ISLAMIC REPUBLIC OF PAKISTAN
WATER AND SANITATION AGENCY FAISALABAD (WASA-F)

ISLAMIC REPUBLIC OF PAKISTAN

THE PROJECT FOR WATER SUPPLY, SEWERAGE AND DRAINAGE MASTER PLAN OF FAISALABAD

FINAL REPORT

VOLUME I EXECUTIVE SUMMARY

FEBRUARY 2019

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIHON SUIDO CONSULTANTS CO., LTD.
JAPAN TECHNO CO., LTD.
YOKOHAMA WATER CO., LTD

Foreign Exchange Rates:
Master Plan
US$ 1 = JPY 111.29
US$ 1 = PKR 104.85
(As of December 2017)

FINAL REPORT
ON
THE PROJECT FOR WATER SUPPLY, SEWERAGE AND DRAINAGE
MASTER PLAN OF FAISALABAD

GENERAL TABLE OF CONTENTS

(In addition to the above reports, a Completion Report summarizing the results, outcomes, and recommendations obtained from the pilot activities of this Project will be prepared in May 2019 as a supplemental report.)

VOLUME I
EXECUTIVE SUMMARY

TABLE OF CONTENTS

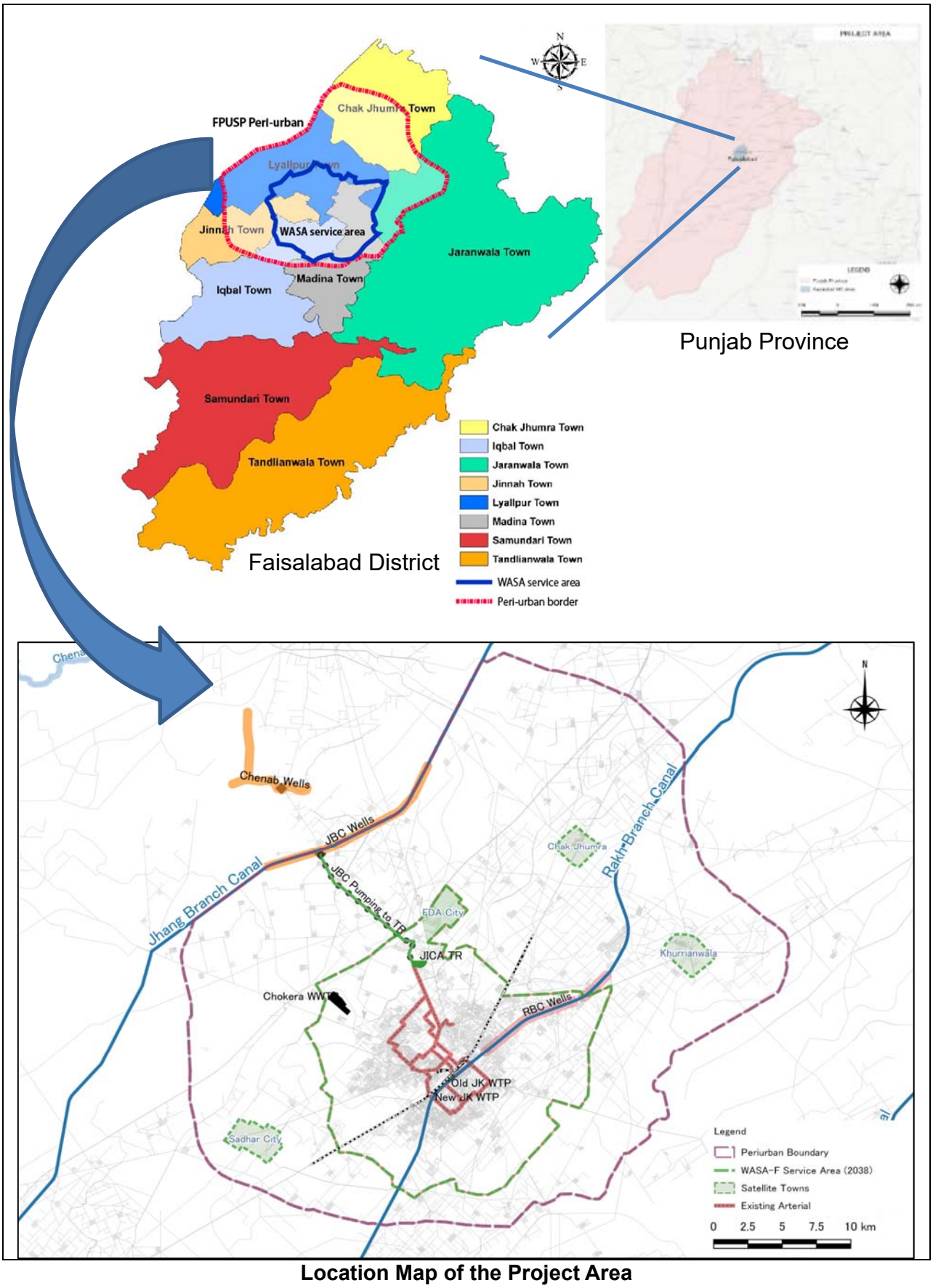
LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND TERMINOLOGY

AC	Asbestos Cement
AFD	Agence Française de Development
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CRC	Customer Relations Center
DC	Distribution Center
DCIP	Ductile Cast Iron Pipe
DF/R	Draft Final Report
DI	Ductile Iron
DMA	District Metered Area
DMD	Deputy Managing Director
DMZ	District Metered Zone
EBIT	Earnings Before Income Tax
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
EPA	Environmental Protection Agency
EPA-F	Environmental Protection Agency, Faisalabad
EPD	Environmental Protection Department
FC/R	Final Completion Report
FDA	Faisalabad Development Authority
FESCO	Faisalabad Electric Supply Company
FIRR	Financial Internal Rate of Return
FPUSP	Faisalabad Peri-Urban Structure Plan
F/R	Final Report
F/S	Feasibility Study
GAAP	Generally Acceptable Accounting Principle
GBC	Gugera Branch Canal
GIS	Geographic Information System
GOJ	Government of Japan
GOP	Government of Pakistan
GOPb	Government of Punjab
GR	Ground Reservoir
HDPE	High Density Polyethylene
HIES	Household Integrated Economic Survey
IEE	Initial Environmental Examination
IRR	Internal Rate of Return
IT	Information Technology
JBC	Jhang Branch Canal
JICA	Japan International Cooperation Agency
JK	Jhal Khanuana
JMT	JICA Mission Team
k	kilo-
km	Kilo-meter
KPI	Key Performance Indicator
l, L, lit	liter
LCC	Lower Chenab Canal
m	meter

m^2	Square meter
m^3	Cubic meter
MD	Managing Director
MGD	Million Gallon* per Day (*1 gallon = 4.546 liters)
MIS	Management Information System
M/P	Master Plan
NBP	New Business Plan
NGO	Non-governmental Organization
NPV	Net Present Value
NRW	Non-Revenue Water
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OHR	Over Head Reservoir
OJT	On the Job Training
O&M	Operation and Maintenance
P&D	Planning & Design, or Planning & Development
PCGIP	Punjab Cities Governance Improvement Project
pH	Potential of Hydrogen
PHED	Public Health Engineering Department
PI	Performance Indicator
PKR, Rs.	Pakistan Rupee
PMD	Pakistan Meteorological Department
PS	Pumping Station
RBC	Rakh Branch Canal
RWR	Raw Water Reservoir
SCADA	Supervisory Control and Data Acquisition
SOP	Standard Operating Procedure
SS	Suspended Solids
TDS	Total Dissolved Solids
TR	Terminal Reservoir
T-N	Total Nitrogen
T-P	Total Phosphorus
UASB	Up-flow Anaerobic Sludge Blanket
VAT	Value Added Tax
WAPDA	Water and Power Development Authority
WASA	Water and Sanitation Agency
WASA-F	Water and Sanitation Agency Faisalabad
WHO	World Health Organization
WSP	Water and Sanitation Program
WSZ	Water Supply Zone
WTP	Water Treatment Plant
WW	Water Works
WWF	World Wildlife Fund
WWTP	Wastewater Treatment Plant



Location Map of the Project Area

OUTLINE OF THE WATER SUPPLY, SEWERAGE AND DRAINAGE MASTER PLAN

1. Background and Objectives

Faisalabad is the second largest city of Punjab Province and the third largest city of Pakistan. The population of the urban areas of Faisalabad was tallied at about 2.7 million as of 2015 and is expected to increase to over 4 million by 2038.

Rapid population growth in Faisalabad has made it difficult to secure adequate quantities of water for supply from both infrastructure development and resource development perspectives. As of 2015, only 60% of the households in the city had access to municipal water supplied by the Water and Sanitation Agency, Faisalabad (WASA-F).

The sewerage coverage ratio within the current WASA-F service area was only about 73% in 2015. The areas without sewerage must cope with chronically unsanitary conditions, while the areas with sewerage drains must cope with pressing challenges to maintenance.

In this context, the Government of Pakistan (GOP) requested the Government of Japan (GOJ) to provide support for the establishment of a long-term plan for appropriate water resource development, facility investment linked to urban planning, the proper maintenance of existing facilities, increased water and sewerage revenue, improved financial performance, and the sustainable operation of water supply and sewerage services.

The main objectives of the study are to develop an integrated Master Plan for water supply, sewerage and drainage in Faisalabad City (hereinafter referred to as the “Master Plan” or “M/P") and to enhance the institutional capacity for implementation of the M/P.

2. Water Supply Master Plan

(1) Proposed Project Components

- Construction and Expansion of Water Treatment Plants (WTPs) and Tubewells
- Installation and Expansion of Transmission Mains
- Installation and Expansion of Arterial Mains
- Installation and Expansion of Distribution Mains
- Construction and Expansion of Terminal Reservoirs (TRs)
- Construction of Distribution Centers (DCs)
- Construction and Expansion of Distribution Networks
- Service Connections

(2) Phased Outline of the Water Supply Master Plan Project

Table 1 Phased Outline of the Water Supply Master Plan

Items	Unit	Phase 1	Phase 2	Phase 3	Phase 4
		2018-2023	2024-2028	2029-2033	2034-2038
Population in Service Area	person	3,026,190	3,399,500	3,772,800	4,146,110
Population Served	person	1,815,700	2,549,600	3,395,500	4,146,100
Service Ratio	%	60%	75%	90%	100%
Total Consumption (Daily Ave.)	1000 m^3/day	552	762	949	1,089
Total Demand (Daily Max.)	1000 m^3/day	663	876	1,092	1,252
Total Water Sources	1000 m^3/day	623	918	1,168	1,259

Source: JICA Mission Team

(3) Phased Water Source Development Plan

To increase the total water supply volume from 500,000m3/day (110 MGD) in 2015 to 1,259,000m3/day (277 MGD) in 2038.

Phase 1 (2018～2023)

No.	Contents
1-1	Original Jhal Khanuana (JK) WTP: replace the existing slow sand filter system, 16,000 m^3/day (3.5 MGD), with a rapid sand filtration system, 22,700 m^3/day (5.0 MGD)
1-2	New JK WTP: expand the rapid sand filtration system constructed by French loan to 22,700 m^3/day (5.0 MGD)
1-3	Gugera WTP-1: New construction, 113,700 m^3/day (25.0 MGD)
1-4	GBC New Tubewells-1: New construction, 22,700 m^3/day (5.0 MGD)
1-5	Allama Iqbal WTP: New construction, 6,800 m^3/day (1.5 MGD)

Phase 2 (2024～2028)

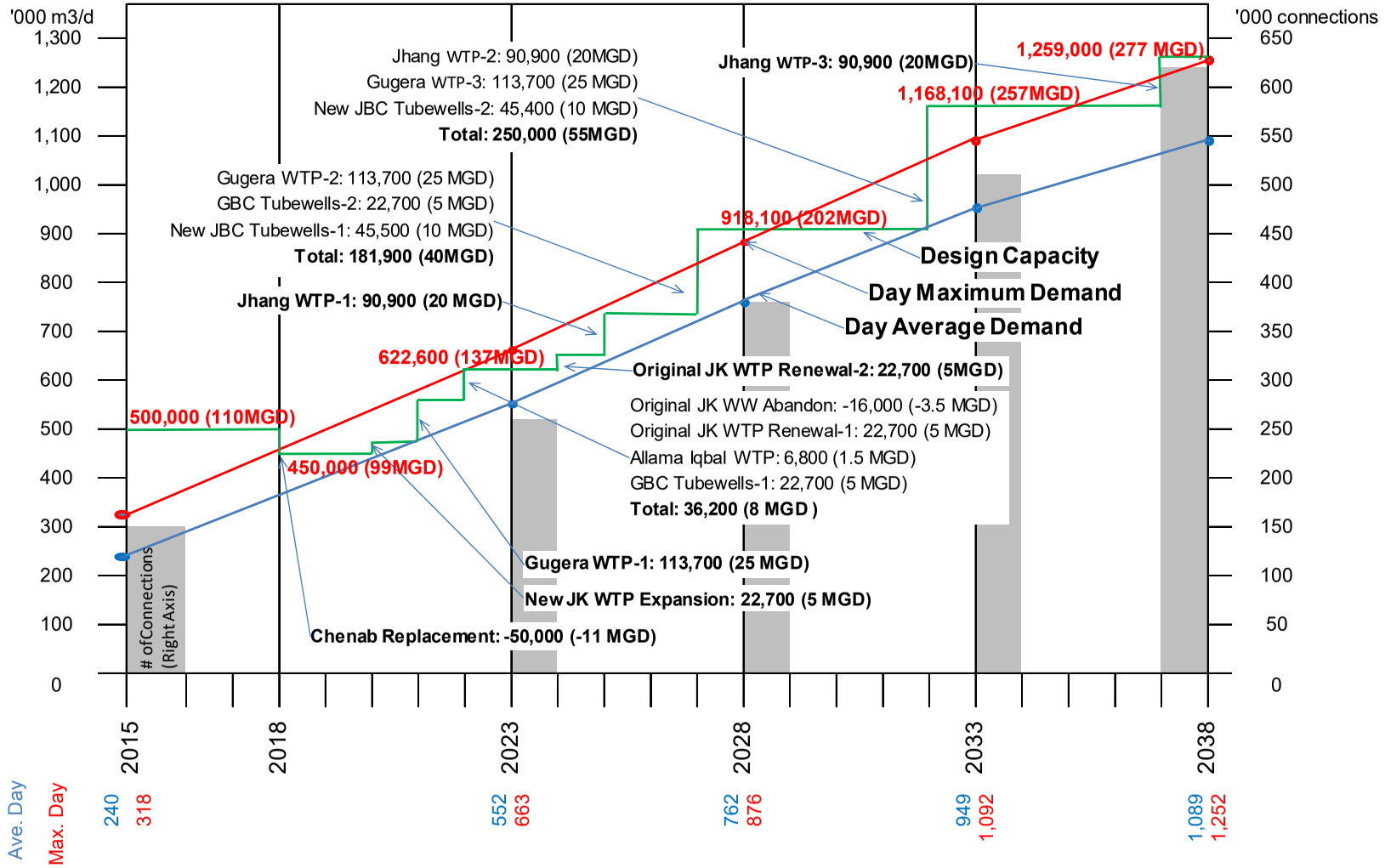
No.	Contents
2-1	Original JK WTP: extend the rapid sand filtration system, 22,700 m^3/day (5.0 MGD)
2-2	Jhang WTP-1: New construction, 90,900 m^3/day (20.0 MGD)
2-3	Gugera WTP-2: Extension, 113,700 m^3/day (25.0 MGD)
2-4	GBC Tubewells-2: Extension, 22,700 m^3/day (5.0 MGD)
2-5	JBC New Tubewells-1: New construction, 45,500 m^3/day (10 MGD)

Phase 3 (2029～2033)

No.	Contents
3-1	Jhang WTP-2: Extension, 90,900 m^3/day (20.0 MGD)
3-2	Gugera WTP-3: Extension, 113,700 m^3/day (25.0 MGD)
3-3	JBC New Tubewells-2: Extension, 45,400 m^3/day (10 MGD)

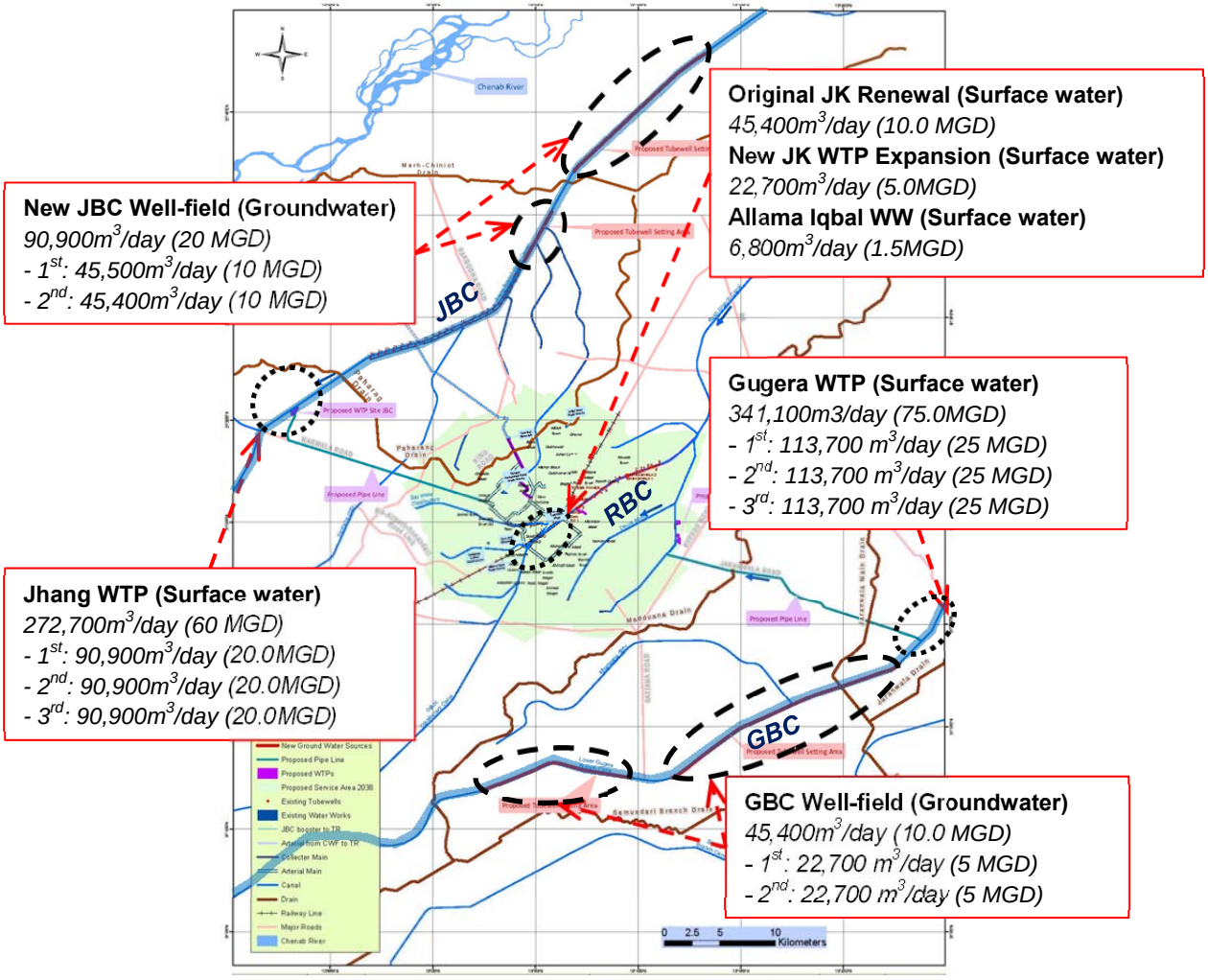
Phase 4 (2034～2038)

No.	Contents
4-1	Jhang WTP-3: Extension, 90,900 m^3/day (20.0 MGD)



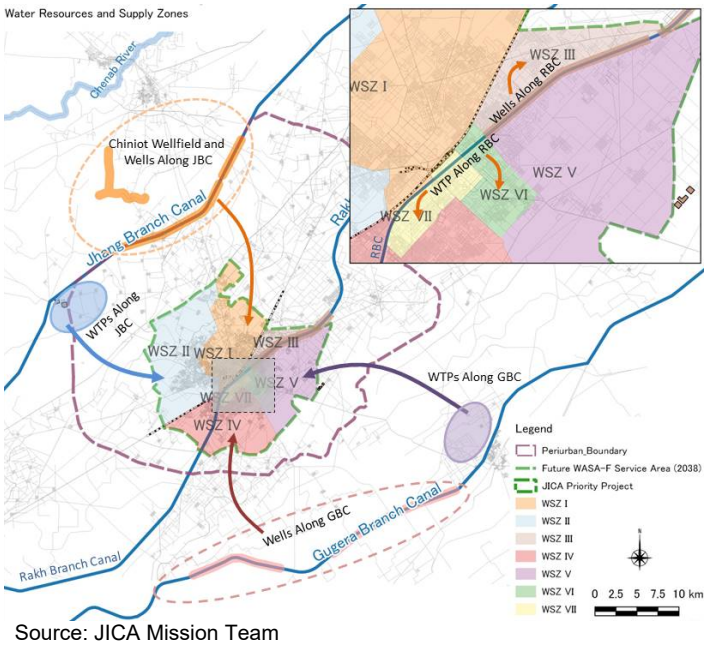
Source: JICA Mission Team

Figure 1 Step-wise Development Plan in Faisalabad City (Core Supply Area)



SOURCE: JICA Mission Team

Figure 2 Location of New Water Source Development



Source: JICA Mission Team

Figure 3 Water Resources and WSZs in 2038

(4) Project Cost Estimations

Table 2 Phased Cost Estimates for the Water Supply Master Plan Project

Unit: million PKR

WTP/Tubewells	Facilities	Phase 1	Phase 2	Phase 3	Phase 4	Total
Original JK Renewal	WTP	1,031	1,139			2,170
	Pipe	1,168	607			1,775
	TR, DC	332	122			454
	Other	174	297			471
	Sub-Total	2,705	2,165			4,870
New JK WTP Expansion	WTP	961				961
	Pipe	1,111				1,111
	TR, DC	311				311
	Other	163				163
	Sub-Total	2,546				2,546
Gugera WTP	WTP	4,979	6,110	7,267		18,356
	Pipe	8,907	11,080	3,943		23,930
	TR, DC	3,110	2,577	454		6,141
	Other	851	1,641	2,038		4,529
	Sub-Total	17,847	21,408	13,702		52,956
Allama Iqbal WTP	WTP	308				308
	Pipe	351				351
	TR, DC	111				111
	Other	52				51
	Sub-Total	822				821
Jhang WTP	WTP		4,642	5,813	6,956	17,411
	Pipe		4,505	5,556	3,374	13,435
	TR, DC		1,466	2,157	2,479	6,102
	Other		1,226	1,634	2,288	5,149
	Sub-Total		11,839	15,160	15,097	42,097
GBC Tubewell	Tubewell	205	239			444
	Pipe	3,804	637			4,441
	TR, DC	472	129			601
	Other	174	327			502
	Sub-Total	4,655	1,332			5,988
New JBC Tubewell	Tubewell		477	559		1,036
	Pipe		2,633	1,579		4,212
	TR, DC		587	153		740
	Other		657	819		1,476
	Sub-Total		4,354	3,110	0	7,464
Construction Cost	**Total**	**28,575**	**41,098**	**31,972**	**15,097**	**116,742**
Consulting Fee 10%		2,857	4,110	3,197	1,510	11,674
Contingency 2%		571	822	639	302	2,335
Grand Total (incl. above fees)		29,152	32,001	46,032	35,808	16,909
Tax 16%		5,120	7,365	5,729	2,705	20,920
Grand Total (incl. tax)		37,121	53,397	41,537	19,614	151,671
Service Connection		**708**	**1,270**	**1,350**	**1,175**	**4,503**

Source: JICA Mission Team

(5) Implementation Schedule

No.	Project	Capacity	Time Frame: Phase 1 2018-2023 (18 19 20 21 22 23)	Phase 2 2024-2028 (24 25 26 27 28)	Phase 3 2029-2033 (29 30 31 32 33)	Phase 4 2034-2038 (34 35 36 37 38)	WTP	Transmission	Arterial Main	Distribution Main	TR	DC	Secondary, etc.	DMA	Cost (Million PKR)	Fund Expected
Cost			**28,575**	**41,098**	**31,972**	**15,097**									**116,742**	
Phase 1															**28,575**	
1-1	Original JK WTP Renewal-1 and Water Distribution System	22,700 m^3/day (5.0MGD)					●		●	●		●	●	●	2,705	JICA Grant
1-2	New JK WTP Expansion and Water Distribution System	22,700 m^3/day (5.0MGD)					●		●	●		●	●	●	2,546	AFD Phase-II
1-3	Gugera WTP-1 and Water Distribution System	113,700 m^3/day (25.0MGD)					●	●	●	●	●	●	●	●	17,847	AFD Phase-II
1-4	GBC Tubewells-1 and Water Distribution System	22,700 m^3/day (5.0MGD)					●	●	●	●	●	●	●	●	4,655	
1-5	Allama Iqbal WTP and Water Distribution System	6,800 m^3/day (1.5MGD)					●		●	●		●	●	●	822	GOPb
Phase 2															**41,098**	
2-1	Original JK WTP Renewal-2 and Water Distribution System	22,700 m^3/day (5.0MGD)					●		●	●		●	●	●	2,165	
2-2	Jhang WTP-1 and Water Distribution System	90,900 m^3/day (20.0MGD)					●	●	●	●	●	●	●	●	11,839	
2-3	Gugera WTP-2 and Water Distribution System	113,700 m^3/day (25.0MGD)					●	●	●	●	●	●	●	●	21,408	
2-4	GBC Tubewells-2 and Water Distribution System	22,700 m^3/day (5.0MGD)					●		●	●		●	●	●	1,332	
2-5	New JBC Tubewells-1 and Water Distribution System	45,500 m^3/day (10.0MGD)					●	●	●	●	●	●	●	●	4,354	
Phase 3															**31,972**	
3-1	Jhang WTP-2 and Water Distribution System	90,900 m^3/day (20.0MGD)					●	●	●	●	●	●	●	●	15,160	
3-3	Gugera WTP-3 and Water Distribution System	113,700 m^3/day (25.0MGD)					●		●	●		●	●	●	13,702	
3-3	New JBC Tubewells-2 and Water Distribution System	45,400 m^3/day (10.0MGD)					●		●	●		●	●	●	3,110	
Phase 4															**15,097**	
4-1	Jhang WTP-3 and Water Distribution System	90,900 m^3/day (20.0MGD)					●		●	●	●	●	●	●	15,097	

