of appropriate statistical methods to improve the operation and maintenance cannot be implemented.

Document control of inventory books is a complex task because entries are made only in longhand. As a result, information on the stock material cannot be acquired rapidly.

Because basic data is lacking, the mapping system concerning the network of pipe lines and open channel networks together with inundation hazard assessment is still incomplete. As a result, citizens receive poor service.

4-5 Procurement of O&M equipment

Cleaning work on sewers and open channels is unhygienic and a source of danger as poisonous fume generation is high. The work efficiency is low because much of it depends on human power due to insufficient machinery. As a result, living conditions are deteriorating due to the overflow of sewage every day because cleaning work is delayed.

Dewatering equipment that reduces inundation damages at times of emergency is a necessity. However, the replacement/upgrading of near obsolete equipment has been delayed. Moreover, the breakdown frequency is high if during repair scrap parts are used.. It is difficult to repair non-working equipment in a short time. As a result, inundation damage expands when there are insufficient machines or they break down often.

(5) Improvement of Customer Services

5-1 Clarification of rights and responsibilities in relations with customers

(See 3-1)

5-2 Regular implementation of customer survey

To establish the confidentiality between WASA and customers, it is necessary to check to what extent the customer satisfies the products and services that WASA provides and to grasp on what points of the products and services that WASA provides the customer has complaints

5-3 Improvement of complaint handling system

Mistakes in communications are generated though the inefficient handling of complaints regarding O&M as they are reported from the reception desk by wireless through the person in charge of the site. Moreover, neither details nor the resulting report of the complaint concerning O&M and the Revenue have been adequately described in the ledger. As a result, this potentially precious data is of little use as material for managerial decisions.

5-4 Expansion of payment options for customers

The method to pay the water bill has been mainly through transfer of cash by the banking facility, the Government Post Office, and the NADRAs' office. The cash payment procedure at the banking facility takes about 1 hour, and the customer feels inconvenience for it. Moreover, there is a possibility of office work mistake by an authorized person of financial institution.

5-5 Preparation of public relation strategy and its implementation

Schedules of the water supply times, information on water rates, and managerial practices are not disclosed to the public. As a result, mutual trust with the citizens is lacking.

Measurements of water leaks and the cleaning of private water tanks at each home are insufficient due to management shortages. In addition, educational campaigns for water-saving measures and water pollution control measures are insufficient.

(6) Groundwater Monitoring and Regulation

6-1 Follow up survey and analysis on groundwater quality and quantity
6-2 Establishment of groundwater committee
6-3 Preparation of groundwater control and regulation plan
6-4 Establishment of regular monitoring of groundwater

The water level of groundwater has been declining and the arsenic concentration of groundwater has shown the ascending trend in the past five years. The groundwater is now used for domestic, industrial and irrigational purposes without any proper control and regulation. Groundwater quality must be monitored continuously. It's high time to evaluate the groundwater resources with the latest data and technical knowledge. Under sharing such information, the committee should be established to consider the control and regulation of groundwater and to share the roles and responsibilities of each sector.