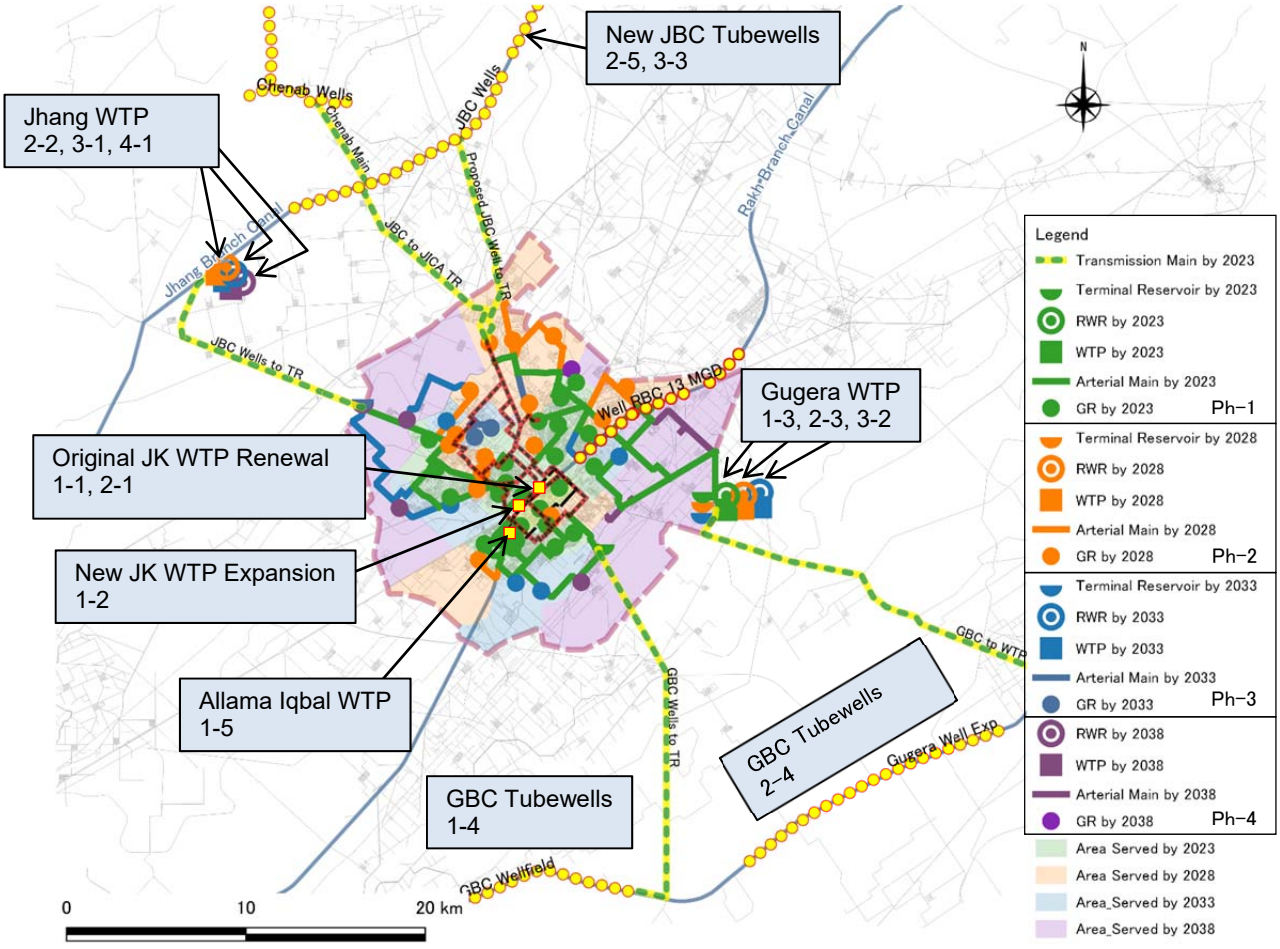
Legend: Preparation (F/S, Fund Arrangement, etc.); Implementation

Source: JICA Mission Team

Figure 4 Phased Implementation Schedule for the Water Supply Master Plan Project

(6) Location of Projects

Project sheets with details on each project are also provided in **Appendix AS1.**1 of the **Supporting Report**.



Source: JICA Mission Team

Figure 5 Locations of Projects

3. Sewerage and Drainage Master Plan

(1) Proposed Project Components

- Main Sewers and Branch Sewers
- Trunk Sewers and/or Interceptor Sewers
- Lift Pumping Stations and Influent Pumping Stations
- Wastewater Treatment Plants

(2) Phased Development of Sewerage and Drainage Facilities

Table 3 Phased Sewerage Development Plan in the West Sewerage District

Item	Unit	Phase 1	Phase 2	Phase 3	Phase 4
		2021-2024	2025-2029	2030-2034	2035-2038
Target Service Area	ha	3,551	7,388	11,836	17,530
Population in Service Area	Persons	1,432,677	1,689,837	1,946,997	2,101,290
Service population	Persons	719,746	1,151,791	1,636,917	2,101,290
Service Connection Rate	%	50%	68%	84%	100%

Source: JICA Mission Team

Table 4 Phased Sewerage Development Plan in the East Sewerage District

Item	Unit	Phase 1	Phase 2	Phase 3	Phase 4
		2021-2024	2025-2029	2030-2034	2035-2038
Target Service Area	ha	3,553	8,383	14,288	20,407
Population in Service Area	Persons	1,365,363	1,622,523	1,879,683	2,044,820
Service population	Persons	616,267	1,270,300	1,569,603	2,044,820
Service Connection Rate	%	45%	78%	90%	100%

Source: JICA Mission Team

(3) Phased Development of Sewerage Service Area

Phased development of sewerage service areas are summarized as below.

Table 5 Phased Development of Sewerage Service Area

No.	Western Area	Eastern Area
Phase 1	Area from the urban center to the Chokera WWTP, together with the areas along Drainage Channel No.1	Areas covered by the existing pumping stations of Satiana Road Original, PS-31 (Satiana Road), and PS-42
Phase 2	Area close to the urban center, including FDA City	Areas covered by the existing pumping stations of PS-36, Peoples Colony No.2 and D-type
Phase 3	Outskirts of the urban center	Areas close to the urban center developed in Phase 1 and 2, including Khurrianwala
Phase 4	Areas remote from the urban center; areas encompassing Sadhar city and areas surroundings around the Chokera WWTP	Areas remote from the urban center, currently farmland

Source: JICA Mission Team

(4) Project Cost Estimations

Table 6 Phased Cost Estimates for the Sewerage and Drainage Master Plan Project

Unit: million PKR

SWD	Component	Phase 1	Phase 2	Phase 3	Phase 4	Total
West	Sewer Replacement	1,701	0	523	0	2,224
	Branch Sewer	8,440	10,677	10,854	16,675	46,646
	Major Sewer	7,160	5,092	8,622	6,132	27,006
	Lift PS, Influent PS	3,752	1,064	0	0	4,816
	WWTP	5,400	5,400	0	0	10,800
	Effluent PS & Pipe	0	0	10,091	8,272	18,363
	Sub-Total	26,453	22,233	30,090	31,079	109,855
East	Sewer Replacement	110	748	0	0	858
	Branch Sewer	12,051	11,903	14,324	15,746	54,024
	Major Sewer	22,304	15,514	5,557	11,564	54,939
	Lift PS, Influent PS	3,387	917	0	0	4,304
	WWTP	3,931	3,931	0	0	7,862
	Effluent PS & Pipe	0	0	8,904	7,085	15,989
	Sub-Total	41,783	33,013	28,785	34,395	137,976
	Construction Cost Total	68,236	55,246	58,875	65,474	247,831

Source: JICA Mission Team

Unit: million PKR

SWD	Component	Phase 1	Phase 2	Phase 3	Phase 4	Total
West		26,453	22,233	30,090	31,079	109,855
	Consulting Fee 10%	2,646	2,223	3,009	3,108	10,986
	Land Acquisition	1,630	0	0	0	1,630
	Administration/Management 5%	1,323	1,111	1,505	1,554	5,493
	Contingency 2%	529	445	602	621	2,197
	Grand Total (incl. above fees)	6,128	3,779	5,116	5,283	20,306
	Tax 16%	5,213	4,162	5,633	5,818	20,826
	Sub-Total	37,794	30,174	40,839	42,180	150,987
East		41,783	33,013	28,785	34,395	137,976
	Consulting Fee 10%	4,178	3,302	2,879	3,439	13,798
	Land Acquisition	5,332	0	0	0	5,332
	Administration/Management 5%	2,089	1,651	1,439	1,720	6,899
	Contingency 2%	836	660	576	688	2,760
	Grand Total (incl. above fees)	12,435	5,613	4,894	5,847	28,789
	Tax 16%	8,675	6,180	5,389	6,439	26,683
	Sub-Total	26,893	44,806	39,068	46,681	193,448

Source: JICA Mission Team

(5) Implementation Schedule

Figure 6 Phased Implementation Schedule for the Sewerage and Drainage Master Plan Project

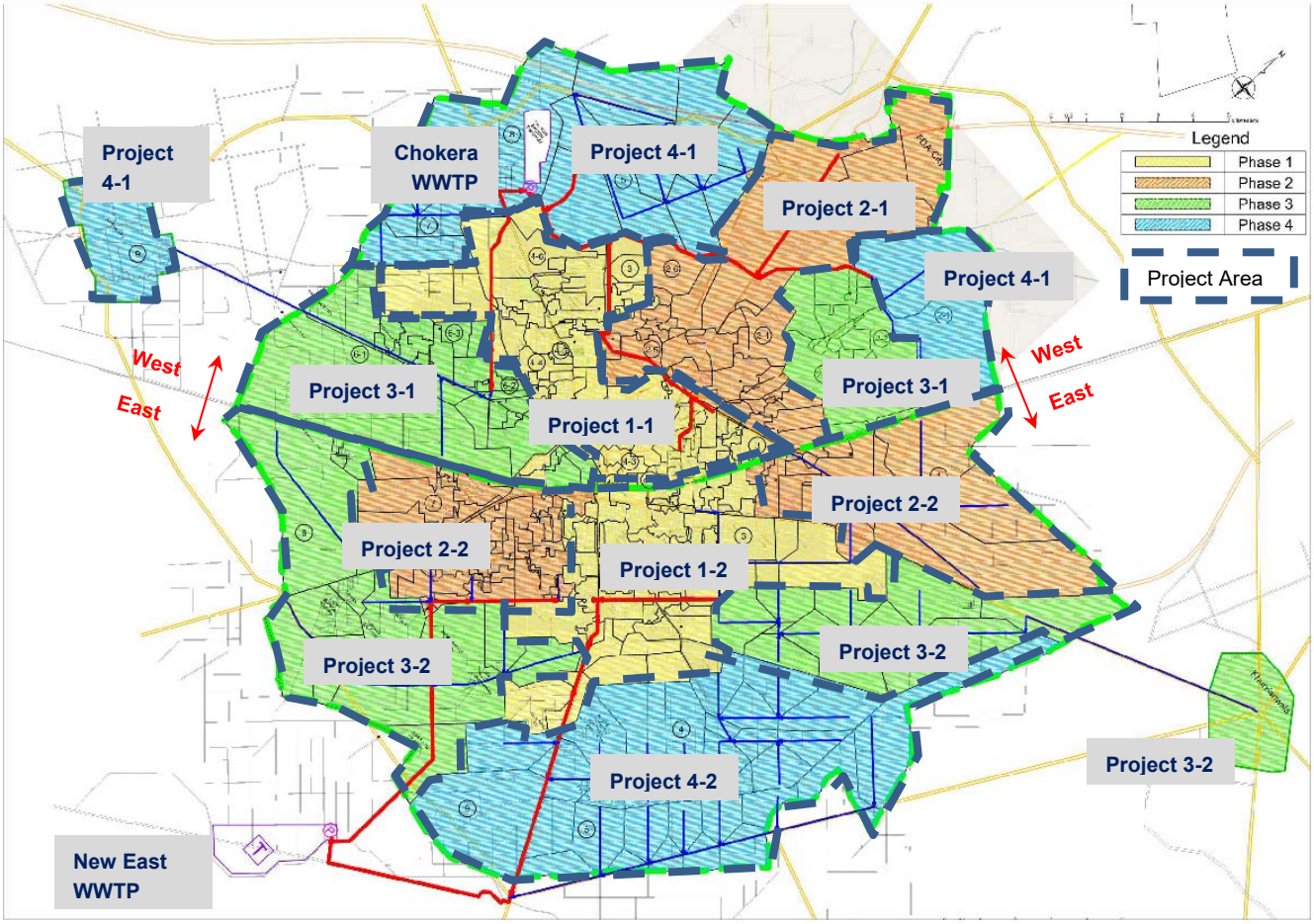
No.	Project	Area	Time Frame: Phase 1 (including Preparation) 2018-2024 (18 19 20 21 22 23 24)	Phase 2 2025-2029 (25 26 27 28 29)	Phase 3 2030-2034 (30 31 32 33 34)	Phase 4 2035-2038 (35 36 37 38)	Sewer Replacement	Branch Sewer	Major Sewer	Lift PS, Influent PS	WWTP	Effluent PS & Pipe	Cost (Million PKR)	Remarks
Cost			**68,236**	**55,246**	**58,875**	**65,474**							**247,831**	
Phase 1													**68,236**	
1-1	West Sewerage District Facilities	3,551 ha					●	●	●	●	●		26,453	
1-2	East Sewerage District Facilities	3,553 ha					●	●	●	●	●		41,783	
Phase 2													**55,246**	
2-1	West Sewerage District Facilities	3,837 ha						●	●	●	●		22,233	
2-2	East Sewerage District Facilities	4,830 ha					●	●	●	●	●		33,013	
Phase 3													**58,875**	
3-1	West Sewerage District Facilities	4,448 ha					●	●	●			●	30,090	
3-2	East Sewerage District Facilities	5,905 ha					●	●	●			●	28,785	
Phase 4													**65,474**	
4-1	West Sewerage District Facilities	5,694 ha					●	●	●			●	31,079	
4-2	East Sewerage District Facilities	6,119 ha					●	●	●			●	34,395	

Legend Preparation (F/S, Fund Arrangement, etc.) / Implementation

Source: JICA Mission Team

(6) Location of Projects

Project sheets with details on each project are also provided in **Appendix AS1.1** of the **Supporting Report**.



Source: JICA Mission Team

Figure 7 Locations of Projects

CHAPTER 1 BACKGROUND

Faisalabad is the second largest city of the Punjab Province and the third largest city of Pakistan, with a population of about 2.7 million[1] in the urban area as of 2015 and an expected population of over 4 million in 2038. The rapid growth of the population has made it difficult to provide the infrastructure development and water resource development necessary to secure adequate quantities of water. As of 2015, only 60%[2] of the households in the current service area of the city have access to municipal water supply from the Water and Sanitation Agency, Faisalabad (WASA-F). The sewerage coverage ratio i in the current service area was only about 73%[3] in 2015. This low ratio has led to chronically unsanitary conditions in the areas without sewerage and causes maintenance issues in the areas with sewerage drains.

In this context, the Government of Pakistan (GOP) requested the Government of Japan (GOJ) to support the establishment of a long-term plan for appropriate water resource development, facility investment suited to the urban planning in place, the proper maintenance of existing facilities, increased water and sewerage revenue, improved financial performance, and the sustainable operation of water supply and sewerage services.

The main objectives of the study are to develop an integrated Master Plan for water supply, sewerage and drainage in Faisalabad City (hereinafter referred to as "Master Plan" or "M/P") and to enhance the institutional capacity for implementation of the M/P. The location of the Project for Water Supply, Sewerage and Drainage Master Plan of Faisalabad (hereinafter referred to as "Project") area is shown in **Location Map of the Project** in the top of this Executive Summary.

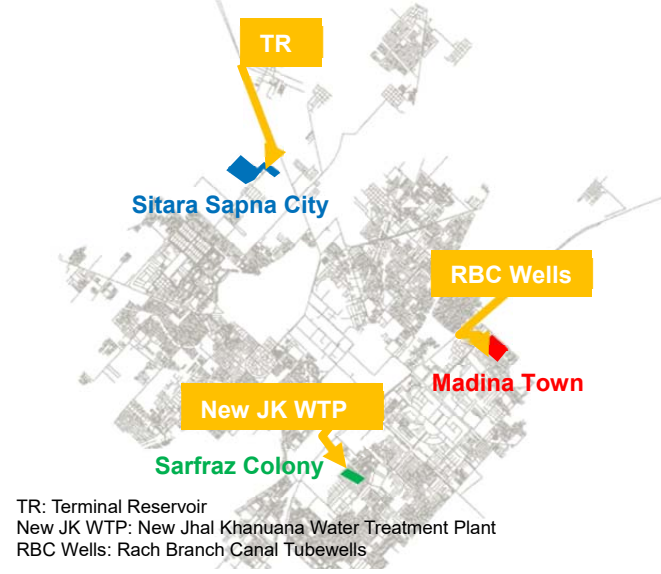
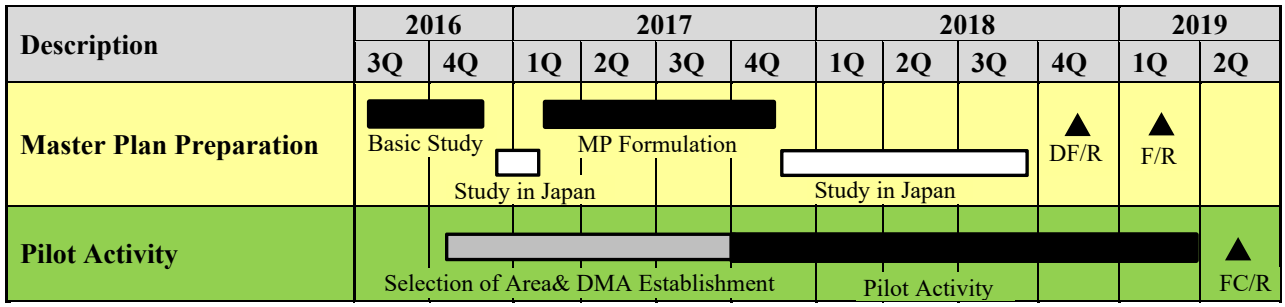


Figure 1.1.1 Locations of Pilot Areas

The M/P formulated in the Project will have to be verified by pilot activities to ensure that it will remain useful in the future. Pilot activities have been carried out in three (3) areas to test and verify whether the plans and assumptions included in the M/P are realistic: Sarfraz Colony, Madina Town, and Sitara Sapna City (see **Figure 1.1.1**). The Project Schedule is shown in **Figure 1.1.2**.



DF/R: Draft Final Report, F/R: Final Report, FC/R: Final Completion Report
Source: JICA Mission Team

Figure 1.1.2 Project Schedule

[1] Population based on estimates of the Government of Punjab Province.

[2] Coverage ratio based on WASA-F's data from the Key Performance Indicator (KPI) in 2015.

[3] Coverage ratio based on WASA-F's data from the Key Performance Indicator (KPI) in 2015.

CHAPTER 2 CURRENT STATUS AND ISSUES IN THE WATER SECTOR

2.1 Outline of WASA-F' Operations

The actual conditions of WASA-F's operation for waterworks, sewerage/drainage works, and financial conditions are summarized below.

Table 2.1.1 Outline of WASA-F Water Supply Works in 2015

Category	Item			Quantity
Outline of the water supply works of WASA-F	Total number of households in Faisalabad City			400,000
	Total number of households in the WASA-F Service Area			250,000
	Total number of connections in the WASA-F Service Area			113,000
	Water supply time			6 hours (2 hours x 3 times)
	Water intake volume (m^3/day)	Groundwater	(Design)	427,000
			(Actual)	209,000
		Surface water	(Design)	73,000
			(Actual)	31,000
	Water supply volume (m^3/day)	Total	(Design)	500,000
			(Actual)	240,000
	Water treatment volume (m^3/day)	Only disinfection	(Design)	427,000
			(Actual)	209,000
		Slow sand filtration	(Design)	28,000
			(Actual)	11,000
		Rapid sand filtration	(Design)	45,000
			(Actual)	20,000
Outline of WASA-F water supply facilities	Number of Tubewells	Chenab Well-field		25
		JBC Well-field		25
		RBC Well-field		28
	Pumping stations	Chenab line 16-32 Cusec	Booster	7
			Distribution	10
		JBC line 15-37 Cusec	Booster	4
			Distribution	5
	Number of WTPs	Slow sand filtration 1.5-2.8 MGD		3
		Rapid sand filtration 10 MGD		1
	Distribution pipes (km)	Arterial main 400 mm-1,600 mm		101
		Secondary & tertiary line 75 mm-300 mm		1309
	Reservoirs	Ground Reservoirs (GRs)		33
		Overhead Reservoirs (OHRs)		42

Source: JICA Mission Team

Table 2.1.2 Outline of WASA-F Sewerage/Drainage Works

Category	Item			Quantity
Outline of WASA-F sewerage/drainage works	Total number of connections in the WASA-F Service Area			246,000
	Wastewater collection volume (m^3/day)		(West)	680,000
			(East)	378,000
	Wastewater treatment volume of WWTPs (m^3/day)		(Design)	90,000
			(Actual)	47,000
Outline of WASA-F sewerage/drainage facilities	Collection system: Separate system, in principle			
	Sewer system	Trunk sewers 500-2,250 mm		193 km
		Branch sewers 225-450 mm		1,579 km
	Pumping Stations	Lift pumping stations		14
		Disposal pumping stations		18
	Wastewater Treatment Plant	90,000 m^3/day		1
	Drainage Channels	Bed width: 1,275-3,300 mm Open channel		7 (53,290 m)

Source: JICA Mission Team

Table 2.1.3 Outline of WASA-F's Financial Condition

Category	Item		Quantity
Outline of WASA-F's financial condition	Tariff System	Domestic	Flat-rate
		Industry & Commercial	Flat-rate & meter-rate
	Bill collection ratio	Domestic	28% at 2015
		Industry & Commercial	75 – 80%
	Budget (2015-2016)	Total receipt	3,943.236 Million PKR
		Total expenditure	3,941.236 Million PKR
	Operation Receipt (2015-2016)	Total	2,079.622 Million PKR
		Water & Sewerage Tariff	840.000 Million PKR

Source: JICA Mission Team

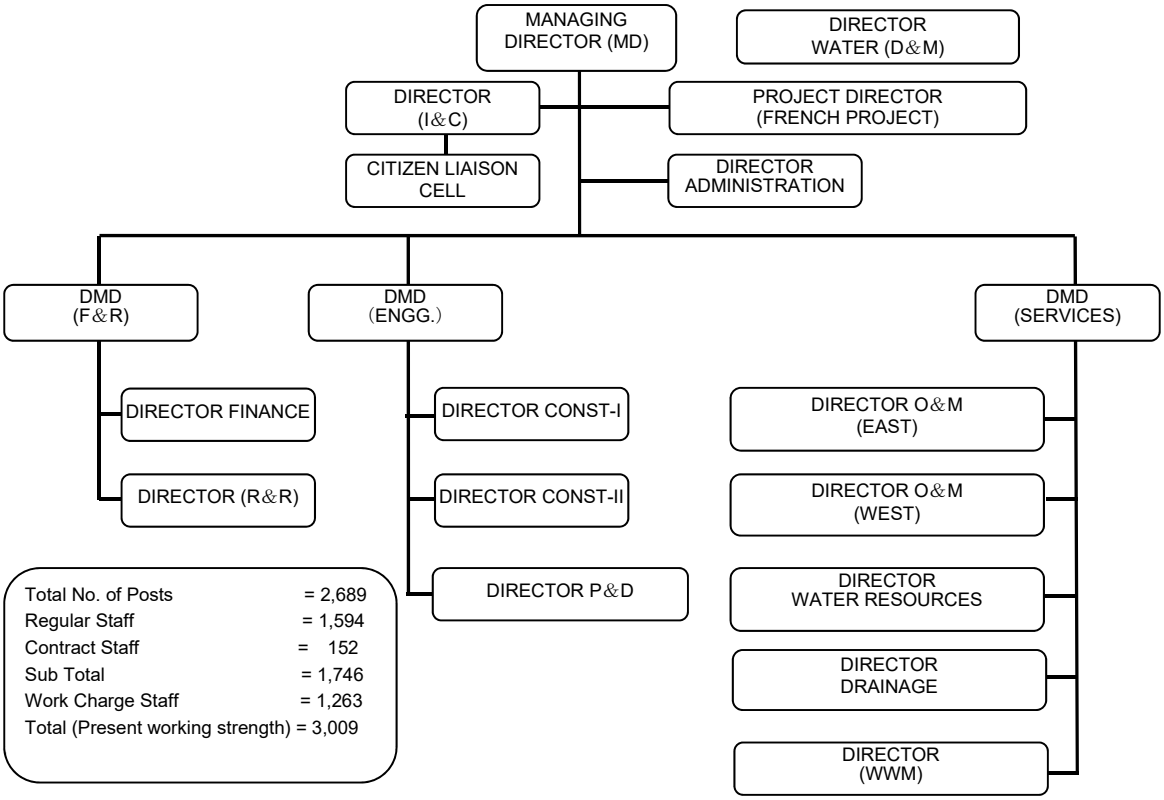
2.2 WASA-F's Organizational Framework

WASA-F was created in 1978 as an FDA agency under the Punjab Development of Cities Act 1976. It serves the following functions:

Planning, design, and construction of water supply, sewerage, and drainage facilities for new construction works and the rehabilitation and augmentation of existing systems
Operation and maintenance of water supply, sewerage, and drainage systems
Billing and collection of revenue for the services provided to consumers.

The project and business of WASA-F are operated as a single FDA entity. Therefore, the annual investment plan for WASA-F is included in the annual investment plan for FDA.

Figure 2.2.1 is an organogram of WASA-F, an entity that engages about 1,750 persons, including regular staff and contract staff. The regular staff and contract staff are employed under the budget of the provincial government. The work charge staff persons, who perform simple tasks, are employed under WASA-F's own budget.



Source: JICA Mission Team

Figure 2.2.1 Organization of WASA-F

2.3 WASA-F's Financial Condition

The budget for the Receipts and Expenditures of WASA-F is classified into Development and Non-Development components. Receipts in Development include: 1) governmental subsidies and 2) financial budgetary support through foreign multilateral grants. Expenditures in Development are capital investments disbursed under the development programs. Receipts in Non-Development, also regarded as Operational Receipts, include: 1) income from water supply and sewerage, 2) grants, transfers, and subsidies, and 3) other income. Expenditures in Non-Development, also regarded as Operating Expenditures, include: 1) pay & allowances, 2) electricity for water supply & sewerage, 3) repair & maintenance, and 4) other expenses.

Table 2.3.1 WASA-F's Budget (Estimated Budget) in FY 2015-16

S/N	Description	PKR in million
A	RECEIPT	3,943.236
	1 Development	1,861.614
	2 Non-Development (Operational Receipt)	2,081.622
B	EXPENDITURE	3,941.236
	1 Development	1,861.614
	2 Non-Development (Operational Expenditure)	2,079.622

Source: WASA-F

Table 2.3.2 WASA-F's Operational Receipts (Estimated Budget) in FY 2015-16

S/N	Particular	PKR in million	%
1	Water Sales & Sewerage Charges	840.000	40
2	Urban Immovable Property Tax Share	290.000	14
3	Subsidy Grant from Government of Punjab	300.000	14
4	Monsoon Grant	60.000	3
5	PCGI Project	496.622	24
6	Miscellaneous/Other Income	93.000	4
	Total	2,079.622	100

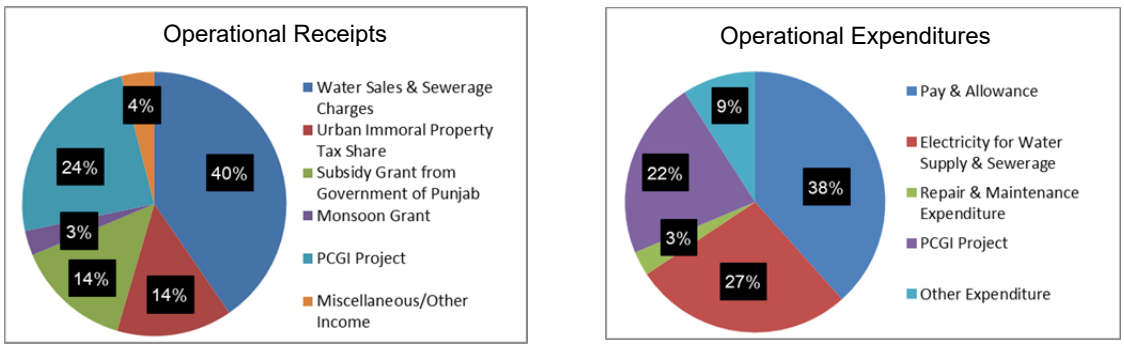
Source: WASA-F

Table 2.3.3 WASA-F's Operational Expenditures (Estimated Budget) in FY 2015-16

S/N	Particular	PKR in million	%
1	Pay & Allowance	847.120	38
2	Electricity for Water Supply & Sewerage	600.000	27
3	Repair & Maintenance Expenditure	61.503	3
4	PCGI Project	496.622	22
5	Other Expenditures	204.627	9
	Total	2,209.872	100

Source: WASA-F

The biggest source of the WASA-F's operational receipts is revenue through water sales and sewerage charges (40%). The biggest expense is pay & allowances (38%) to the WASA-F staff.



Source: WASA-F

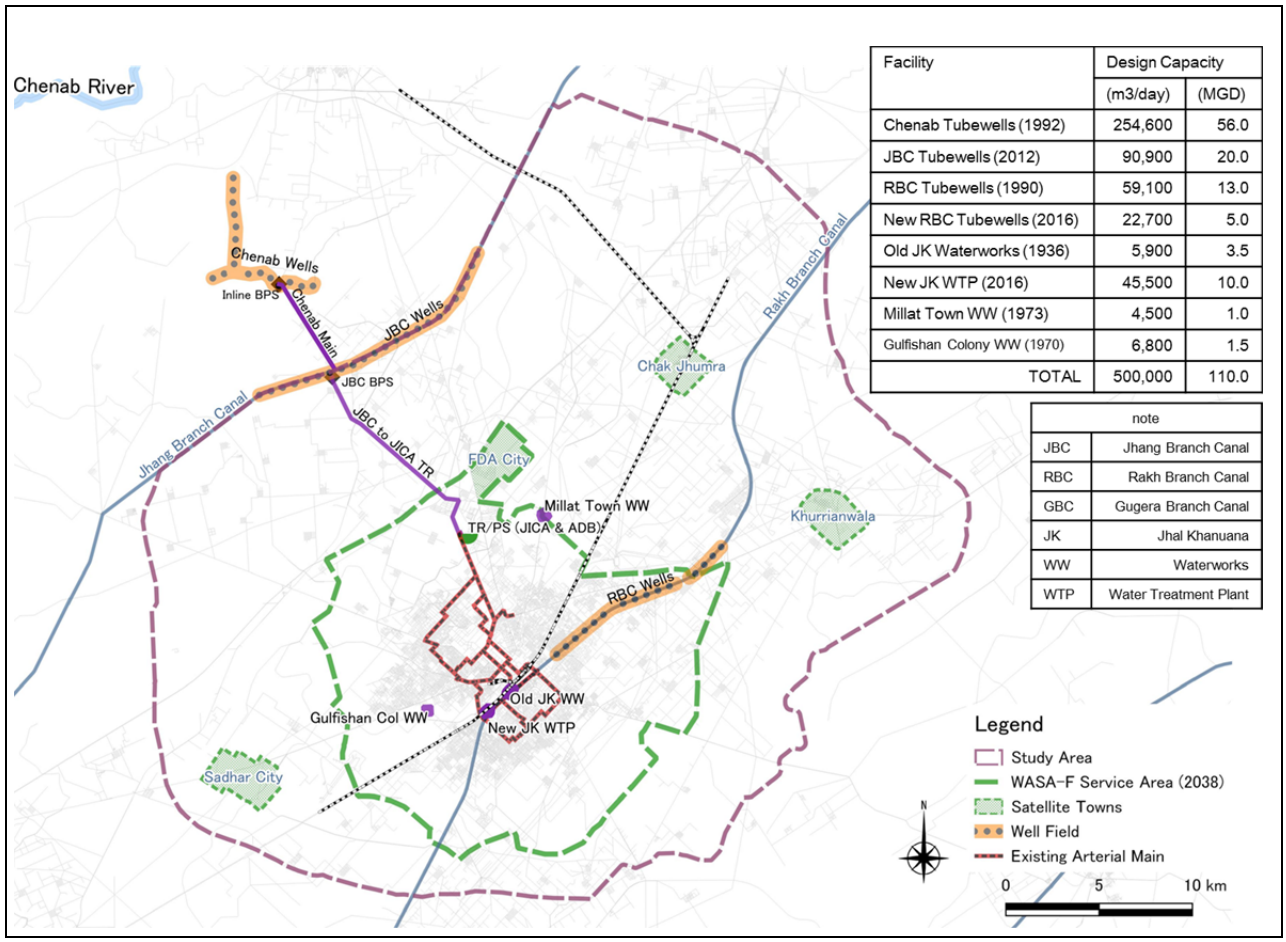
Figure 2.3.1 Operational Receipts and Expenditures in the WASA-F Budget (2015-16)

2.4 WASA-F's Present Operations

Table 2.4.1 summarizes the planning directions considered based on analyses and evaluations of the present conditions of WASA-F's operations.

2.5 Present Water Supply System

The locations of existing water supply facilities are shown in **Figure 2.5.1**.



Facility	Design Capacity	
	(m3/day)	(MGD)
Chenab Tubewells (1992)	254,600	56.0
JBC Tubewells (2012)	90,900	20.0
RBC Tubewells (1990)	59,100	13.0
New RBC Tubewells (2016)	22,700	5.0
Old JK Waterworks (1936)	5,900	3.5
New JK WTP (2016)	45,500	10.0
Millat Town WW (1973)	4,500	1.0
Gulfishan Colony WW (1970)	6,800	1.5
TOTAL	500,000	110.0

note	
JBC	Jhang Branch Canal
RBC	Rakh Branch Canal
GBC	Gugera Branch Canal
JK	Jhal Khanuana
WW	Waterworks
WTP	Water Treatment Plant

Source: JICA Mission Team

Figure 2.5.1 Location Map of Existing Water Supply Facilities

Table 2.5.1, **Table 2.5.2**, and **Table 2.5.3**. summarize the planning directions considered based on evaluations and analyses of the present conditions of the water sources, water supply system, and water supply service and management in Faisalabad City.

Table 2.4.1 Present Conditions, Issues Pointed Out, and the Direction of Planning in WASA-F's Operations

Item	Present Conditions	Issues Pointed Out	Directions of Planning
Service Level	Intermittent pump operation (2 hours x 3 times a day) and inadequate water pressure limit the daily water supply to only 6 hours.	As commonly identified in Sarfraz Colony, customers install their own suction pumps along WASA-F water supply pipes to illegally draw water and pump it up to rooftop water tanks.	Use appropriate methods and strategies to extend the water supply hours, ultimately to achieve 24/7 water supply, applying the lessons learned from pilot activities.
	Many customers have their own groundwater sources, besides the water supplied by WASA-F.	According to data on the current status of water use in sample households in pilot areas, the ratios of groundwater, WASA tap water, and bottled water use are 75%, 24%, and 1%, respectively.	Operations must be continuously improved to provide more efficient and higher-quality services.
Inefficient Use of Facilities	Some facilities are non-operational.	As of 2015, nearly half of the OHRs and GRs are non-operational.	Secure sufficient budget to improve the operation efficiency of existing facilities.
	The ratio of non-revenue water (NRW) is officially reported at 33%, but other studies have reported it to be in a much higher range of about 50%.	It remains undetermined whether the NRW value is officially defined as the rate of physical loss or the rate of unaccounted-for water against the total amount billed for water.	A pilot activity would reveal the actual NRW and make it possible to calculate revenues in comparison to the unit water supply cost from the water bills.
Organization and Management	Numerous posts are left vacant, hence the available labor opportunities are underused.	Budget constraints dissuade the provincial government from approving the required employment of labor.	More information needs to be obtained, including details on which posts remain vacant and affect the execution of work.
	On-site workers are quite numerous.	Personnel costs represent a large part of WASA-F's total budget.	On-site workers should be reduced by mechanized management.
	While on-line systems are increasingly available, they are seldom used effectively.	While the GIS, SCADA, and CRC systems are all praised, they have been problematic when applied to the work.	Integrated IT systems in the form of a Management Information System (MIS) are proposed.
	No annual training program has been prepared. Human resources are not allocated in a proper or systematic way.	WASA-F needs to cooperate with the Al Jazari ACADEMY. A training program has been prepared to develop the capacities of individual staff members and their career advancement.	Based on a careful review of the previous training sessions for the year, an effective training plan must be prepared to make up for the components that are lacking.
	WASA-F is in charge of the three sectors of water supply, sewerage and drainage, but its organizational structure is not categorized by these three sectors.	The current WASA-F organization structure is categorized from an administrative viewpoint into units such an engineering department, a services department, and the like.	A separation of the sectors into a water supply department (or section), sewerage department, and drainage department has been proposed.
Fiscal Conditions	The tariff collection efficiency in the water billing is substantially low, at around 28%. The rate has been gradually rising, but a drastic solution has yet to been found.	A lower service level leads to lower customer satisfaction, which in turn brings down the tariff collection efficiency.	Services must be improved and strategic promotional activities must be orchestrated.
	An area-based, fixed rate tariff system with low pricing is applied.	Though not applied practically, the existing metered-rate tariff structure sets a much lower price.	Improved collection efficiency is the first priority. Next, tariff revisions will be required. Improved services will be essential for that purpose.
	WASA-F is not an autonomous body. Budgeting is difficult to secure for water supply, sewerage, and drainage projects and operations.	Not only development costs, but also most non-development costs (operational receipts) such as electricity, repairs, and maintenance costs, are subsidies from GOPb.	Review and raise tariffs according to a long-term financial plan to ensure that WASA-F becomes an autonomous body in the water supply business within the period of the M/P.

Item	Present Conditions	Issues Pointed Out	Directions of Planning
Water Environment Conservation	Laws and regulations are being developed for water supply and sewerage works. The enforcement of the laws and regulations, however, is seriously lagging.	The Punjab Municipal Water Act drafted in 2014 has not yet been enforced.	New regulations need to be examined if they are to be implemented as stipulated. Thorough knowledge of the regulations will be important to strengthen enforcement power.

Note: GIS, Geographic Information System; SCADA, Supervisory Control and Data Acquisition System; CRC, Customer Relations Center.
Source: JICA Mission Team

Table 2.5.1 Present Conditions, Analysis Results, and Direction of Planning in Water Source Development

Item	Present Conditions	Issues Pointed Out	Directions of Planning
Water Sources	The principal groundwater sources are the JBC, RBC, and GBC well-fields. Excessive water pumping in the past has brought groundwater levels down. The potential for new development is low.	In addition to being limited in potential, the groundwater is brackish in and around the city.	New water source development should be shifted to surface water from irrigation canals. WASA-F is required to negotiate with the Irrigation Department to obtain water rights.
	Intake from irrigation canals and/or rivers can be considered as surface water sources. The irrigation canals must be periodically closed for maintenance, requiring a halting of water flow.	The typical period of closure for canal maintenance is approximately three weeks.	Some infrastructure must be provided to meet the water needs during the closure period, including multiple canals and reservoir construction.
Groundwater (Chenab well-field, JBC well-field, RBC well-field, and GBC well-field)	The Chenab tubewells have been yielding water since they started operating 25 years ago. A long period of excessive water intake has brought the groundwater level in the surrounding areas down by as much as 20 m.	When a JICA study was conducted in 2007, residents in the area strongly objected to further development in light of the steep declines in the groundwater level due to abundant discharge from the well-fields.	The amount of water intake from the Chenab well-field should be maintained at the current amount (140,000 m^3/day) or reduced.
	Changes in the groundwater level identified in the JBC well-field after the start of facility operation indicate excessive water intake leading to a continuous decline of the water level by nearly 1 m per year up to 2015.	The JBC tubewells are relatively deep, ranging from around 120 to 130 meters. Note that excessive water withdrawals may lead to the drawing of deep brackish water out from the wells, possibly degrading the water quality.	Development along the JBC and in the vicinity of the existing JBC tubewells could have some potential for future development.
	The areas around Jaranwala and Satiana along the GBC have a high density of existing wells, which limits the development potential. The existing wells scattered in areas between these towns along the GBC are thought to have potential for further development.	The groundwater along the GBC is generally brackish, hence the supply of drinking water completely depends on the seepage water from the canal. The seepage water is unavailable when the water flow is low in the canal.	The feasibility of development needs to be examined between Jaranwala and Satiana along the GBC, where fewer water facilities are in place.
	The potential for groundwater sources is summarized to be relatively low.	There are prospects for further development in the JBC and GBC well-fields.	Groundwater development will continue obtain supplemental water sources.
Surface Water (Irrigation Canals: JBC, RBC, and GBC)	Although the irrigation canals (JBC, RBC, and GBC) generally have stable water flow, the available amount of water is still insufficient to supply the amount of water required for irrigation.	Water intake from the irrigation canals requires water rights allocated for drinking water. It could take substantial time to negotiate on the water rights with the Irrigation Department and complete the applicable procedures.	With respect to the irrigation canals to be used as new water sources in the future, it will be important to develop them step-by-step in accordance with an adjustable plan negotiated with the Irrigation Department.

Item	Present Conditions	Issues Pointed Out	Directions of Planning
	The canals are closed once a year for maintenance. A typical period of closure is approximately three weeks.	JBC is fed by the Lower Chenab Canal Feeder. RBC and GBC have common headwater at the Main Line Lower Canal. Thus, JBC can be operated independently while the RBC and GCB canals are operated as a set and close simultaneously.	Countermeasures must be provided to meet the water needs during the closure periods. Multiple water sources, backup systems between areas with excess water and water shortages, and RWR constructions will all be required.
Surface Water (Chenab River)	The water flow of the Chenab River is controlled at a barrage upstream. Hence, no water is discharged over a period of a few months every year.	The intake of water from the rivers requires the identities of authorities to negotiate the allocation of water.	If water is taken in from the Chenab River, further surveys on factors such as the flow rate, water quality, and intake by water intake structures must be ensured.
	This natural river may possibly change the river course where the water flows.	Monitoring (measuring) the water flow in the river is demanding and will require at least one year.	Technical and economic evaluations must be done to assess the feasibility.
	The intake point is located farther away from the city. As an alternative intake point, WAPDA plans to construct the Chiniot Dam approx. 40 km outside of the city.	Construction for the installation of a transmission main from the Chiniot Dam to the city is costly, given the long distance. The O&M expenses are also higher than those in the case of intake from the irrigation canals.	Allocation from the Chiniot Dam (under consideration) is a noteworthy future possibility. The certainty of the dam construction plan should be watched.

Note: JBC, Jhang Branch Canal; RBC, Rahk Branch Canal; GBC, Gugera Branch Canal; RWR, raw water reservoir.
Source: JICA Mission Team.

Table 2.5.2 Present Conditions, Analysis Results, and Direction of Planning in Water Supply System

Item	Present Conditions	Issues Pointed Out	Directions of Planning
Tubewells	At present, the Chenab and JBC tubewells operate for 12 - 20 hours a day and the RBC tubewells operate for 2 - 6 hours a day.	The groundwater is generally brackish in most parts. Freshwater suitable for drinking is limited to the seepage water from the irrigation canals.	The designs and specifications for the new tubewells should be decided by considering the performance of the existing tubewells. Seepage water from the canals should be a primary focus.
Pump Stations	The booster pumps operate for 18 to 20 hours a day, whereas the distribution pumps at TRPS operate for 6 hours a day. The daily average of water supply is currently only 48% of the design capacity.	Distribution pumps set at TRPS operate for 2 hours x 3 times (6 hours a day). In the remaining 18 hours, water is allowed to bypass or flow out from the TR by gravity to save power costs and prevent negative pressure in the distribution network.	Extension of the running hours of the distribution pumps is a key aim, together with energy saving measures. Measures for revenue increase (or reduction in expenditure) are also important and recommended, and have been attempted in the pilot activity.
	Electric supply availability in Faisalabad City is very tough and tight.	FESCO supplies electric power to the city according to the planned power outage for load shedding.	An energy saving pumping system and the use of natural energy (e.g., solar power) would alleviate the strain of electricity costs.
Water Treatment Plants	The JK WW (15,900 m^3/day or 3.5 MGD, slow sand filtration) was constructed in 1936, making it the oldest one in Faisalabad City. It operated at ratio of only 43% (6,800 m^3/day or 1.5 MGD) in 2015.	WASA-F listed up the renewal of Original JK WW as a high-priority project. The request letter was submitted to JICA as a grant aid project in May 2014.	Rehabilitation or renewal of the Original JK WW is considered, including steps to upgrade the capacity and ameliorate facilities by switching over from the slow sand filtration method to rapid sand filtration method.

Item	Present Conditions	Issues Pointed Out	Directions of Planning
	The New JK WTP (45,500 m^3/day or 10 MGD, rapid sand filtration) was constructed under a project for "Extension of Water Resources for Faisalabad City Phase-I" financed by a French loan and launched into operation from 2016.	Preparations for the "Extension of Water Resources for Faisalabad City Phase-II" by AFD are underway to follow up Phase-I. Phase-II includes an expansion of the New JK WTP (22,700 m^3/day or 5 MGD) and the construction of a new WTP (113,700 m^3/day or 25 MGD) at the GBC.	A future development plan with funding from WASA-F's own resources, with the possible addition of foreign donor assistance and loans, is being prepared.
	The Ghulfishan Colony WW (6,800 m^3/day or 1.5 MGD, slow sand filtration) has been suspended for half a year for rehabilitation and maintenance.	Rehabilitation work was expected to be completed in 2017. The work, however, is still behind schedule and remains uncompleted as of 2018.	Further study will be required to examine maintenance plans for the respective treatment plants.
Transmission and Distribution Facilities	As the land is mostly flat in Faisalabad City, WASA-F has constructed dozens of OHRs and GRs with pump facilities for direct pump distribution from the GRs or by gravity flow from the OHRs. Half of them, however, are too degraded to use at present.	Distribution reservoirs (OHRs and GRs) need to be effectively used and optimized in due consideration of the maintenance capacities of WASA-F. The designation of distribution zones and DMAs to hydraulically isolate the areas is effective for distribution management.	A hydraulic analysis is conducted to bring the plan for the restructuring of the transmission and distribution system into view. Pilot activities include upskilling for WASA-F's distribution management personnel with established DMAs.
	AC pipes account for 85% of the total existing pipe length in the distribution network of Faisalabad City. More than 95% of the AC pipes have been used in small diameters.	The Housing, Urban Development Department in Punjab Province will evaluate the designs, including the pipe materials. AC pipes are still used for some projects, as the pipe material is still inexpensive.	Current plans propose a conversion from AC pipes to DI and HDPE pipes in the future, in view of the improved pressure resistance, leakage control, economic efficiency, and workability of the latter.

Note: WW, Water Works; WTP, Water Treatment Plant; TR, Terminal Reservoir; OHR, Overhead Reservoir; GR, Ground Reservoir; DMA, District Metered Area.
Source: JICA Mission Team

Table 2.5.3 Present Conditions, Analysis Results, and Direction of Planning in Water Supply Service and Management

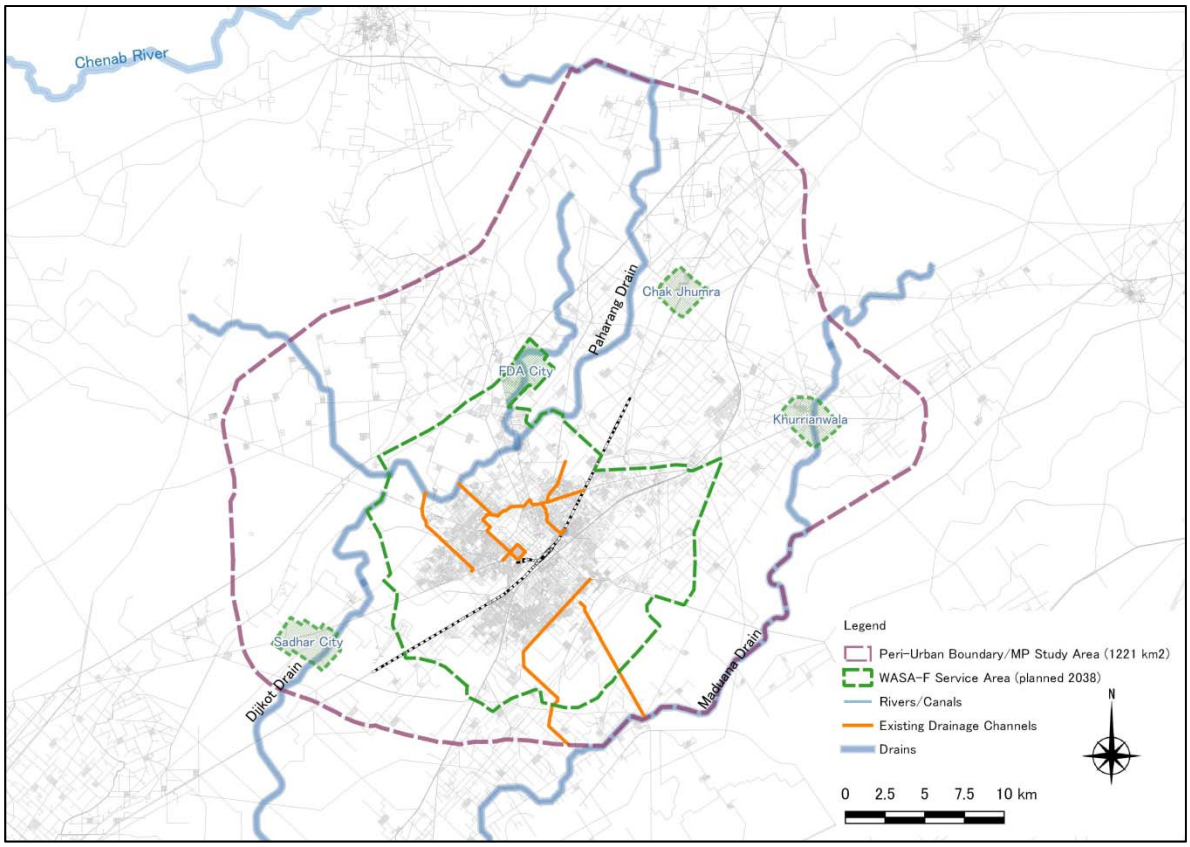
Item	Present Conditions	Issues Pointed Out	Directions of Planning
Water Distribution Management	In setting the distribution area, this M/P separates the WASA-F service area and the Peri-Urban areas for the purposes of planning and surveillance.	The area planned for the future WASA-F service area was delineated and set based on the current and population density and population density projections for the future.	The M/P water supply policy is to first concentrate on increasing the coverage ratio within the current WASA-F service area and next to extend the services area gradually to outlying areas.
	Insufficient water supply quantity, pressure, and quality are chronic.	Improvement of the operation rate of the existing facility is considered through a restructuring of the water supply system.	The M/P aims at the establishment of a proper water distribution management system that can secure adequate quantity, quality, and pressure, as necessary, in the WASA-F service area.
IT Management	A SCADA system has been introduced in the New JK WTP. Daily data on flows and pressures at some the inlet nodes to the DMZs are stored in the operation room.	GIS, SCADA, and CRC systems have recently been developed in WASA-F. The next hope is to realize the effective use of these applications.	Integrated IT systems in the form of a Management Information System (MIS) are proposed in the M/P (See Chapter A9, Part A, Main Report)

Item	Present Conditions	Issues Pointed Out	Directions of Planning
NRW Reduction	The NRW ratio of WASA-F is officially estimated to be as high as 33%, as of 2017. According to a study carried out by the French Fund Project in 2014, the NRW ratio was calculated to be considerably higher, at 55%.	WASA-F is trying to improve water supply service and reduce NRW with special activities in three pilot areas. The outcome of the pilot project is expected to devise a way to effectively reduce the NRW.	One of the most essential methods for successfully reducing NRW is to shift to a volumetric water tariff system (i.e., metered-rate tariff system) from the existing flat-rate tariff system.
Water Meters and Service Connections	Low pressure and inadequate water supply compel residents to draw water illegally by connecting suction pumps to the water supply pipes.	Illegal pump suction has caused further head losses and water deficits around the area.	The solution requires proper water pressure and extended hours of water supply, along with measures to discourage illegal acts and connections.
	WASA-F has been installing domestic water meters since 2015 with a view to shifting from the current flat-rate tariff system to a metered-rate tariff system in the future.	The conditions of the meters and meter maintenance shed doubt on the accuracy of the meters. Many meters installed at households are unreadable because of improper installation. A standard operation procedure (SOP) was therefore prepared in a pilot activity.	A meter procurement plan will be prepared for the future tariff system. Domestic meters are adequately installed and maintained in accordance with the SOP provided by the pilot activity.

Note: WW, Water Works; WTP, Water Treatment Plant; TR, Terminal Reservoir.
Source: JICA Mission Team

2.6 Present Sewerage and Drainage System

The locations of the existing sewerage and drainage facilities are shown in **Figure 2.6.1**.



Source: JICA Mission Team

Figure 2.6.1 Existing Sewerage and Drainage Facilities

Table 2.6.1 summarizes the present conditions and analysis results on wastewater management and the sewerage system in Faisalabad. **Table 2.6.2** and **Table 2.6.3** summarize the same on industrial wastewater management and stormwater management, respectively.

Table 2.6.1 and **Table 2.6.2** also present the planning directions for the sewerage facilities and draining facilities vis-à-vis the above, respectively.

Table 2.6.1 Present Conditions, Analysis Results, and Direction of Planning in Domestic Wastewater Management and the Sewerage System

Subject	Present Conditions	Analysis Results	Directions of Planning
Wastewater collection and Treatment status	The wastewater generated in the urban area is collected by the sewer system based on the former M/P.	The sewer has been developed as a good infrastructure to remove wastewater from the living environment in the urban area.	To set the boundaries for the sewerage planning area based on the population density and land use as specified in the water supply plan. To identify the number of households and customers served by the sewerage system.
	On-site sanitation facilities such as cesspools and septic tanks are used in suburban and rural areas, but the wastewater is not treated properly. This situation worsens the living environment.	The septic tanks function improperly because they have smaller capacities than the Provincial design criteria and their owners fail to desludge them for proper maintenance. Domestic wastewater left untreated due to inadequate management of on-site sanitation is risky for people's health. It would be difficult to use wastewater treated by on-site sanitation facilities for farmlands in Faisalabad due to the high TDS concentrations in the brackish groundwater used for living purposes.	To identify the number of households and customers using on-site sanitation systems. To recommend that the PHED conduct surveys on the present status of the existing on-site sanitation facilities by type, O&M conditions, and problems for enhancing access to quality sanitation as described in the policy support statements in the Pakistan's Sustainable Development Goals (SDGs). To recommend guidelines and materials with useful information on improving the design and O/M of on-site sanitation facilities with community participation, e.g., reports and handbooks prepared by NGOs, universities, other international institutions in Pakistan, and neighboring countries. To refrain from proposing the re-use of treated water by on-site sanitation facilities where brackish water is used.
	Very limited qualitative and quantitative data on wastewater: - flow rate records at the pumping stations and the Chokera WWTP. - wastewater quality data on each treatment process at the WWTP - water quality in the drainage channels	Need operation data on the pumping stations and WWTP to improve the sewerage management. Need operations to monitor the treated wastewater quality and quantity at the Chokera WWTP. Need qualitative and quantitative data on the wastewater discharged to the drainage channels.	To propose that WASA-F collect qualitative and quantitative data at the pumping stations and WWTP for use for the operation, planning, and design of the sewerage facilities. To propose that WASA-F regularly collect qualitative and quantitative data at the outlets of the drainage channels to determine the pollution loads to the Paharang and Madhuana Drains. To propose that EPD/EPA-F regularly collect qualitative and quantitative data for pollution load analysis.
	Wastewater is discharged to drainage channels. The drainage channels are used as open drains	Wastewater discharged to open channels poses risks to a healthy environment, especially for the people	To propose the deeper installation of trunk sewers using micro-tunneling methods so that the wastewater can be

Subject	Present Conditions	Analysis Results	Directions of Planning
	to convey the wastewater.	living near the open channels, largely because of the tendency of the wastewater to spray into the air. Untreated industrial wastewater discharged to open channels is also hazardous due to the high pH, chemicals, and heavy metals.	conveyed to the WWTP by gravity flow for treatment before it is discharged to the receiving water bodies. To propose the use of disposal pumping stations as stormwater pumping stations.
	Wastewater is overflowing from branch sewer manholes.	The wastewater overflow may be attributable to inappropriate sloping of the sewers installed, sewer clogging due to insufficient cleaning work, or other causes.	To propose the collection of data and information on sewers and manholes based on topographic surveys to identify the actual slope of the sewer installed for the assessment of the existing sewer capacity. To propose sewer cleaning methods using mechanical equipment.
Sewer and Pumping Station and O&M	The data on the existing sewers only provide details on the locations, diameters, materials, and lengths of the pipes. No other details are available.	No design and installation data are used to develop sewer information by GIS. The engineers and WASA-F and FDA may not fully understand the importance of sewer data for the O&M and design of sewers.	To propose the collection of data and information on sewers such as drawings (plans and profiles), the locations of the manholes, earth cover, slope, manhole structures, and house inlets, based on field reconnaissance and topographic surveys. To suggest the establishment of a sewer database for design and O&M using collected data and information on the existing sewers and manholes and new sewer systems designed and installed by design documents and shop drawings. To suggest human resources development through OJT during the implementation of sewerage projects.
	The topographic features have required that many of the pumping stations are constructed to dispose of the wastewater to the Paharang Drain and Madhuana Drain.	The first priority in the past sewerage development strategy in Faisalabad was the discharge of the wastewater, not the treatment of all of the wastewater.	To construct trunk sewers to convey the wastewater to the WWTP for treatment before discharge to the drains. Minimize the number of disposal pumping stations to increase the efficiency of the sewerage system.
Wastewater Treatment Plant and O&M	The Chokera WWTP treats the wastewater but is working at only about half of its capacity. The JICA Mission Team's survey found that half of the volume of influent was drawn and used as water for farmlands near the WWTP.	The raw wastewater is hazardous for farmers and agricultural products. Farmers need to be apprised of the dangers of using raw wastewater and the importance of removing structures that provide the raw wastewater to their farmlands.	Staff training on the roles and responsibilities of sewerage services is required, along with public relations on wastewaters and environmental education.
	The anaerobic ponds are not functioning properly, as no sludge has been removed since the commissioning.	Knowledge on stabilization pond operation and key maintenance work is lacking. No budget has been prepared for periodical sludge removal from the anaerobic ponds.	Personnel must be educated on the role of the WWTP and importance of maintenance work for the proper functioning of the wastewater treatment facilities. To propose an O&M plan for the WWTP

Subject	Present Conditions	Analysis Results	Directions of Planning
	No repair work has been done on the sewerage facilities. For example, i) the screen facilities are damaged by corrosion and not used; ii) metal structures such as gates are damaged or corroded by the sulfide gas.	The steel products used for the facilities are damaged easily by corrosion of hydrogen gas. The steel products have not been painted to reduce damage by corrosion. No annual budget is prepared for O&M and repair work.	To propose an O&M plan based on the preventive O&M concept. To suggest the allocation of an annual budget for preventive O&M.
Wastewater Use	The raw wastewater is used directly as an irrigation water source near the Chokera WWTP or Paharang/Madhuana Drain.	Farmers have the misconception that raw wastewater is better than treated wastewater due to the high nutrient content.	To prohibit the use of raw wastewater for agricultural purposes in order to eliminate the high risks for farmers' health. To conduct public environmental education campaigns, especially for farmers, on the health risks of handling wastewater and using it as irrigation water.
	The influent and effluent at the Chokera WWTP have high TDS concentrations of between 2,300 to 3,300 mg/L, a level exceeding the WHO irrigation water quality standard of 2,000 mg/L.	The high TDS in the wastewater stems from the use of brackish groundwater as a water supply source and the processing of industrial wastewater.	To suggest that the piped water supply system be promoted using surface water instead of brackish groundwater. To reduce the ratio of industrial wastewater in the influent to the WWTP, which can maintain the TDS concentration at a level lower than the guided level.
	WASA-F's sewerage system receives a large volume of industrial wastewater.	If the treated wastewater at the WWTP is used as an irrigation water source, it will be difficult to reduce the volume of the industrial wastewater received by the sewerage system.	To propose a plan for reducing the volume of industrial wastewater up to the target year of 2038 by two approaches: first, by treatment and discharge to drainage channels or to the Paharang Drain or Madhuana Drain by individual or grouped treatment facilities; second, by accelerating the relocation of industrial units to other areas such as industrial parks equipped with treatment facilities To propose that the provincial government give some incentives to industrial units that stop discharging to sewerage. To study water quality standards for irrigation purposes.
	The treated wastewater at the Chokera WWTP is discharged to the Paharang Drain.	The treated wastewater under the proposed sewerage plan is expected to be useful for agricultural purposes. Studying the reuse of treated wastewater follows the 2018 national sanitation policy of enhancing the reuse of treated wastewater. The following conditions will be required to realize the indirect reuse of treated wastewater for irrigation	To study a plan for supplying the treated wastewater to irrigation canals. To study the treated wastewater quality standards for irrigation purposes. To propose strict monitoring of the treated wastewater quality as a prerequisite for provision to irrigation canals as an irrigation water source. The irrigation water is an important and major source for

Subject	Present Conditions	Analysis Results	Directions of Planning
		purposes: - Low-TDS water shall be provided under the water supply plan - the volume of industrial wastewater received by the sewerage system shall be low enough to minimize risks to human health and agricultural products. - the industrial wastewater received by the sewerage system shall meet Pakistan's NEQS for Municipal and Liquid Industrial Effluent (into sewerage) through the introduction of pre-treatment facilities.	future water resources in the water supply system. The irrigation water supplied to the water supply system needs to be returned to irrigation canals together with the treated wastewater from the sewerage system. To propose that the national and provincial EPAs set water quality standards for the treated wastewater to be used for agricultural purposes. To propose that ISO/TC283/SC1, SC3 be referred to regarding the reuse of treated wastewater for irrigation purposes.
Other	Documents within WASA-F for the planning and design, bidding, construction, and O&M are difficult to access.	Easy access to the documents within WASA-F cannot be arranged.	To propose a document management system for easy access.

Source: JICA Mission Team

Table 2.6.2 Present Conditions, Analysis Results, and Direction of Planning in Industrial Wastewater Management

Subject	Present Conditions	Analysis Results	Directions of Planning
Industrial wastewater disposal and treatment	Industrial wastewater is discharged to roadside drains.	Roadside drains are installed to discharge storm water. The drains cannot collect or discharge the storm water under wet weather conditions.	To propose that the FDA road department take necessary actions to legally prohibit the use of roadside drains to convey industrial wastewater. To propose that the FDA road department monitor the wastewater flows in the roadside drains under dry weather conditions.
	Industrial wastewater is discharged to the drainage channels without any treatment.	Though constructed to discharge storm water, the drainage channels are used as wastewater drains to convey wastewater, including industrial wastewater.	To propose that WASA-F take necessary actions to stop the direct discharge of industrial wastewater, with assistance from EPD/EPA-F. To propose that EPD/EPA-F enforce Pakistan's NEQS for Municipal and Liquid Industrial Effluent (into Inland Waters) on industrial units by assisting with the introduction of the treatment facilities. To propose that FDA take actions to move the industrial units to other areas such as industrial parks. To propose that WASA-F monitor the wastewater volume flowing through the drainage channels during dry weather conditions.
	Industrial wastewater is discharged to WASA-F's sewers without any pre-treatment.	The industrial wastewater polluters shall comply with Pakistan's NEQS for Municipal and Liquid Industrial Effluent (for Sewerage) with pre-treatment facilities. Industrial wastewater survey results suggest that: - High pH may damage sewers and the wastewater treatment process. - High concentrations of BOD, COD, phenol, and TDS may hinder compliance with Pakistan's NEQS for Municipal and Liquid Industrial Effluent (into Inland Waters). - The biological wastewater treatment processes are incapable of treating COD, TDS and heavy metals.	To propose that EPD/EPA-F and WASA-F enforce stricter environmental laws and sewerage regulations by strengthening the penal code. Further, to promote the installation of pretreatment facilities for each industrial unit.
	Industrial wastewater is discharged to the Paharang and Madhuana Drains without any treatment	The industrial wastewater polluters shall comply with Pakistan's NEQS for Municipal and Liquid Industrial Effluent (into Inland Waters) by treatment facilities.	To propose that EPD/EPA-F and WASA-F enforce environmental laws, including some to strengthen the penal code and promote the installation of treatment facilities by individual or grouped industrial units.

Subject	Present Conditions	Analysis Results	Directions of Planning
Industrial wastewater disposal and treatment	The qualitative and quantitative data on industrial wastewater are very limited.	The collection of qualitative and quantitative data is the first step towards understanding the main water pollution sources and studying measures for water pollution control in the Study Area and the planning and O&M of sewerage facilities. The industrial wastewater survey on the 30 selected factories by the JICA Mission Team reveals high pH, SS, BOD, COD, phenol, and TDS levels exceeding Pakistan's NEQS for Municipal and Liquid Industrial Effluent (into Inland Waters).	To propose that EPD/EPA-F collect more qualitative and quantitative data on the industrial wastewater discharged directly to the Paharang and Madhuana Drains. To propose that WASA-F collect qualitative and quantitative data on the industrial wastewater received by the sewerage and drainage facilities, in order to formulate industrial wastewater database.
	Technical assistance programs on industrial wastewater management have been established. WWF, the international environmental protection group, conducted a technology transfer program on industrial wastewater management. GTZ recently started a program on industrial wastewater management in Punjab province.	A technical manual on industrial wastewater management in the textile industry in Punjab Province prepared by WWF's programs is very useful. Technologies for inspecting and monitoring the industrial wastewater should be transferred to the EPD/EPA-F and WASA-F staffs.	To propose technology transfer programs for inspection and monitoring of the industrial wastewater by WASA-F and EPD/EPA-F. To suggest collaborative work with donors and international environmental groups such as GTZ, WWF, universities, and others.
Industrial Wastewater Acceptance by the Sewerage	WASA-F has received industrial wastewater discharge into its sewers without any assessment of the flow rates or wastewater quality.	The representative of WASA-F should recognize WASA-F is responsible for treating the industrial wastewater received by its sewerage system, in order to satisfy the Pakistan's standards for effluent discharged into Inland Waters. In the case of Japan, a representative of the public sewerage system is responsible for monitoring the treated wastewater and industrial wastewater received. The representative is punished if the treated wastewater exceeds the effluent quality standards.	To propose that WASA-F enhance the sewerage regulations on the provision of data by industrial units. To propose that EPD/EPA-F assist WASA-F by providing technical assistance and data collected through the EIA process.
	WASA-F's registration system for industrial units to receive the industrial wastewater is only used for billing the user charges. The system has no data on flowrates or wastewater quality.	WASA's registration system must be improved to enable better collection and analysis of data and information for inspections and industrial wastewater monitoring. WASA-F must enforce its sewerage regulations on the provision of data on flowrates and wastewater quality by each industrial unit.	To propose that WASA-F formulate an industrial wastewater database of the numbers of industrial units, categories, discharge rates, effluent quality, wastewater treatment methods, and sludge treatment and disposal methods, for inspection and monitoring. To suggest that WASA-F strengthen and enforce the penal code against violations of WASA-F' sewerage regulations.

Subject	Present Conditions	Analysis Results	Directions of Planning
Industrial Wastewater Acceptance by the Sewerage	No organizations in WASA-F inspect or monitor the industrial wastewater received by WASA-F's sewer system.	An organization to inspect and monitor the industrial wastewater received by the sewers is needed. In Japan, this type of organization is established in local governmental sewerage bureaus/departments or sewerage works entities.	To propose that WASA-F establish an industrial management unit and gives it the authority to perform technical evaluations for the issuance of WASA-F sewerage connection permits and to inspect and monitor the facilities based on WASA's sewerage regulations.
	Though equipped to analyze fundamental wastewater quality parameters such as pH, temperature, color, BOD, COD, SS, T-N, T-P, Nitrate, the WASA-F laboratory conducts no wastewater quality analysis.	Understanding on the importance of wastewater quality data for the O&M of sewerage facilities and monitoring of industrial wastewater seems to be lacking. WASA-F's laboratory is capable to analyzing the fundamental quality parameters of industrial wastewater.	To propose an O&M plan covering wastewater quality monitoring by the proposed industrial wastewater management unit in WASA-F.

Source: JICA Mission Team

Table 2.6.3 Present Conditions, Analysis Results, and Direction of Planning in Stormwater Management

Subject	Present Conditions	Analysis Results	Directions of Planning
Rainfall data analysis	Daily rainfall data from 1944 to 2016 are available from the Pakistan Meteorological Department (PMD), and hourly rainfall data have been available since 2010.	Probable rainfall intensity formula: Talbot type r = 4,212 / (t + 81.1) The probable rainfall intensity over a one-year return period is 30 mm/hr.	To propose that PMD and FDA collect shorter duration rainfall data (at least every 10 min.). To propose that FDA and WASA-F update their rainfall intensity analysis.
	The hourly rainfall data from 2013, 2014, and 2015 indicate an annual rainfall of about 480 mm, with some degree of rainfall recorded on about 40 days a year. Heavier rainfall events bringing more than 10 mm and more than 100 mm of rainfall are rarer, occurring on only 13 days and 3 days, respectively. The duration of a rainfall event is typically one to two hours.	Countermeasures for storm water run-off would be required to tackle inundation occurring for 3 days or more annually.	To prepare realistic storm water measures considering the rainfall characteristics.
Storm water drainage	Ponding occurs in some low lying areas but generally can be solved within several hours or a day.	The increase in the stormwater run-off ratio by urbanization is one of the reasons for the inundation in Faisalabad. The floods have never destroyed public or private property, but they have disrupted traffic and inconvenienced the public in other ways.	To prepare realistic stormwater measures considering the level of damages caused by stormwater run-off.
	The main roads only have road drains. The network of road drains and gutters, however, has not been developed to collect stormwater or convey it to drainage facilities even though drainage channels are installed nearby.	Conventional stormwater drainage facilities generally must be large in size and require huge investment for the smooth discharge of stormwater. A lower degree of development of a stormwater drain system may be due to lower priorities and lower cost-effects compared to that of wastewater discharge.	To propose a street drain system as a mitigation measure for inundated areas near drainage channels. To propose that WASA-F introduce soft components for O&M.
	The stormwater in inundated areas is discharged to the sewers nearby by opening the manholes or using pumps.	The existing sewer system receives some portion of the stormwater to mitigate the inundation problems.	The capacity of the existing sewers must be assessed in order to check the capacity allowance.
Storm water drainage facilities	In some central urban areas, the rainwater from households is discharged to the branch sewer nearby through household inlets designed for wastewater collection.	This practice of discharging rainwater to branch sewers is used in some areas but not the whole area. No eaves or troughs are equipped to collect and discharge the stormwater in the buildings in Faisalabad.	To allow the stormwater into the sewers within their capacity allowance. To propose the following as realistic mitigation measure using the sewers: intercept the wastewater and stormwater collected by the sewers under wet weather conditions at an overflow structure and then discharge the overflow into

Subject	Present Conditions	Analysis Results	Directions of Planning
			drainage channels or the Paharang/Madhuana Drains using stormwater pumps (converted from the former disposal pumps).
	Drainage channels installed for the discharge of stormwater are being used as a wastewater conveyance system to the Paharang and Madhuana Drains.	The wastewater discharge reduces the stormwater conveyance function of the drainage channels. When the wastewater is conveyed by trunk sewers proposed in the M/P, more stormwater can be conveyed by the drainage channels.	To propose measures using sewers, overflow structures, and pumps.
Storm water drainage facilities	WASA-F dredges the stormwater drainage channels before and after the rainy season.	Important work to preserve the proper function of the drainage channels.	To suggest continuous dredging of the drainage channels before and after the rainy season.
	WASA-F organizes a “monsoon emergency team” as a 24-hour customer service to solve the inundation problems using mobile pumping vehicles and other tools.	Important public services to respond to the problems caused by the inundation.	To propose a reduction of the 24-hour customer services by improving the sewer cleaning technique and introducing a preventative maintenance approach.

Source: JICA Mission Team

CHAPTER 3 CONDITIONS AND CONSIDERATIONS FOR PLANNING

3.1 Planning Background

The Faisalabad Development Authority (FDA) is responsible for regulating, supervising, and implementing development activities over a service area of almost 1,300 km2. WASA-F is currently responsible for providing water supply, sewerage, and drainage services works under the administrative control of FDA.

WASA-F currently provides services to a limited city area under FDA, with plans to expand its services in the future. In a previous JICA survey, the Detailed Planning Survey on the Project for Updating the Water Supply Sewerage and Drainage Master Plan of Faisalabad City (2015), the survey area discussed for this M/P was defined by either the FDA boundary or Peri-Urban boundary. As the current basis for the urban development in Faisalabad City, the survey area for this study was defined as the area within the Peri-Urban boundary.

3.2 Population

Table 3.2.1 below shows the JICA Mission Team estimates of the populations of the Urban and Peri-Urban areas, the rates at which they grew from 1998 to 2015, and the number of union councils falling within the Urban and Peri-Urban areas.

Table 3.2.1 Population of the Faisalabad Urban and Peri-Urban Areas in the M/P Study

Survey area for Study	Number of Union Councils	Population		Annual Compound Growth Rate (1998-2015)
		1998	2015	
Faisalabad Urban	108	2,031,000*	2,702,000*	1.69%
Faisalabad Peri-Urban	47	898,000**	1,324,000**	2.31%
Total	155	2,929,000	4,026,000	1.89%

Source: * Punjab Development Statistics, 2015; ** Estimated by JMT

3.3 Land Use

The land use pattern in the Urban and Peri-Urban areas is presented in **Table 3.3.1**. The main land uses are residential land and agriculture in the Urban area and agriculture in the Peri-Urban area.

Table3.3.1 Land Use Patterns in Faisalabad

	Land Use	Area (km^2)	%		Land Use	Area (km^2)	%
Built-up (Urban) Area				Peri-Urban Area			
1	Residential Area	56.08	46.49	1	Agriculture	6.37	83.11
2	Commercial	2.56	2.31	2	Commercial	4.14	0.54
3	Industrial Area	6.09	5.05	3	Community Facility	2.50	0.33
4	Educational Area	4.41	3.65	4	Dairy and Livestock	1.83	0.24
5	Open Space	1.96	1.62	5	Empty	53.48	6.97
6	Public Buildings	4.76	3.94	6	Industry	20.42	2.66
7	Graveyards	1.04	0.86	7	Residential	42.85	5.59
8	Agriculture Area	41.54	34.44	8	Transportation	4.28	0.56
9	Major Roads	2.19	1.81				
	Total Area	120.65	100.00		Total	767.05	100.00

Source: FPUSP-2015

3.4 Socio-Economic Characteristics

According to the household survey carried out by the JMT, the general household electricity charges for groundwater pumping were estimated at around PKR 1,000 to PKR 1,500 monthly. The WASA-F water tariff, meanwhile, is PKR 125 to PKR 500 per month at present. The survey showed that around 30% of households were subject to water-borne diseases such as diarrhea, dysentery, cholera, etc.

Household income distribution in Punjab Urban (urban areas in Punjab province) and Pakistan from 2015 to 2016 was determined by the Household Integrated Economic Survey (HIES). The HIES 2015-16 reported a 15-20% increase in household income and consumption in the urban area over the survey period. Ongoing increases in income and expenditure are therefore expected.

Table 3.4.1 Income Distribution of Punjab Urban and Pakistan in 2015-16

Quintile	Punjab Urban			Pakistan	
	Average monthly income (PKR)	Average monthly expenditure (PKR)	Percentage of household	Average monthly income (PKR)	Average monthly expenditure (PKR)
1st	19,366	17,977	6.1 %	19,742	18,500
2nd	24,315	22,948	10.4 %	23,826	22,874
3rd	28,224	27,264	15.9 %	28,020	26,702
4th	34,558	32,841	23.9 %	33,668	31,337
5th	68,975	58,834	43.7 %	60,451	52,906
Average/Total	46,616	41,385	100.0 %	35,662	32,578

Source: HIES 2015-16

According to *Poverty & Social Impact Analysis in Urban Punjab 2010,* the income ratio of Faisalabad compared to the Punjab Urban average was about 75%[4]. Therefore, the average household income in Faisalabad City is currently about 35,000 PKR/month (i.e., 75% of 46,616 PKR/month). According to the OECD estimation framework, the affordable level for the water and sewerage tariff is estimated to be 1,750 PKR, when set as 5% of the average household income (5% of 35,000 PKR/month).

3.5 Considerations in Planning

In order to achieve the target set under the Master Plan, the following issues need to be considered:

(1) Water Rights

WASA-F proposes intake from irrigation canals as a future water source, and discharge of treated wastewater in return.
This idea of a trade-off or reciprocity requires further discussion and mutual understanding between WASA-F and the Irrigation Dept. (e.g., the development time frames for the water supply system and sewerage system differ.)

(2) Canal Closure

Coordination with the Irrigation Dept. to avoid multiple canals closures at the same time and to shorten the closure periods.
Construction of a raw water reservoir with adequate capacity to reserve water during canal closure is recommended.
Connection between the WSZs to share water in order to minimize water shortage areas by diverting excess water to shortage zones.

(3) Industrial Wastewater

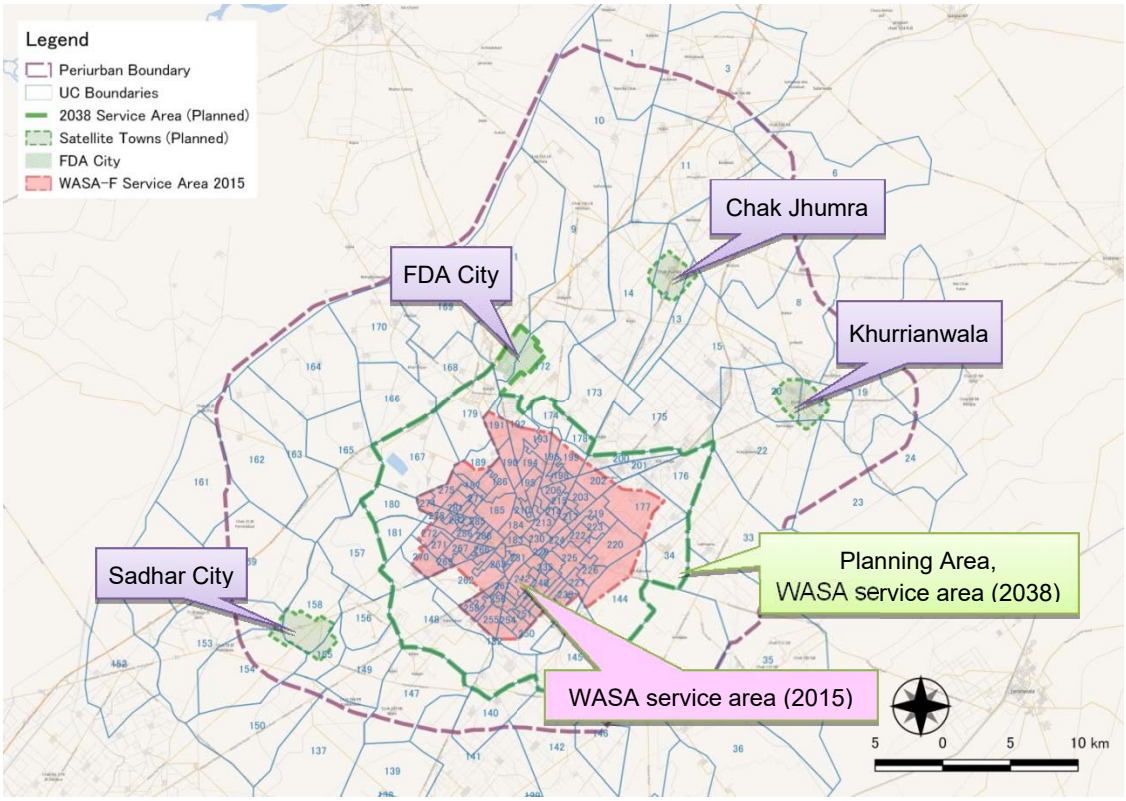
Enforcement of the regulations on industrial wastewater management and monitoring to ensure compliance.
The commitment of politicians and the industrial sector is important.
Cross-sectoral industrial wastewater management unit to be established.
The roles and responsibilities of relevant institutions must be clearly defined.

[4] The income distribution of Table 3.4.1 shows all of the urban areas of Punjab Province such as Faisalabad, Gujranwala, Lahore, Multan, and Rawalpindi. The household income of Faisalabad is lower than that of the Punjab Urban area on average. According to the results of a survey conducted by UU, "Poverty & Social Impact Analysis in Urban Punjab (PSIAUP) 2010," the average household income of Faisalabad is equivalent to approx.75% of that of the Punjab Urban area.

CHAPTER 4 FUTURE DEVELOPMENT PLANS

4.1 Planning Area

The area to become WASA-F's future service area in this M/P was set in consideration of population data from the bureau of statistics in GOPb, survey results on water supply conditions, and discussions with WASA-F. Once the target year of 2038 is reached, the service area will encompass the following urban areas, including FDA City and three remote towns (satellite cities), namely, Chak Jhumra, Khurrianwala, and Sadhar City. A map of the area is shown in **Figure 4.1.1**.



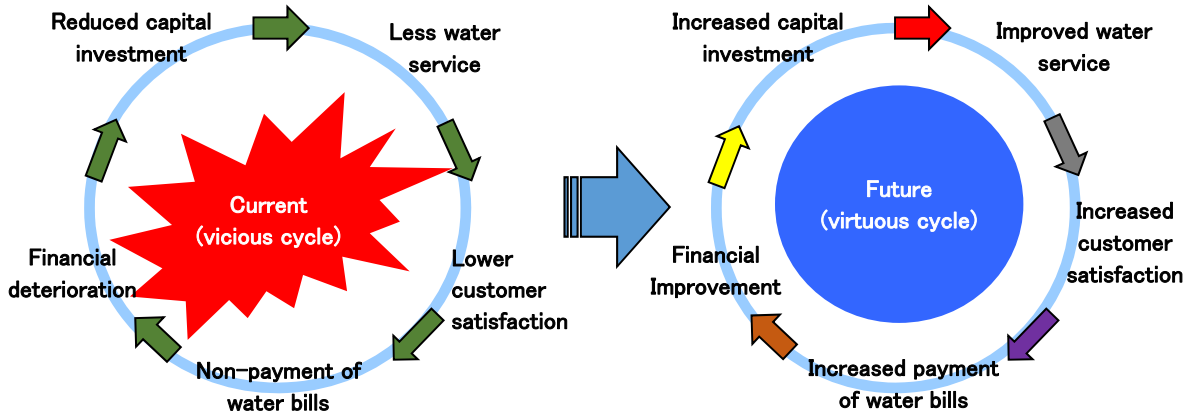
Source: JICA Mission Team

Figure 4.1.1 Planning Area up to 2038

4.2 Objectives and Goals

(1) Water Supply

WASA-F is currently pressed to develop water supply infrastructure to cope with a growing urban population and industrial expansion. In practice, however, water with pressure is supplied for only six hours a day. Water supply services provided for customers are not improving, which is leading to low customer satisfaction and a poor bill collection rate. As a consequence, WASA-F's financial conditions are deteriorating, which feeds a vicious cycle that must be remedied without fail in the future. One idea for shifting to a virtuous cycle through WASA-F's business operations is illustrated in **Figure 4.2.1**.



Source: JICA

Figure 4.2.1 Improvement from the Current Vicious Cycle to a Future Virtuous Cycle

To improve the above-mentioned situation, the M/P will deliberate on technical and management issues to enhance water supply services, particularly in terms of the supply water quantity (a duration of water supply), water pressure, and water quality. It aims at increasing customer satisfaction and willingness to pay. Furthermore, the M/P will restructure the water supply system to achieve the optimal efficiency and energy conservation, which will enable financial conditions to improve. The ultimate objective is to plan self-supporting service management, i.e., sustainable business, for WASA-F, and strategic investment in development on a long-term basis.

This Master Plan thus seeks to create a road map for a shift from a vicious to a virtuous cycle. Trials and demonstrations will also be scheduled as pilot activities to make the M/P a practical plan.

The goal of the above is to provide 100% of the population in the urban area, including FDA City, with high-level WASA-F water supply service, as shown in **Table 4.2.1**.

Table 4.2.1 Targeting the Water Supply Service in the WASA-F Service Area

Parameter	2015	2038	Balance
1) Population in the service area	2,428,904	4,146,110	+1,717,206
2) Population served	1,008,000	4,146,110	+3,138,110
3) Water supply coverage in the service area	42%	100%	+58%
4) Water supply amount (Daily Max. in m^3/day)	500,000	1,259,000	759,000
5) Water supply amount (Daily Max. in MGD)	110	277	167
6) Operation Rate (Daily Max.)	64%	99%	+35%

Note: Three satellite cities, Chak Jhumra, Khurrianwala, and Sadhar City, are excluded (each has a system of its own).
Source: JICA Mission Team

(2) Sewerage

The domestic and commercial wastewater generated in the urban area of Faisalabad is collected by the public sewerage system, but most is discharged to the Paharang Drain, Madhuana Drain, and drainage channels without any treatment. Most of the industrial wastewater is discharged to the sewerage system without any pre-treatment or to the drains without any treatment of any form. The heavily polluted water in the drains is discharged to Chenab River or Ravi River. Though hazardous for human health, some of the wastewater in the drains and drainage channels is used to irrigate farmlands near the drains.

To improve the present situation, the M/P will deliberate on technical and management issues to enhance sewerage services and industrial wastewater management, particularly in terms of service expansion, system efficiency, and wastewater quality. The sustainable water use and wastewater reuse are also important issues for the M/P, as the rapid urbanization and industrialization to come are expected to accelerate the water shortage and water pollution problems in the water-stressed area.

The objectives set for sewerage development are therefore to improve the living environment in the urban areas of Faisalabad district and contribute to sustainable wastewater use. Three specific goals to this end will be pursued:

to increase the sewerage service population in the urban areas and satellite cities;
to collect wastewater in the sewer system and treat all of it at wastewater treatment plants (that is, no wastewater is to directly discharge to drainage channels or drains), and improve the sewerage system for that purpose
to supply the treated wastewater to irrigation canals in order to return the water supplied by WASA-F.

Under the first goal, the population with access to the sewerage system is to be increased from 72% (in the current WASA-F service area) to 100% (in the total urban area, including FDA City and the two satellite cities) by the target year of 2038, as shown in **Table 4.2.2**. The remaining 22% live in rural areas and are to use on-site sanitation facilities.

Table 4.2.2 Target Sewerage Service Population in the Study Area

Parameter	2015	2038	Balance
1) Population in the Study Area	3,804,300	5,503,790	+1,699,490
2) Population in the urban area (sewerage planning area)	2,456,000	*4,292,110	+1,836,110
3) Population served by sewerage	1,769,400	*4,292,110	+2,522,710
4) Population using on-site sanitation	2,034,900	1,211,680	-823,220
5) Population coverage by sewerage in the Study Area	47%	78%	+31%
6) Population coverage by sewerage in the urban area	72%	100%	+28%

Note: * Figures includes the population of 71,000 in the Satellite cities of Sadhar City and Khurrianwala
Source: JICA Mission Team

Goals are set to prepare sewerage plans by which to realize the second and third objectives.

(3) Drainage

Conventional drainage facilities planned by the rational methods would be large in size and require huge investment. The effects, on the other hand, would be either limited due to the low number of rainfall events annually, or essentially unneeded given that the inundation causes little damage to the Faisalabad district beyond temporal nuisances (the inundation caused by stormwater may disrupt the flow of traffic or detract from the healthy living environment in the urban area in Faisalabad district). The objective of the drainage plan is therefore focused on mitigating the disadvantages caused by inundation. Goals are set in the drainage plan to formulate mitigation measures, albeit ones that can be executed at a low cost.

4.3 Water Demand Projection

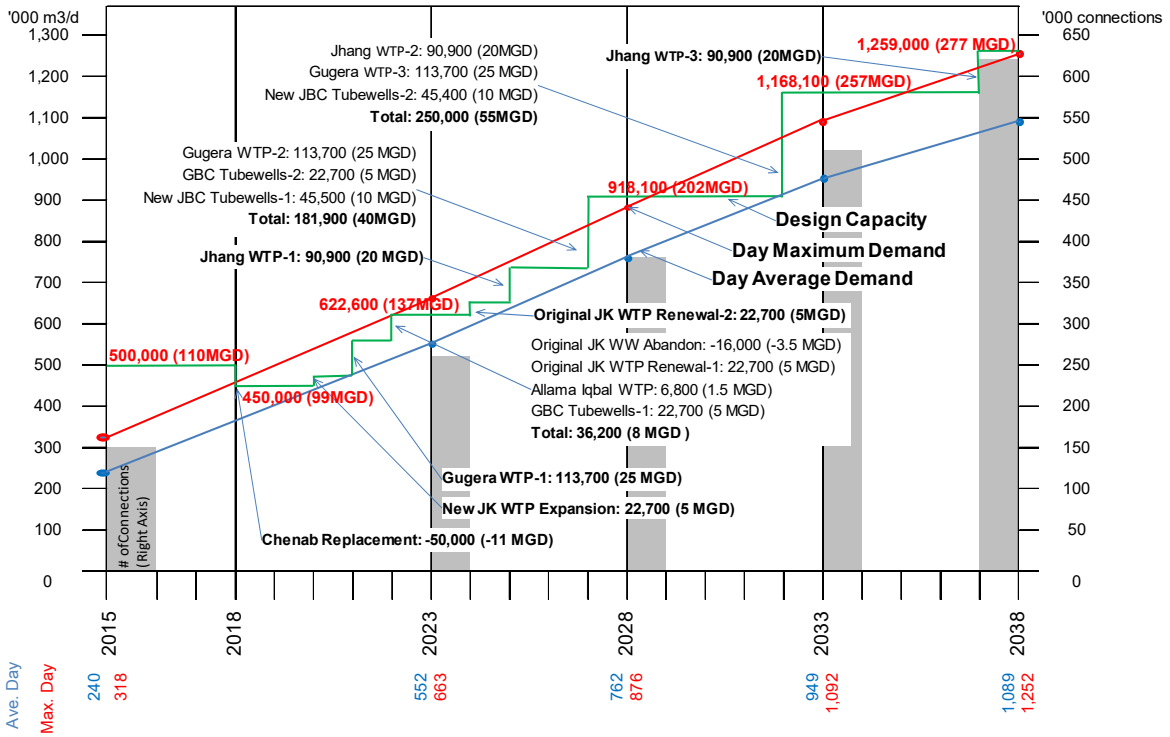
The future water demand in key years has been estimated based on the projected growth of the population, extension of the service area, and increases in unit consumption and the service coverage ratio (see **Table 4.3.1)**.

Table 4.3.1 Future Water Demand Estimates

Description	Unit	2015	2023	2028	2033	2038
Population	person	3,743,080	4,175,410	4,489,580	4,783,120	5,386,120
Population in Service Area	person	2,428,904	3,026,190	3,399,500	3,772,800	4,146,110
Population Served	person	1,008,000	1,815,700	2,549,600	3,395,500	4,146,100
Service ratio		42%	60%	75%	90%	100%
Domestic Consumption	m^3/d	129,000	241,500	369,690	492,350	601,180
Service Connections (Domestic)	Nos.	140,000	254,000	359,000	482,000	590,000
Per-capita (lcpd)	l/d/person	128	133	145	145	145
Non-Domestic Consumption	m^3/d	15,000	60,400	158,440	211,010	257,650
Service Connections (Non-Domestic)	Nos.	3,000	8,000	19,000	25,000	30,000
Rate		10%	20%	30%	30%	30%
Total Consumption	m^3/d	144,000	329,100	528,130	703,360	858,810
Service Connections	Nos.	143,000	262,000	378,000	507,000	620,000
Physical Loss	m^3/d	96,000	219,400	226,340	234,450	214,710
Percentage Loss		40%	45%	30%	25%	20%
Daily Average Demand	m^3/d	240,000	548,900	754,470	937,810	1,073,540
Daily Maximum Demand	m^3/d	318,000	658,700	867,640	1,078,480	1,234,570
Max. Factor		1.3	1.20	1.15	1.15	1.15
Bulk Supply to FDA City		0	4,540	8,680	13,040	17,380
Total Demand	m^3/d	318,000	663,000	876,000	1,092,000	1,252,000

Note: Three satellite cities Chak Jhumra, Khurrianwala, and Sadhar City are excluded because they are remote and have systems of their own.
Source: JICA Mission Team

Figure 4.3.1 shows the water demand in the WASA-F service area of Faisalabad by 2038. The service population will increase from 1 million at present to over 4 million in 2038. Correspondingly, the future water supply amount will reach 1,252,000 m^3/day (277 MGD) in 2038, more than doubling from the present design production capacity of 500,000 m^3/day (110 MGD).



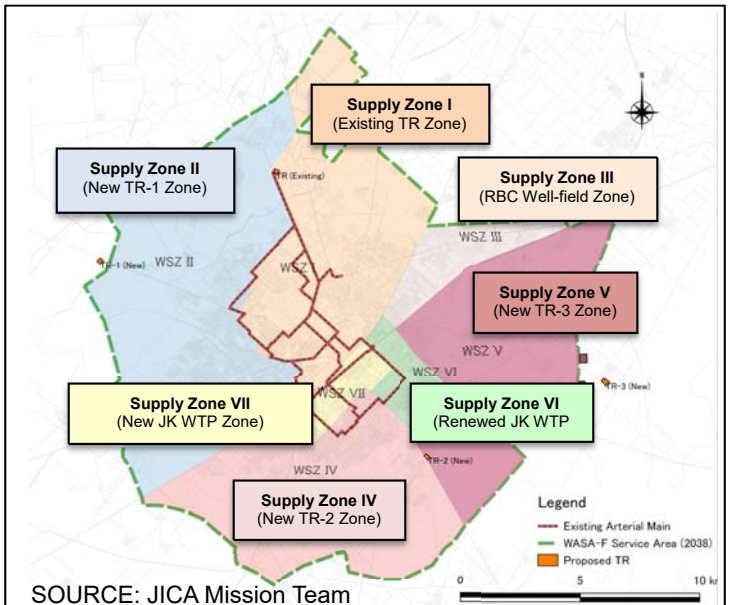
Source: JICA Mission Team

Figure 4.3.1 Water Demand Projection and Required Development

4.4 Water Supply Plans

(1) Water Supply Zones

The entire WASA-F service area is to be divided into seven Water Supply Zones (WSZs), each of which is provided water from Water Treatment Plants (WTPs) or directly from well-fields directly. Four WSZs have individual Terminal Reservoirs (TRs) that receive cleaned water from either WTPs or well-fields. An WSZ is independent and hydraulically isolated from adjacent supply zones. **Figure 4.4.1** illustrates the proposed WSZs. The water demand and expected water source capacity of each WSZ in 2038 are shown in **Table 4.4.1**.



SOURCE: JICA Mission Team

Figure 4.4.1 Water Supply Zones (WSZs)

Table 4.4.1 Water Supply Zones and Water Source Capacities in 2038

	Supply Zone		Area	Population	Water Demand		Water Resources (Well-field or WTP)	MP Design Capacity		
			Km²	-	MGD	m³/day	Name	MGD	MGD (Sum)	m³/day
Western Part	I	Existing TR	81.5	1,715,000	110	500,000	Gulfishan WW	1.5	107.5	488,000
							Jhang WTP-1	20.0		
							New JBC Well-field-1	10.0		
							New JBC Well-field-2	10.0		
							Millat Town WW	1.0		
							Chenab (Chiniot) Well-field	45.0		
							JBC Well-field	20.0		
	II	TR-1 (New)	84.1	603,000	39	178,000	Jhang WTP-2	20.0	40.0	182,000
							Jhang WTP-3	20.0		
Eastern Part	III	RBC Well	30.8	262,000	17	78,000	RBC Well-field (New)	5.0	18.0	82,000
							RBC Well-field	13.0		
	IV	TR-2 (New)	70.0	907,000	59	268,000	Gugera WTP-1	25.0	60.0	273,000
							Gugera WTP-2	25.0		
							Gugera Well-field-1	5.0		
							Gugera Well-field-2	5.0		
	V	TR-3 (New)	80.7	344,000	23	105,000	Gugera WTP-3	25.0	25.0	114,000
	VI	Original JK	7.4	162,000	11	50,000	Original JK Renewal-1	5.0	10.0	45,000
							Original JK Renewal-2	5.0		
	VII	New JK	6.2	252,000	16	73,000	New JK WTP	10.0	16.5	75,000
							NEW JK WTP Exp	5.0		
							Allama Iqbal WTP	1.5		
			360.7	4,245,000	**275**	**1,252,000**		**277.0**	**277.0**	**1,259,000**
							Proposed Future Source			

Source: JICA Mission Team

(2) Water Source Development Plan

Figure 4.4.2 shows the locations of future water sources.

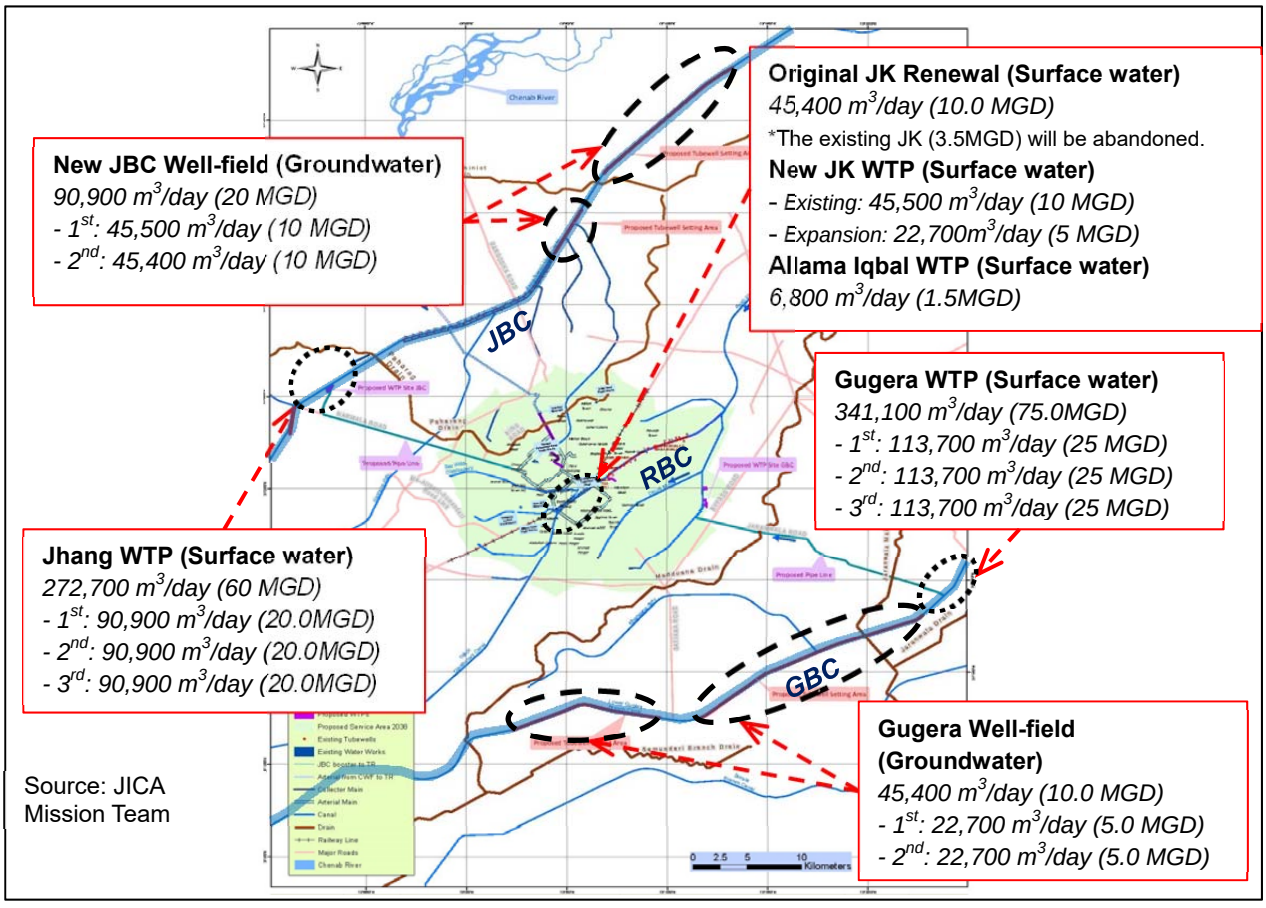


Figure 4.4.2 Location of New Water Source Development

(3) Transmission and Distribution Network Development Plan

Each WSZ is independent and hydraulically separated from the adjacent WSZs. To deal with emergencies, connection pipes must be installed between adjacent WSZs to enable interchange. Each connection pipe is provided with a boundary valve that is normally kept closed. Transmission mains convey cleaned water from WTPs or well-fields to TRs. Each supply zone has several distribution centers (DCs) from which cleaned water is supplied to consumers throughout the DCs by gravity. A DC is composed of a ground reservoir (GR) and an overhead reservoir (OHR) in order to adequately manage the distribution within a DC zone to ensure a sufficient supply of water at proper pressure inside of the zone (see **Figure 4.4.3)**. Arterial mains convey cleaned water from the TRs to the DCs. A DC zone, a water supply area served by a DC, is composed of multiple DMAs served by a distribution network made up of primary, secondary and tertiary mains**.** A DMA is an independent service area hydraulically isolated from adjacent DMAs in ordinal operation. Interconnecting pipelines are provided between adjacent DMAs, each with a boundary valve in case of an emergency. A flow meter and pressure gauge are installed at the entrance of a DMA to help provide a clear picture of the water demand and non-revenue water (NRW) tendencies within the DMA. The diagram in **Figure 4.4.4** below gives an overview of a WASA-F pipeline facility

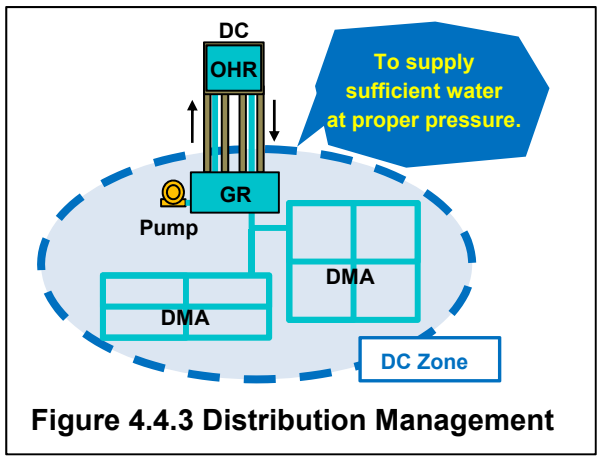
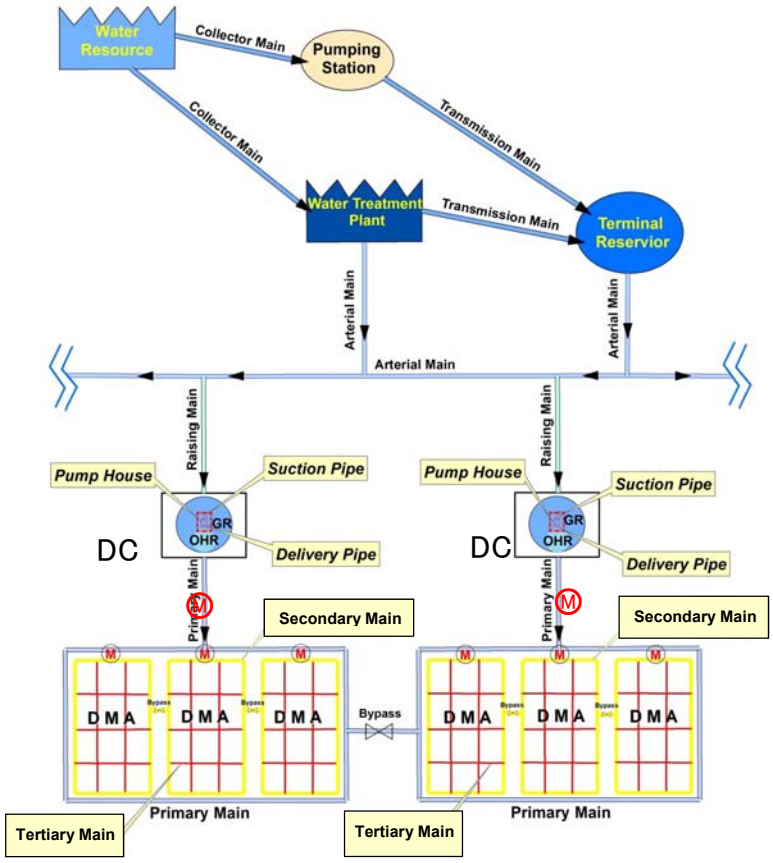


Figure 4.4.3 Distribution Management

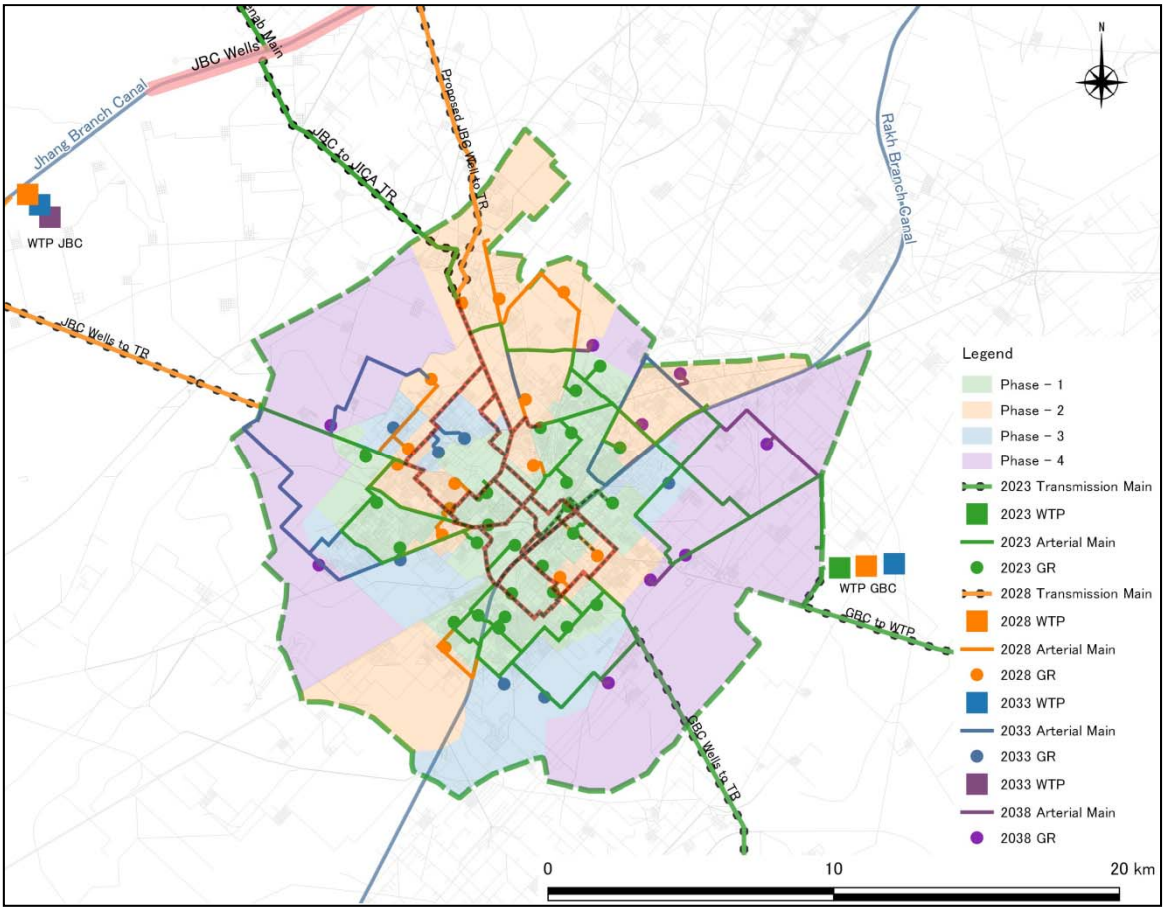


Source: JICA Mission Team

Figure 4.4.4 Diagram of a Transmission and Distribution Network

(4) Phased Development Plan

Figure 4.4.5 shows the proposed step-wise development plan to meet the demand up to 2038. According to the demand projection, a total of 1.25 million m3/day (277 MGD) will be required in Faisalabad City by 2038. The plan is divided into four phases to meet the demand by 2023, 2028, 2033, and 2038, with facility upgrades staged according to the demand year by year up to 2038.



Source: JICA Mission Team

Figure 4.4.5 Phased Development of Facilities

Table 4.4.2 shows the implementation plans for water source developments up to 2038.

Table 4.4.2 Water Sources Development Plan

Unit: '000 m^3/d

		2015	2018	2023	2028	2033	2038
Demand	Daily Maximum	287		664	870	1,092	1,252
	Daily Average	239		552	762	949	1,089
Production							
Exist. system	Chenab (Chiniot) Tubewells	**254.6**	204.6	204.6	204.6	204.6	204.6
	JBC (JICA) Tubewells	**90.9**	90.9	90.9	90.9	90.9	90.9
	RBC Tubewells	**81.7**	81.7	81.7	81.7	81.7	81.7
	New JK WTP	**45.5**	45.5	45.5	45.5	45.5	45.5
	Original JK WTP	**16.0**	16.0	-	-	-	-
	Millat Town WW	**4.5**	4.5	4.5	4.5	4.5	4.5
	Gulfishan WW	**6.8**	6.8	6.8	6.8	6.8	6.8
	Subtotal	**500.0**	**450.0**	434.0	434.0	434.0	434.0
Expansion 1	New JK WTP Expansion			**22.7**	22.7	22.7	22.7
	Gugera WTP-1			**113.7**	113.7	113.7	113.7
	Original JK Renewal-1			**22.7**	22.7	22.7	22.7
	Allama Iqbal WTP	**-**	**-**	**6.8**	6.8	6.8	6.8
	GBC Tubewells-1			**22.7**	22.7	22.7	22.7
	Subtotal			**188.6**	188.6	188.6	188.6
Expansion 2	Original JK Renewal-2				**22.7**	22.7	22.7
	Jhang WTP-1				**90.9**	90.9	90.9
	Gugera WTP-2				**113.7**	113.7	113.7
	GBC Tubewells-2				**22.7**	22.7	22.7
	New JBC Tubewells-1				**45.5**	45.5	45.5
	Subtotal				**295.5**	295.5	295.5
Expansion 3	Jhang WTP-2					**90.9**	90.9
	Gugera WTP-3					**113.7**	113.7
	New JBC Tubewells-2					**45.4**	45.4
	Subtotal					**250.0**	250.0
Expansion 4	Jhang WTP-3						**90.9**
Total		**500.0**	**450.0**	**622.6**	**918.1**	**1,168.1**	**1,259.0**

Source: JICA Mission Team

(5) Countermeasures to Reduce or Shorten Canal Closures

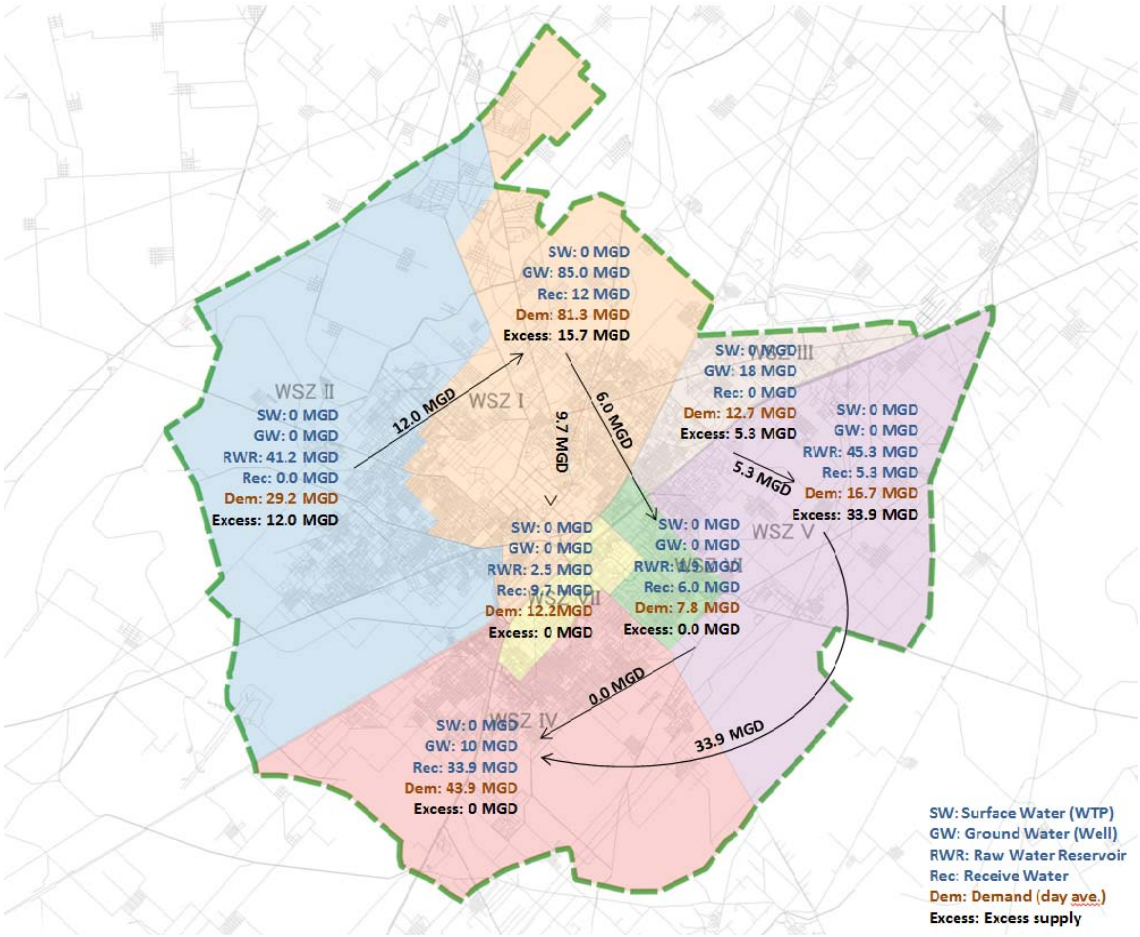
This Master Plan uses a combination of WTPs (surface water) and wells (groundwater) to meet the water demand. WTPs will take in water from the nearby Jhang Branch Canal, Rahk Branch Canal, and Gugera Branch Canal for treatment and distribution to the city. These canals, however, are closed once a year by the Irrigation Department for inspection and maintenance works. The standard duration of each closure period now stands at 18 days, or approximately 3 weeks, with 12 of the days overlapping with closures in other canals. The proposed measures below were formulated in an investigation into countermeasures to ensure water supply during these canal closure periods:

1) Arrangements with the Irrigation Department to avoid the overlapping of canal closures and to ensure that at least one canal is open to maintain water supply,
2) Sharing and interchange of water between WSZs to provide water to WSZs short of water through a networked arrangement,
3) Construction of raw water reservoirs (RWRs) for water storage at strategic locations.

In addition, water consumption is expected to decrease in the cooler winter months of December and January. Daily water demand is set at the daily minimum demand (85% of the daily average demand) during this period.

Insofar as possible, excess water from one WSZ will be diverted to another WSZ that is short of water. Diversion alone, however, will not be sufficient meet the whole demand. Therefore, two RWRs will be constructed to store water and act as a surface water source during the canal closure period. Arterial mains will be used as the transfer mains. The proposed stage-wise development of the arterial mains satisfies the

transfer main requirements. The arrangements for Measure 1) will have to be negotiated between the Irrigation Department and WASA-F. Measures 2) and 3) have been studied through a simulation process. The simulation results show that the water shortages can be covered when the RWRs in WSZ-2 and WSZ-5 supply water to over a period of canal closing. The total volume required are as shown in the table below. A raw-water-to-treated-water conversion of 0.95 is applied for the calculation of the reservoir volumes. The water supply sharing plan is shown in the figure below.



Source: JICA Mission Team

Figure 4.4.6 Water Sharing Plan during Canal Closure Periods

Table 4.4.3 shows the required RWR volumes in WSZ2 and WSZ5. These RWRs should be constructed and expanded step by step in parallel with the construction and expansion of the Jhang and Gugera WTPs, respectively.

Table 4.4.3 Required RWR Volume

WSZ	2	5
Facility	Jhang WTP	Gugera WTP
Storage volume required	2,728,000 m^3 (600 MG)	4,637,000 m^3 (1,020 MG)
RWR reservoir (assume 4 m depth)	69 hectare	116 hectare

Source: JICA Mission Team

(6) Service Connections (including ferrule and meter installations)

WASA-F has been installing water meters since 2015 to shift the tariff system from the current fixed rate billing to metered-rate billing in the future. **Table 4.4.4** shows the required number of service connections up to 2038.

Table 4.4.4 Required Numbers of Service Connections

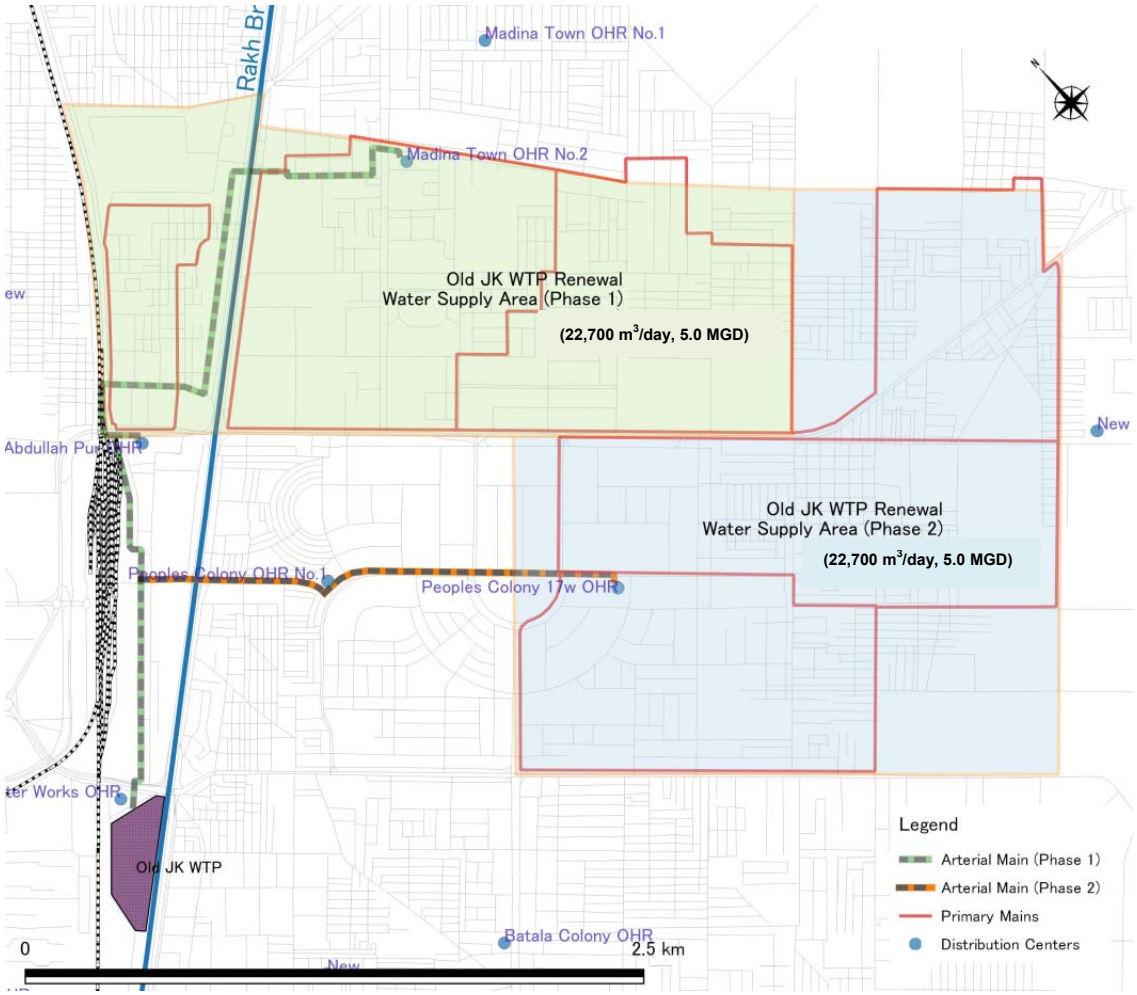
Description	Unit	2015	2023	2028	2033	2038
Households in Service Area	Nos.	250,000	420,000	480,000	530,000	590,000
Domestic	Nos.	140,000	254,000	359,000	482,000	590,000
Non-domestic	Nos.	3,000	8,000	19,000	25,000	30,000
Total	Nos.	143,000	262,000	378,000	507,000	620,000

Source: JICA Mission Team

While service connection rules are set forth in the Water Supply Faisalabad Regulations – 2015 published in the Punjab Gazette dated October 29, 2015, these rules are not necessarily observed on site. It will therefore be necessary to revise the existing regulations, to prepare a manual or standard operation procedure (SOP) for the construction and inspection works on service connections, to thoroughly disseminate them within WASA-F, to establish a training system for contractors, and to establish a water supply inspection system.

4.5 Priority Project

The existing Jhal Khanauana Water Works (JK WW) is currently operating with a slow sand filtration system that produces treated water at only 43% of the original capacity of 16,000 m^3/day (3.5 MGD). The selected Priority Project includes renewal of the JK WW into a rapid sand filtration system with a capacity increase to 45,400 m^3/day (10 MGD), the construction of new DCs, and pipeline installations. The locations of the JK WW to be renewed, new DCs, pipelines, and phased development area of the Priority Project are shown in **Figure 4.5.1**.



Source: JICA Mission Team

Figure 4.5.1 JK WW to be Renewed, New OHRs, Pipelines and Phased Development Area

(1) Design Criteria and Layout of the JK Water Treatment Plant

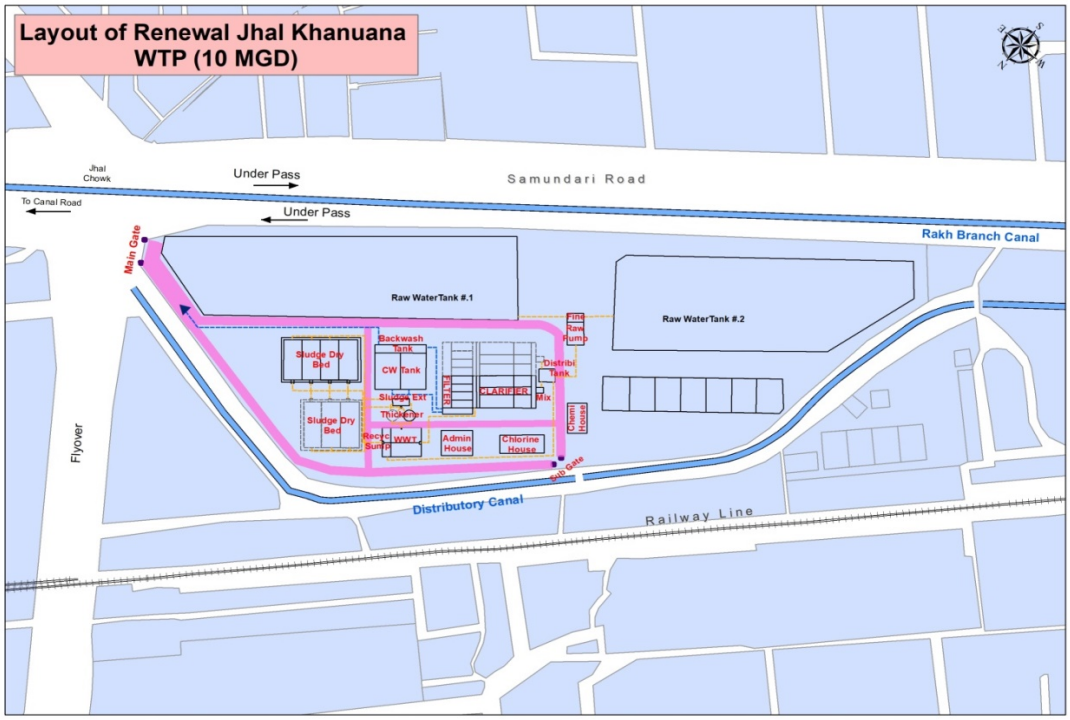
The design criteria for the renewal of the JK Water Treatment Plant (WTP)[5] are summarized in **Table 4.5.1**. The layout of the renewed JK WTP is shown in **Figure 4.5.2.**

Table 4.5.1 Design Criteria for Water Treatment

Category	Facility	Item	Criteria	Remark
General	Design Capacity	Production capacity	45,400 m^3/day	10.0 MGD
Water Purification	Receiving/ Distribution tank	Pre-chlorination	1 to 3 mg/l	
		Pre-lime	0 to 20 mg/l	
	Flash mixing tank	Aluminum Sulphate	15 to 40 mg/l	Solid Alum
	Flocculation tank	Polymer dosage	0.2 to 1.0 mg/l	
	Settling tank	Surface loading	< 0.8 $m^3/hr/m^2$	Upflow rate
	Rapid sand filter	Backwashing	0.5 $m^3/min/m^2$	Air 6 min + air/water 2 min + water 8 min
		Post-chlorination	1 to 2 mg/l	
	Clear water reservoir	Detention time	2 hours	
Sludge Handling	Wastewater tank	Detention tank		
	Drying bed	Average dry time	1 to 3 months	

Source: JICA Mission Team

[5] Regarding the terminology used in WASA-F, this Report labels older treatment plants operating with slow sand filtration systems as Water Works (WWs) and new treatment plants operating with rapid sand filtration systems as Water Treatment Plant (WTPs).



Source: JICA Mission Team

Figure 4.5.2 Layout of the Renewed JK WTP

(2) Capital Costs for the Priority Project

The capital costs of the Priority Project are estimated as follows.

Table 4.5.2 Capital Costs of the Priority Project

Item	Cost	
	(million PKR)	(thousand. USD)
Water Treatment Plant	3,060	25,900
Transmission Main	360	3,000
Distribution Center	900	7,600
Distribution Main	640	5,400
Distribution Secondary & Tertiary Pipe	360	3,000
District Meter	40	300
Service Connection (w/ meter)	280	2,400
Security Management Cost	340	2,900
Total	5,980	50,600
Consulting Fee	840	7,100
Grand Total	**6,820**	**57,700**

Source: JICA Mission Team

(3) Operation and Maintenance Cost of the Priority Project

The operation and maintenance (O&M) cost of the Priority Project is estimated as follows.

Table 4.5.3 O&M Cost of the Priority Project

Item		After Phase I completion	After Phase II completion
O&M Cost	(million PKR/year)	108	200
	(thous. USD/year)	910	1,690

Source: JICA Mission Team

(4) Project Implementation Schedule

The schedule for implementation of the Priority Project is shown below.

Table 4.5.4 Project Implementation Schedule

Phase	Procedure	2019	2020	2021	2022	2023	2024
Phase 1	Preparatory Survey						
	Detailed Design & Tendering						
	Construction						
Phase 2	Detailed Design & Tendering						
	Construction						

Source: JICA Mission Team

4.6 Sewerage and Drainage Plans

4.6.1 Sewerage Plan

(1) Outline of the Sewerage Plan

Table 4.6.1 summarizes the respective areas (in km2 and hectares) and their service populations in 2038.

Table 4.6.1 Sewerage Service Areas and Service Populations in the Study Area (2038)

Zone	Service Area	Service Population in Urban Area	Service Population in Satellite City	Total Service Population	Total Population in the Study Area
Western SWD	175.2975 km^2 (17,530 ha)	*2,176,290	30,000	2,206,290	-
Eastern SWD	204.0677 km^2 (20,407 ha)	2,044,820	41,000	2,085,820	-
Service Area	379.3652 km^2 (37,937 ha)	4,221,110	71,000	4,292,110	-
Study Area	1,221 km^2 (122,100 ha)	-	-	4,292,110	5,503,790

Note: * Figures include those of FDA City of 75,000
Source: JICA Mission Team

Table 4.6.2 summarizes the design flow for the Western and Eastern SWDs, respectively.

Table 4.6.2 Design Average Flows (2038)

(Unit: m^3/d)

WSD	Domestic WW in Urban Area	Non-Domestic WW in Urban Area			WW in Urban Area	Point Source*	Total WW	I/I of Ground water	Ave. Flow	Design Ave. Flow
		Comm.	Indus.	Total						
Western	289,980	39,790	68,170	107,960	397,940	15,160	413,100	20,650	433,750	433,800
Eastern	282,190	40,840	85,350	126,190	408,380	4,920	413,300	20,660	433,960	434,000
Total	572,170	107,960	153,520	234,150	806,320	20,080	826,400	41,310	867,710	867,800

Note: * FDA City, Sadhar City and Khurrianwala
Source: JICA Mission Team

Table 4.6.3 outlines the sewerage facility plan and **Figure 4.6.1** shows the general plan for the proposed sewerage facilities.

Table 4.6.3 Outline of the Sewerage Plan

Parameter		Western SWD	Eastern SWD
1.1	Service Area	17,530 ha	20,407 ha
2.1	Service Population by Project	2,206,290 persons	2,044,820 persons
2.2	Service Population by service area	126 persons/ha (=2,206,290/17,530)	100 persons/ha (=2,044,820/20,407)
2.3	Service Population Increase by Project	1,443,890 persons (=2,206,290-762,400)	1,037,820 persons (=2,044,820-1,007,000)
3.	Proposed Sewerage Facilities	1) Trunk/Interceptor sewer: 450-2,700 mm, 42.57 km 2) Main sewer: 300-1,650 mm, 43.42 km,	1) Trunk/Interceptor sewer: 600-2,700 mm, 66.79 km 2) Main sewer: 225-1,350 mm, 79.15 km,

		including existing sewer replacement 3) Branch sewer: 225 mm, 2,081.6 km 4) 6 lift stations, Rehabilitation 5) New influent pumping station: Coarse/Fine Screens, Grit chambers, Pumps (capacity 65 m^3/min, total head 17.0 m, 2 units, capacity 130 m^3/min, total Head 17.0 m, 4 units.) 6) Chokera WWTP improvement, Capacity 433,800 m^3/d, UASB reactors, Facultative Ponds, Sludge Drying Beds. 7) Treated Wastewater Pumping and Transmission Facilities, Pumps (capacity 75.33 m^3/min, total head 25.0 m, 5 units), Force Main: DCIP, Dia. 1,500 mm, Length 14.55 km, 2 lines, Surge tank	including existing sewer replacement 3) Branch sewer: 225 mm, 2,389.3 km 4) 3 lift stations, Rehabilitation 5) New influent pumping station: Coarse/Fine Screens, Grit chambers, Pumps (capacity 63 m^3/min, total Head 30.0 m, 2 units, capacity 126 m^3/min, total Head 30.0 m, 4 units). 6) New WWTP, Capacity 434,000 m^3/d, Anaerobic Ponds, Facultative Ponds. 7) Treated Wastewater Pumping and Transmission Facilities, Pumps (capacity 75.33 m^3/min, total head 22.0 m, 5 units), Force Main: DCIP, Dia. 1,500 mm, Length 12.3 km, 2 lines, Surge tank
4.1	Construction Cost	109,855 Million PKR	137,976 Million PKR
4.2	Project Cost	150,987 Million PKR	193,448 Million PKR
4.3	Project Cost per Service Population	68,430 PKR/person (=150,987,000,000/2,206,290)	94,600 PKR/person (=193,448,000,000/2,044,820)

Source: JICA Mission Team

The most appropriate wastewater treatment process for both sewerage districts was selected by comparing three alternative wastewater treatment processes (Anaerobic Pond + Facultative Pond, UASB + Facultative Pond, and Anaerobic Pond + Trickling Filter + Polishing Pond) with a focus on technical aspects and the costs of construction, land acquisition, and O&M in present-day terms, applying discount rates of 7% and 9%. The details will be presented in Section 9.4 of Part C in the Main Report.

The UASB + Facultative Pond process was selected for improvement of the Chokera WWTP in the Western SWD. The Anaerobic Pond + Facultative Pond process was selected for the new East WWTP in the Eastern SWD.

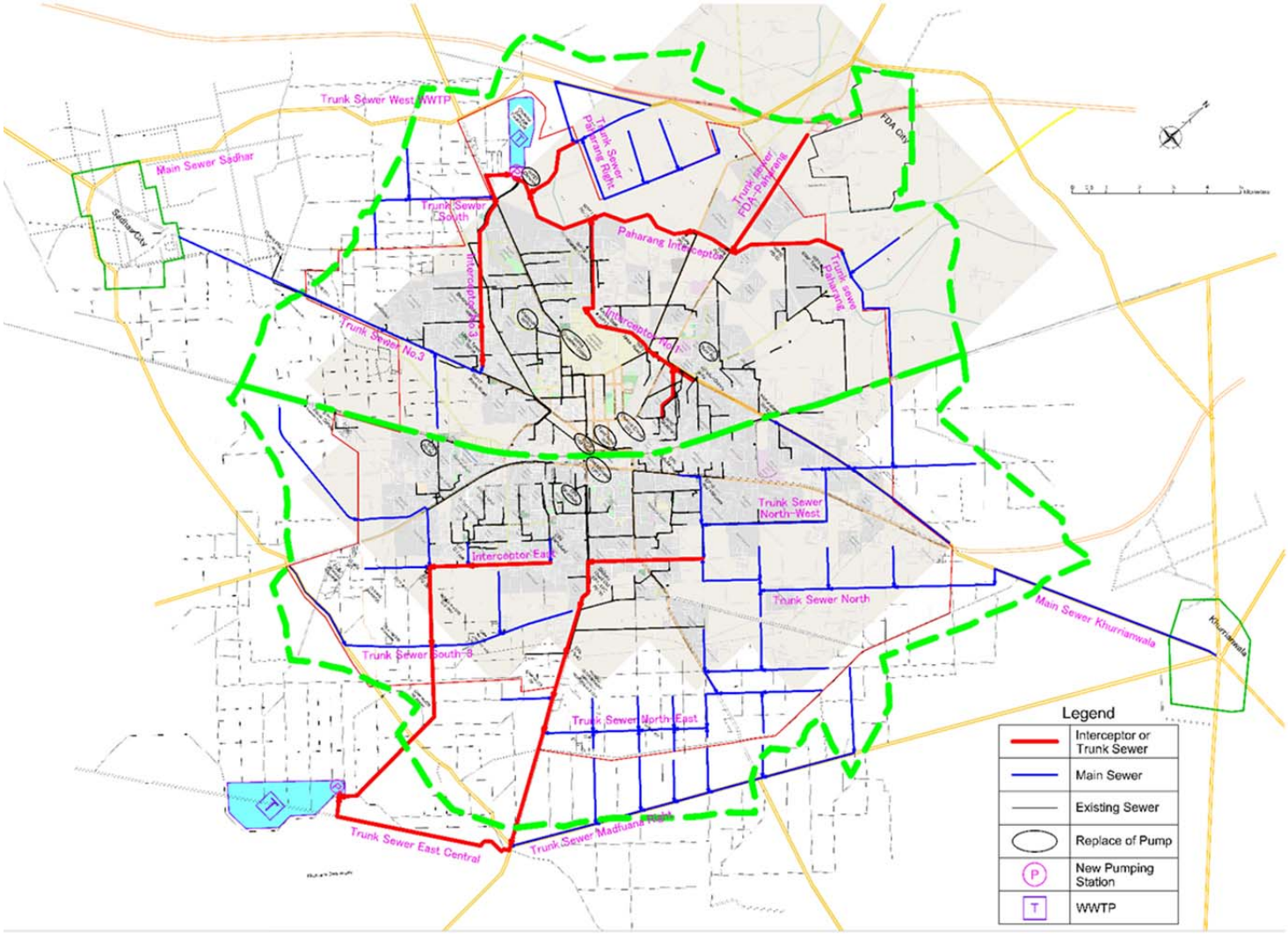
(2) Sewerage Development Plan

Table 4.6.4 and **Figure 4.6.2** show the four-phase sewerage service area development plans for the Western SWD and Eastern SWD.

Table 4.6.4 Phased Sewerage Service Area Expansion Plan

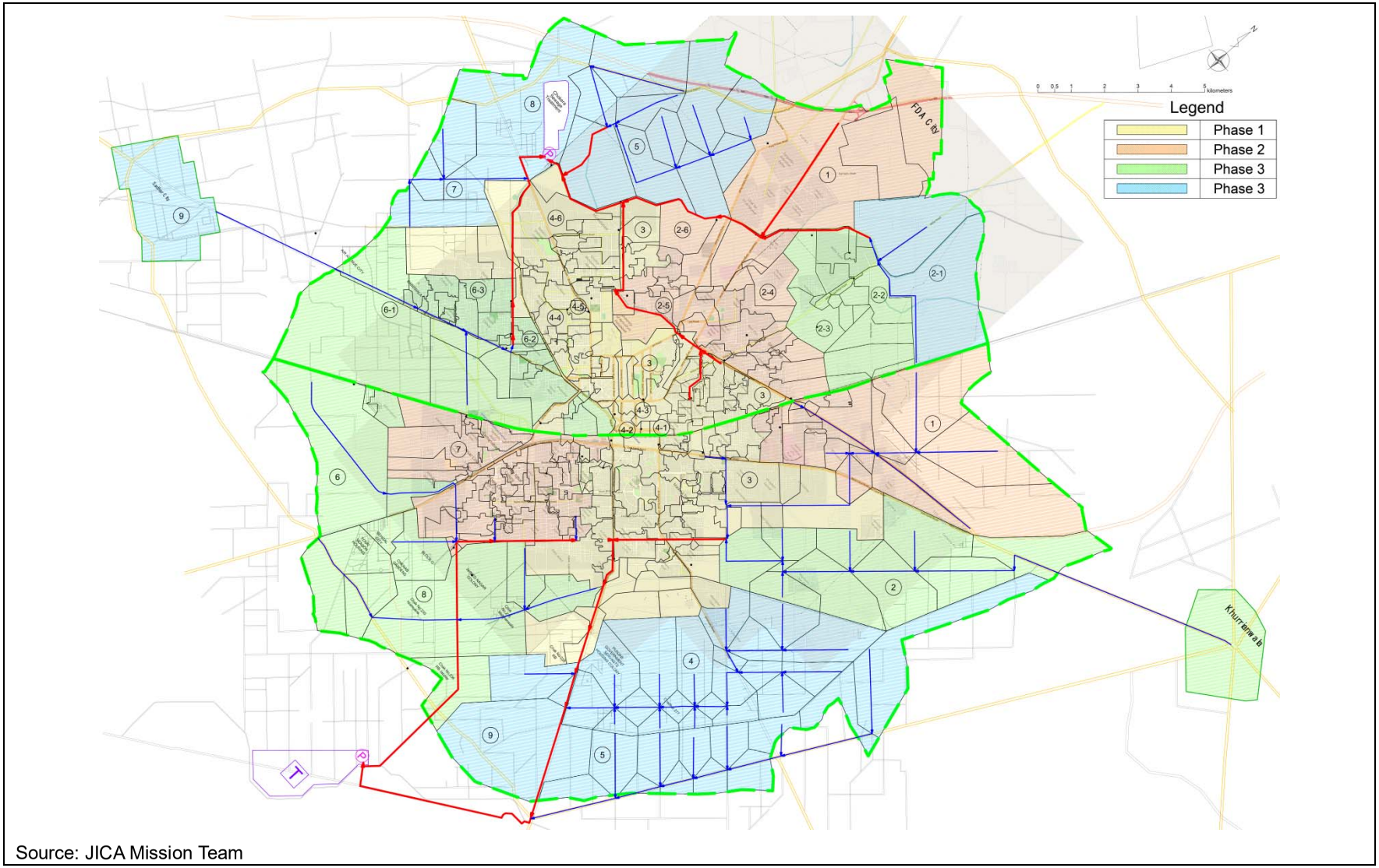
Item	Western SWD	Eastern SWD
Phase 1	The area from the urban center to the Chokera WWTP (area covered by PS-3), together with the areas along Drainage Channel No.1. The areas are densely populated with households. A high presence of shopping centers, shops, restaurants, universities and schools, and the offices of public and private companies pushes the daytime population up to even higher levels.	Areas covered by the existing pumping stations of Satiana Road Original, PS-31 (Satiana Road), and PS-42 will be covered by the new sewer system. The area is densely populated with households. A high presence of shopping centers, shops, restaurants, universities and schools, and the offices of public and private companies pushes the daytime population up to even higher levels.
Phase 2	Close to the urban center, including FDA City now being developed	Areas covered by the existing pumping stations of PS-36, Peoples Colony No.2 and D-type The area is densely populated with households. A high presence of factories, offices, shopping centers, shops, restaurants, and schools pushes the daytime population up to higher levels.
Phase 3	Outskirts of the urban center	Areas close to the urban center developed in Phase 1 and 2, including Khurrianwala.
Phase 4	Areas remote from the urban center; areas encompassing Sadhar city and areas surroundings around the Chokera WWTP	Areas remote from the urban center, currently farmland

Note: SWD stands for Sewerage District
Source: JICA Mission Team



Source: JICA Mission Team

Figure 4.6.1 General Plan for the Sewerage System



Source: JICA Mission Team

Figure 4.6.2 Phased Expansion of the Sewerage Service Area

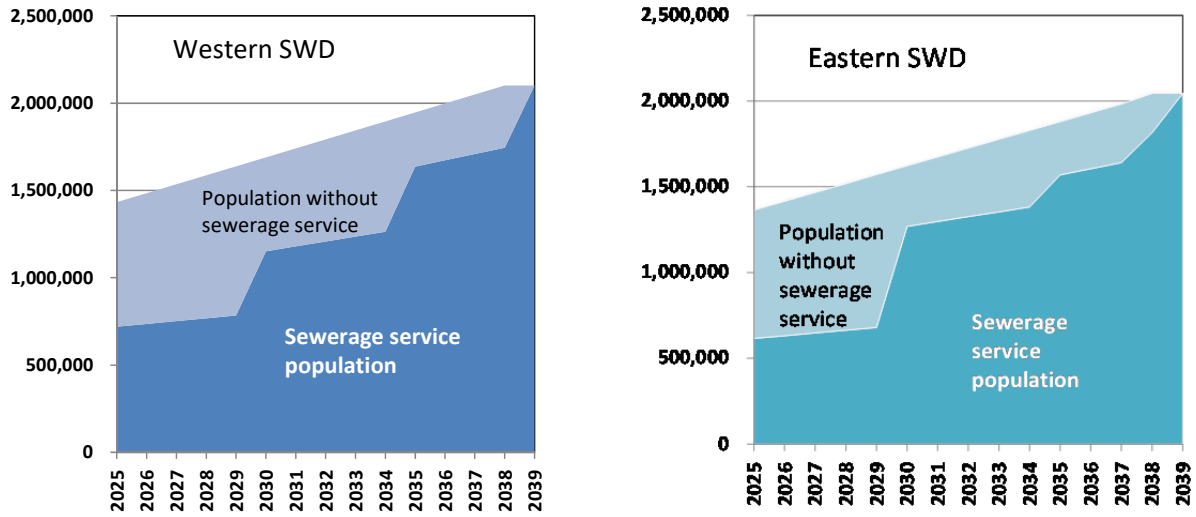
Table 4.6.5 presents the targets and measures set to prepare for the phased sewerage and drainage development, including soft components required to facilitate the sewerage phases.

Table 4.6.5 Targets and Measures in the Phased Sewerage Development

Targets or Measures*	Western SWD				Eastern SWD			
	Phase 1**	Phase 2	Phase 3	Phase 4	Phase 1	Phase 2	Phase 3	Phase 4
1. No discharge of wastewater to open drainage channels	■	■			■	■		
2. Improvement of existing sewers	■	■			■	■		
3. Expansion of new sewers	■	■	■	■	■	■	■	■
4. Improvement of the public water environment improvement by wastewater treatment at WWTPs	■	■			■	■		
5. Supply of treated wastewater to irrigation canals			■	■			■	■
6. Decrease in the number of disposal pumping stations through the introduction of trunk sewers installed more deeply into the ground	■	■	■		■	■		
7. Stormwater pumps converted from disposal pumping stations	■	■	■		■	■		
8. Proposed road drain system for inundated areas	■		■			■		
A. Formulation of a sewer database based on surveys	■	■			■	■		
B. Sewer cleaning using mechanical equipment	■	■	■	■	■	■	■	■
C. Industrial wastewater management	■	■	■	■	■	■	■	■
D. Formulation of a road drain database based on surveys	■	■			■	■		

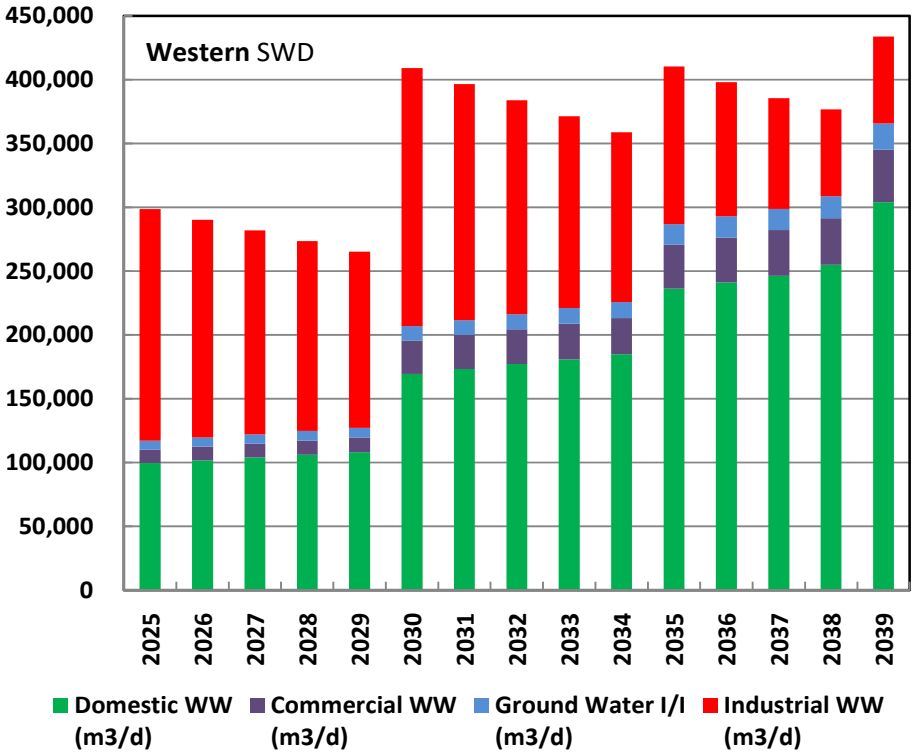
Note: * 1 to 7. Facility development; A to D: Soft components to facilitate the facility development
** Phases: Phase 1 (2021-2024), Phase 2 (2025-2029), Phase 3 (2030-2034), Phase 4 (2035-2038)
Source: JICA Mission Team

Figure 4.6.3 shows the service population expected to be reached through the implementation of the phased sewerage development. The service population jumps between 2029 and 2030, 2034 and 2035, and 2038 and 2039, reflecting the service commissioning after completion of each phase of construction work. **Figures 4.6.4** and **4.6.5** respectively show the influent flows to the WWTPs in the Western and Eastern SWDs, estimated based on the sewerage service. The figures clearly reveal that the domestic and commercial wastewater will increase gradually in step with the service expansion, while the industrial wastewater will be brought down to the design flow by the target year.



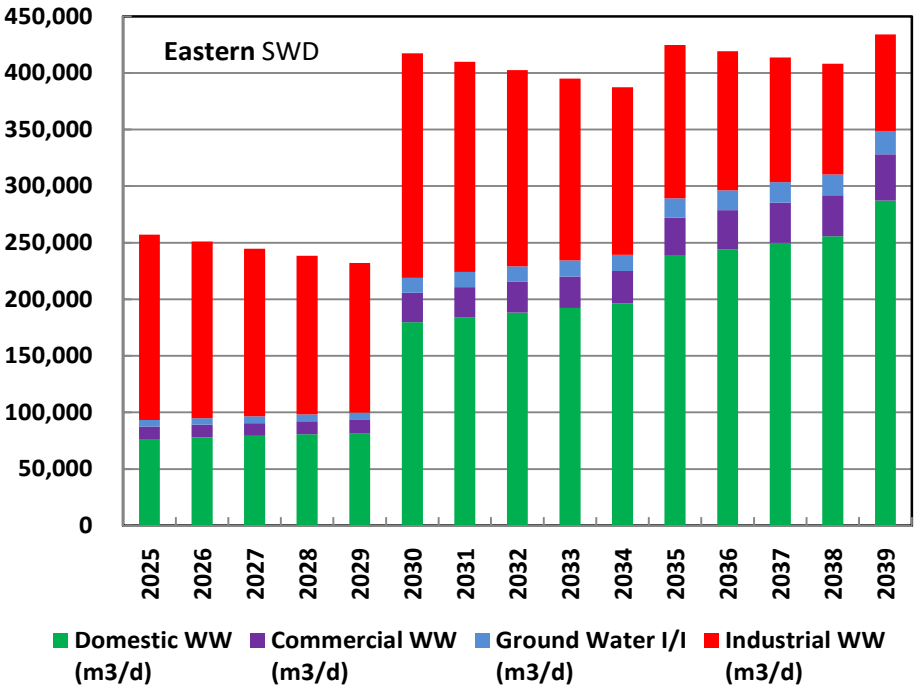
Source: JICA Mission Team

Figure 4.6.3 Sewerage Service Population Reached through the Phased Sewerage Development



Source: JICA Mission Team

Figure 4.6.4 Planned Influent Flow Rate to the Chokera WWTP by the Phased Sewerage Development Plan after the Phase 1 Commissioning (2025)



Note: Commission of each phase: Phase 1 (after 2025), Phase 2 (after 2030), Phase 3 (after 2035) and Phase 4 (after 2039)
Source: JICA Mission Team

Figure 4.6.5 Planned Influent Flow Rate to the New East WWTP Achieved by the Phased Sewerage Development Plan after the Phase 1 Commissioning (2025)

(3) Industrial Wastewater Management

Industrial wastewater management will be key to succeeding in the sewerage project and enabling the use of treated wastewater as an irrigation water source (discharge to irrigation channels and mixed water could be used as irrigation water).

A large volume of wastewater is accepted by the sewerage system. In the future, however, the sewerage system will regulate or control the volume according to the design industrial wastewater volumes, as presented in **Figure 4.6.4**. and **Figure 4.6.5**.

Table 4.6.6 presents a proposed list of measures on industrial wastewater management and their scheduling in the phased sewerage development

Table 4.6.6 Industrial Wastewater Management Measures and Their Scheduling in the Phased Sewerage Development

Management Measures	Prepara-tion **	Phase 1 **	Phase 2 **	Phase 3 **	Phase 4 **
1. Formulation of the WASA-F policy for accepting industrial wastewater into the WASA-F sewerage system					
2. Improvement of WASA-F regulations on sewerage, especially those related to industrial wastewater management, including an improved definition of the penal code					
3. Establishment and operation of an industrial WW management unit or division in WASA-F with an annual operation budget					
4. Establishment of a registration system for the industrial units in order to evaluate and monitor industrial wastewater					
5. Preparation and execution of public relation programs with industrial units					
6. Preparation and execution of a staff training program with the assistance of international donor organizations					
A. Demarcation and confirmation of industrial wastewater management responsibilities among agencies concerned					
B. Promotion of industrial wastewater treatment facilities within their properties of industrial units					
C. Promotion of factory relocation to industrial estates					
D. Industrial wastewater monitoring					

Note: * 1 to 7: Measures by WASA, WASA-F: A to D, EPA-F and Other Provincial Government bodies related to Industry
** Phases: Preparation (2019-20), Phase 1 (2021-2024), Phase 2 (2025-2029), Phase 3 (2030-2034), Phase 4 (2035-2038)
Source: JICA Mission Team

(4) Selection of Priority Project

The phase 1 projects of both the Western SWD and Eastern SWD place high priority on living environment improvement in the Study Area. Because of financial constraints, however, it will be necessary to designate one of the phase 1 projects as the highest-priority project. **Table 4.6.7** lists a set of parameters for comparing the two phase 1 projects.

Table 4.6.7 Comparison of the Phase 1 Projects of the Western SWD and Eastern SWD

Parameter		Western SWD	Eastern SWD
1.1	Service Area by Project	3,551 ha	3,553 ha
1.2	Service area coverage	20 % (=3,551/17,530)	17 % (=3,553/20,407)
2.1	Service Population by Project	719,750 persons (year 2025)	616,270 persons (year 2025)
2.2	Service Population by service area	203 persons/ha (=719,750/3,551)	173 persons/ha (=616,270/3,553)

Parameter		Western SWD	Eastern SWD
2.3	Service Population Increase by Project	159,520 persons (=719,750-560,230)	159,520 persons (=616,270-456,750)
2.4	Service Population Increase by service area	45 persons/ha (=159,520/3,551)	45 persons/ha (=159,520/3,553)
3.	Population Coverage Ratio by Project	2025: 50% (=719,750/1,432,700)	2025: 45% (=616,270/1,365,400)
4.	Proposed Sewerage Facilities	1) Trunk/Interceptor sewer: 450-2,700 mm, 11.61 km 2) Main sewer: 750-1,650 mm, 11.42 km, existing sewer replacement only 3) Branch sewer: 225 mm, 391.9 km 4) 5 lift stations, Rehabilitation 5) New influent pumping station: Coarse/Fine Screens, Grit chambers, Pumps (capacity 65 m^3/min, total head 17.0 m, 2 units, capacity 130 m^3/min, total head 17.0 m , 3 units.) 6) Chokera WWTP improvement, Capacity 216,900 m^3/d, UASB reactor, Facultative Ponds, Sludge Drying Bed.	1) Trunk/Interceptor sewer: 1,950-2,700 mm, 23.16 km 2) Main sewer: 300-1,350 mm, 6.24 km, including existing sewer replacement 3) Branch sewer: 225 mm, 533.0 km 4) 2 lift stations, Rehabilitation 5) New influent pumping station: Coarse/Fine Screens, Grit chambers, Pumps (capacity 63 m^3/min, total head 30.0 m, 2 units, capacity 126 m^3/min, total head 30.0 m, 2 units.) 6) New WWTP, Capacity 217,000 m^3/d, Anaerobic Ponds, Facultative Ponds.
5.1	Direct Cost	26,753 Million PKR	41,783 Million PKR
5.2	Project Cost	37,794 Million PKR	62,893 Million PKR
5.3	Project Cost per capita in the Service Population	52,510 PKR/person (=37,794,000,000/719,750)	102,055 PKR/person (=62,893,000,000/616,270)

Source: JICA Mission Team

The economic and financial analyses for the phase 1 projects in both SWDs indicate that the projects are economically viable but financially unfeasible. The phase 1 project of the Western SWD, however, performs better in the financial analysis than the phase 1 project of the Eastern SWD. Hence, that project is selected as the Priority Project.

4.6.2 Drainage Plan

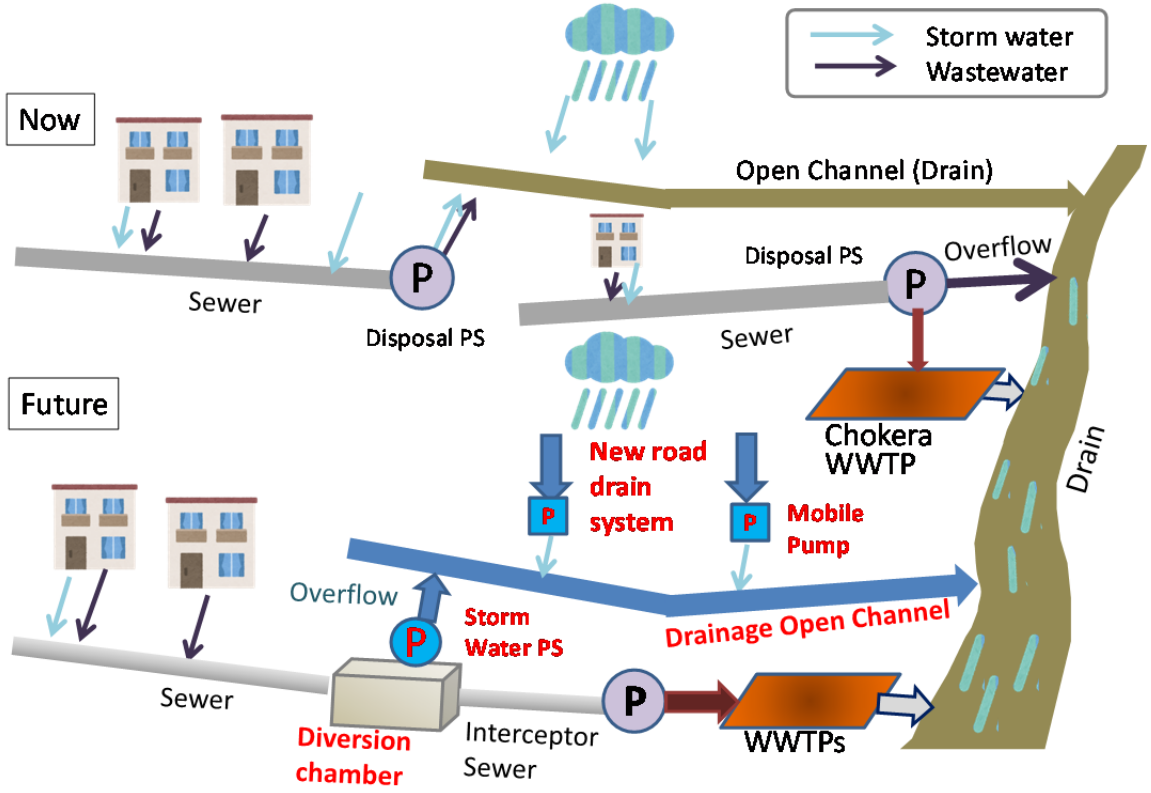
(1) Drainage Plan Using Existing Sewers

Some of the existing branch sewers in Faisalabad receive part of the stormwater through the inlets of house connections within the full capacity of the sewers during rainy season. In some cases, the stormwater in inundated areas is discharged to nearby sewers by mobile WASA-F pumps.

In general, the inflow and infiltration (I/I) of stormwater and groundwater to sewers cannot not be protected completely in the separate sewer system. Volume reduction of the I/I of stormwater and groundwater is one of the big issues in the sewer O&M and cost in the separate sewer system. Therefore, the sewers in Faisalabad are to accept some part of the inflow of stormwater within the capacity allowance of the new trunk and interceptor sewers designed under dry weather flow conditions, as shown in **Table C8.5.2** in the Main Report.

To arrange for the acceptance of stormwater, diversion chambers are to be installed between the present inlet sewers to the disposal pumping stations and the new trunk (interceptor) sewers. The diversion chamber has a weir to control the dry weather design flow to the interceptor sewer, while the overflow of wastewater and stormwater is discharged to the pumping station and finally pumped up to the open drainage channels or Paharang or Madhuana Drain.

The diagram in **Figure 4.6.6** illustrates the flow of stormwater discharge using the existing sewer and using the new road drain system to be introduced. The new road drain system will be explained in the next section.



Source: JICA Mission Team

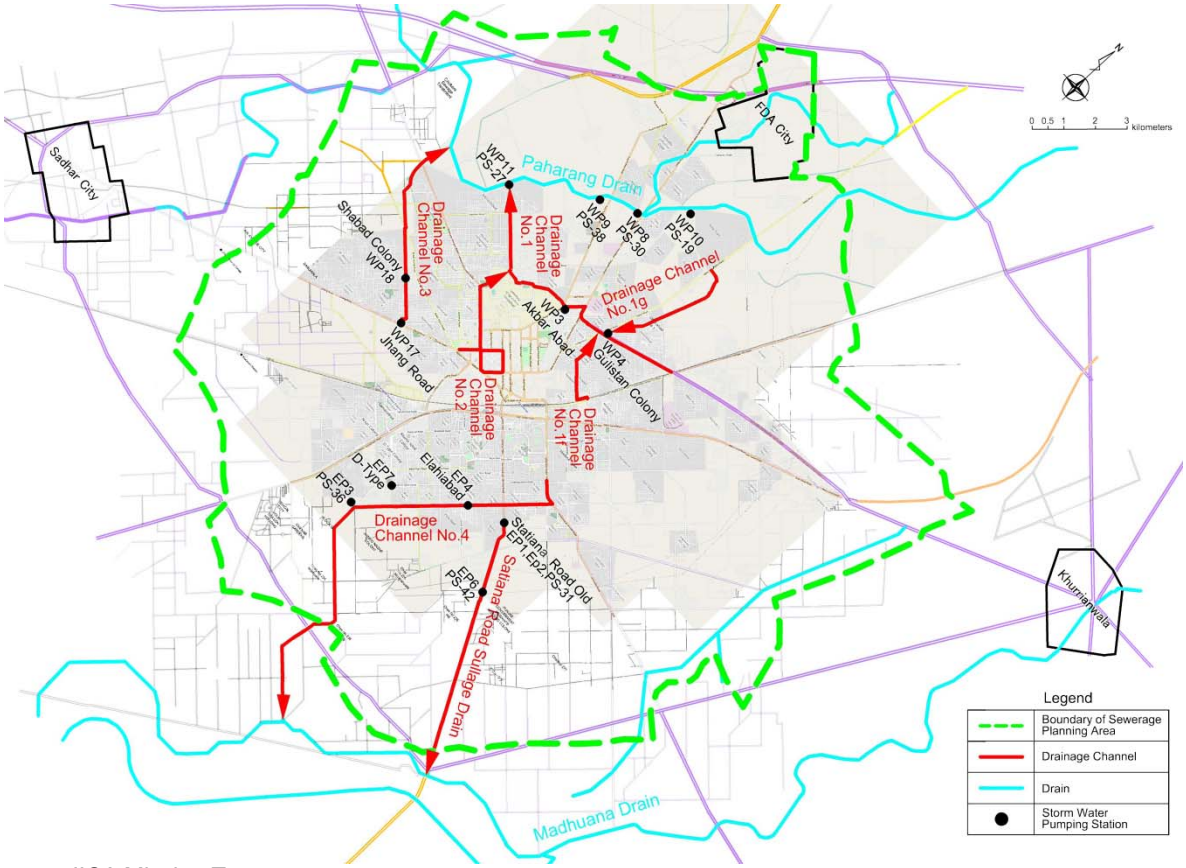
Figure 4.6.6 Proposed Drainage System using the Existing Sewer System and New Drain System

Table 4.6.8 is a list of stormwater pumping stations to be converted to stormwater pump stations from the disposal pumping stations after the interceptor or trunk sewers are installed. The locations of the stormwater pumping stations are shown in **Figure 4.6.7**.

Table 4.6.8 List of Pumping Stations to be Converted to Stormwater Pumping Stations

PS ID	Name of Pumping Station	Project Phase	PS ID	Name of Pumping Station	Project Phase
1. WP3	Akbar Abad	1	10. WP17	Jhang Road	3
2. WP4	Gulistan Colony	1	11. WP18	Shadab Colony	3
3. WP6	Shadman	1	12. EP1	Satiana Road Original	1
4. WP8	PS-30	2	13. EP2	PS-31, Satiana Road	1
5. WP9	PS-38	2	14. EP3	PS-36	2
6. WP10	PS-19	3	15. EP4	Peoples Colony No.2	2
7. WP11	PS-27*	1	16. EP6	PS-42	1
8. WP12	Weaver Colony*	1	17. EP7	D-type*	2
9. WP16	Liaqat Town*	3			

Note: * Rehabilitation work is planned for the new pump equipment.
Source: JICA Mission Team



Source: JICA Mission Team

Figure 4.6.7 Locations of the Stormwater Pumping Stations to be Converted from Disposal Pumping Stations

(2) Street Drain Plan for Areas Near the Drainage Channels

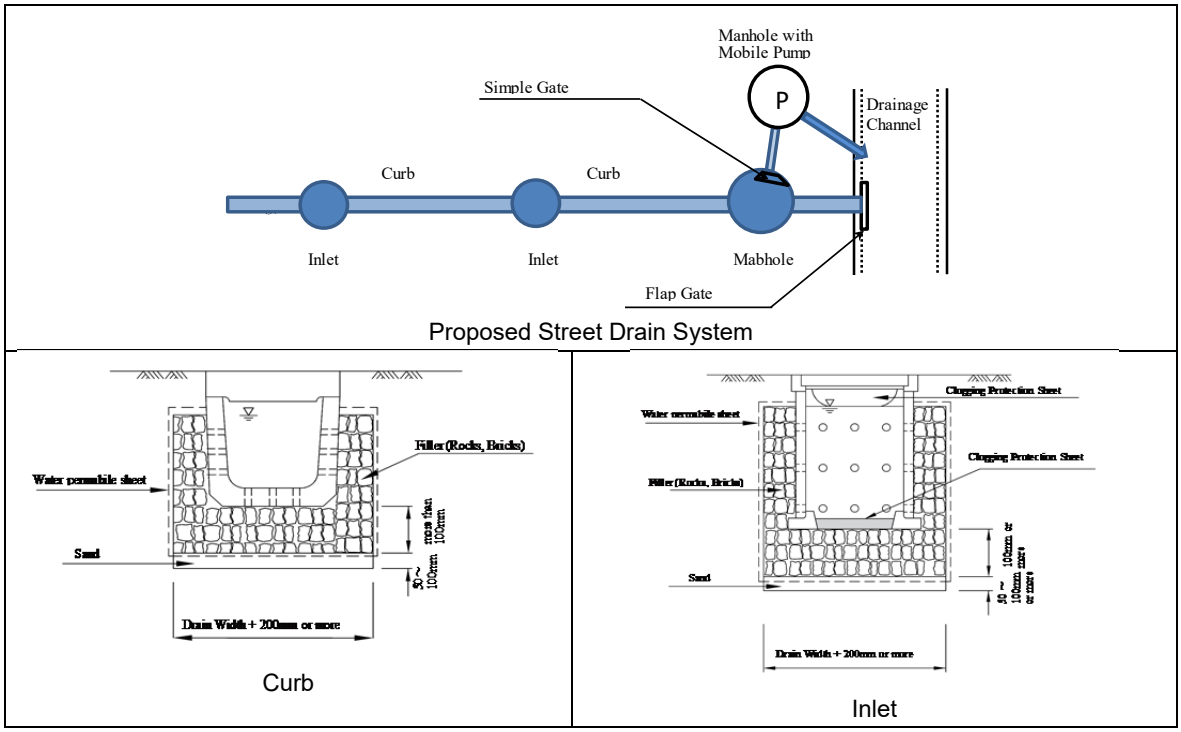
The schematic in **Figure 4.6.8** shows the proposed street drain system for the areas near the drainage channels. This proposed drain system consists of curbs, an inlet, a standard manhole, a manhole for a mobile pump, and flap gates. The curb is installed at the center or on both sides of the street. The inlet is constructed at a cross section of the street or at the point where the dimensions of the curb expand. The flap gate is equipped at the outlet of the curb to prevent the backward flow of stormwater. If the water level of the open drainage channels rises above that at the outlet of the curve, two manholes are needed. The first manhole is to divert the stormwater flow to another manhole through a simple gate. The second manhole is equipped with a mobile pump system (submergible pump) to discharge the stormwater to the open drainage channels.

The details for this proposal shall be studied further in the F/S and D/D stages based on actual geotechnical investigation data at the installation sites to expect infiltration to the sub-surface at a depth of at least 3 to 5 m underground.

Figure 4.6.9 shows the proposed locations of the street drain systems planned for flood control in the areas: 14 locations in the Western SWD and 3 locations in the Eastern SWD.

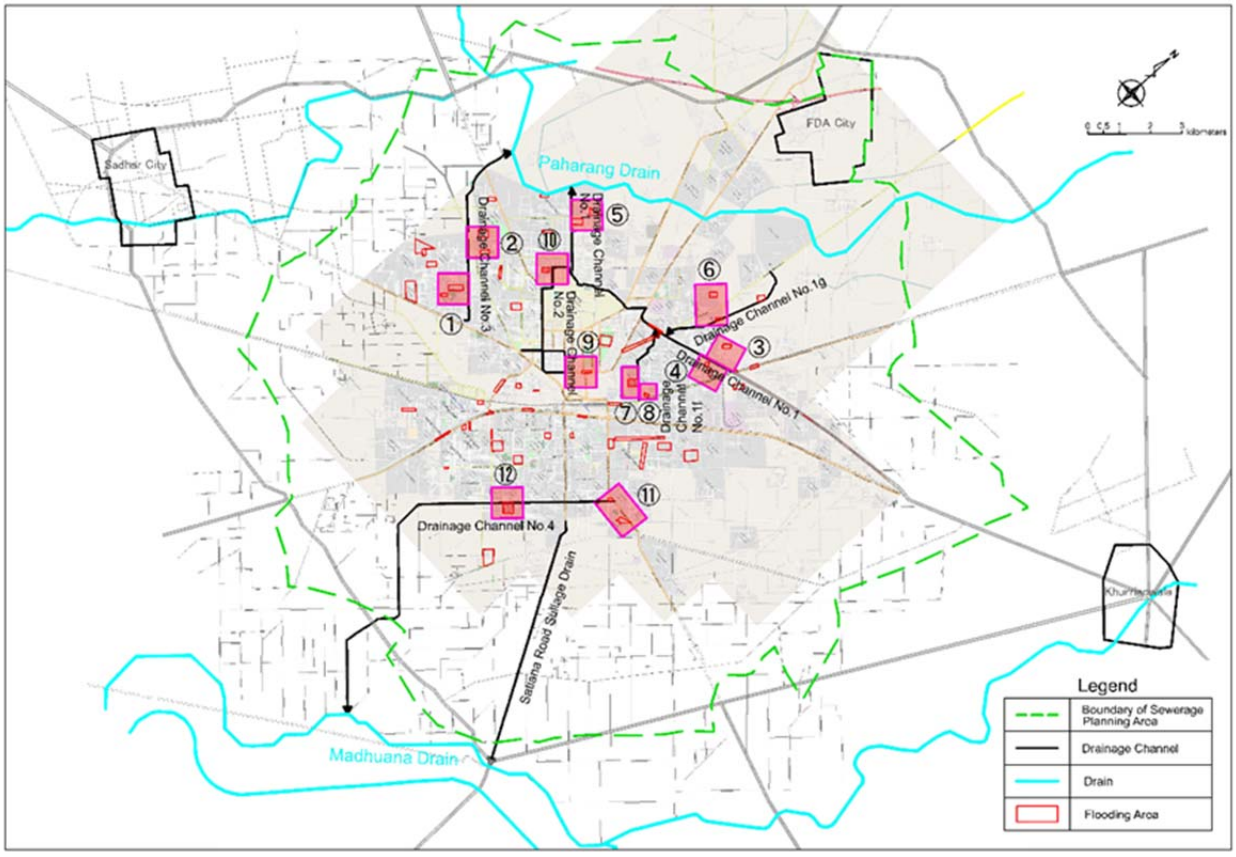
(3) Soft Component of the Measures

The soft components of the measures are summarized in **Table 4.6.9**.



Source: JICA Mission Team

Figure 4.6.8 Proposed Street Drain System for the Areas Near the Drainage Channels



Source: JICA Mission Team

Figure 4.6.9 Target Areas of the Proposed Street Drain System

Table 4.6.9 Soft Components of Stormwater Management and Implementation

Organization	Proposed Soft Component	Action Plan	Schedule
WASA-F	1) Collect data and information on open drainage channels (e.g., the water level and sediment accumulation). 2) Collect data and information on the road drains maintained by WASA-F.	1) Prepare an annual plan for dredging the open drainage channels (ongoing) 2) Prepare a map of the road drains maintained by WASA-F	2018 to 2024 (Phase 1)
	3) Dredge the open drainage channels to maintain the capacity	3) Continue the present activities while preparing an annual work report	Annual activity
	4) Inspect the road drains	4) Prepare action programs and execute the programs together with the community, either quarterly or before and after the rainy season	2018 to 2020 (prepare program) 2020 to 2024 (Phase 1) 2025 to 2029 (Phase 2)
	5) Conduct clean-up activities together with the community to clear the road drains (with tools to be prepared and provided by WASA-F)	5) Prepare an annual event plan	2018 to 2021 (prepare annual program, conduct the pilot activity) 2022 (start the annual program)
	6) Conduct public awareness campaigns to stop the public from disposing of solid waste into drains	6) Prepare and execute campaign programs targeting the communities and schools.	2018 to 2024 (Phase 1)
FDA, Road Management Agency	1) Collect data and information on the road drains (e.g., locations, sizes, condition of the openings and covers, accumulation of sediments, and garbage disposal)	1-1) Prepare a road drain map for the planning, design, construction, and O&M of the road drains. 1-2) Prepare an annual report on road drain conditions	2018 to 2024 (Phase 1) 2022 (start the annual program)
	2) Clean the roads, especially before the rainy season	2) Prepare a road cleaning plan	2020 to 2024
	3) Conduct clean-up activities together with the community to clear up the road drains (with tools to be prepared and provided by the road agency)	3) Prepare an annual event plan	2020 to 2024

Source: JICA Mission Team

4.7 Cost Estimation for M/P

(1) Water Supply M/P

Table 4.7.1 summarizes the project cost required implementing the whole phase water supply system development, factoring in price escalations. The O&M costs (shown in **Table 4.7.2**) are the expenditure needed for personnel, power, chemical, and other uses.

Table 4.7.1 Summary of the Estimated Construction Cost

Expansion Unit: million PKR

Phase	Facilities	Total	Phase 1	Phase 2	Phase 3	Phase 4
Phase1	**New JK WTP Expansion**	2,546	2,546	0	0	0
	Gugera I WTP	17,847	17,847	0	0	0
	Original JK Renewal-1	2,705	2,705	0	0	0
	Gugera I Well	4,655	4,655	0	0	0
	Allama Iqbal WTP	822	822	0	0	0
Phase 1 Total		**28,575**	**28,575**	**0**	**0**	**0**
Phase2	**Original JK Renewal-2**	2,165	0	2,165	0	0
	Jhang I WTP	11,839	0	11,839	0	0
	Gugera II WTP	21,408	0	21,408	0	0
	Gugera II Well	1,332	0	1,332	0	0
	New JBC I Well	4,354	0	4,354	0	0
Phase 2 Total		**41,098**	**0**	**41,098**	**0**	**0**
Phase 3	**Gugera III WTP**	13,703	0	0	13,703	0
	Jhang II WTP	15,160	0	0	15,160	0
	New JBC II Well	3,110	0	0	3,110	0
Phase 3 Total		**31,972**	**0**	**0**	**31,972**	**0**
Phase 4	**Jhang III WTP**	15,097	0	0	0	15,097
Phase 4 Total		**15,097**	**0**	**0**	**0**	**15,097**
Construction Cost Total		**116,743**	**28,575**	**41,098**	**31,972**	**15,097**
Project Cost (incl. a 10% consulting fee & 2% contingency)		**130,752**	**32,004**	**46,030**	**35,809**	**16,909**
Service Connection		6,995	800	1,731	2,187	2,278
Grand Total		**137,747**	**32,804**	**47,761**	**37,996**	**19,187**

Replacement Unit: million PKR

Category	Total	Phase 1	Phase 2	Phase 3	Phase 4
WTP and Well (M&E)	2,682	789	0	396	1,497
Pump	4,202	2,340	0	1,862	0
Pipe	4,502	998	986	1,156	1,362
Replacement Cost Total	11,386	4,127	986	3,414	2,859
Grand Total (incl. a 10% consulting fee & 2% contingency)	**12,753**	**4,622**	**1,104**	**3,824**	**3,202**

Source: JICA Mission Team

Table 4.7.2 Summary of Estimated O&M Cost

Unit: million PKR

Period	2018-2023	2024-2028	2029-2033	2034-2038
O&M Cost	11,615	19,067	30,741	46,139

Source: JICA Mission Team

(2) Sewerage and Drainage Plan

Table 4.7.3 and **Table 4.7.4** show the phased project cost required for the Western SWD and Eastern SWD, respectively.

The O&M costs are the expenditure needed for personnel, power, and other uses. The O&M costs required to operate and maintain the proposed sewerage facilities in the Western SWD and Eastern SWD are summarized in **Figure 4.7.1**.

Table 4.7.3 Phased Project Cost Required for the Western SWD

(Unit: Million PKR)

Item	Total	Phase 1	Phase 2	Phase 3	Phase 4
Sewers	75,876	17,301	15,769	19,999	22,807
Lift & Influent PS	4,186	3,752	1,064	0	0
WWTP	10,800	5,400	5,400	0	0
Effluent PS + Pipe System	18,363	0	0	10,091	8,272
Construction Cost	109,855	26,453	22,233	30,090	31,079
Indirect Cost	20,306	6,128	3,779	5,116	5,283
VAT	20,826	5,213	4,162	5,633	5,818
Project Cost	150,987	37,794	30,174	40,839	42,180

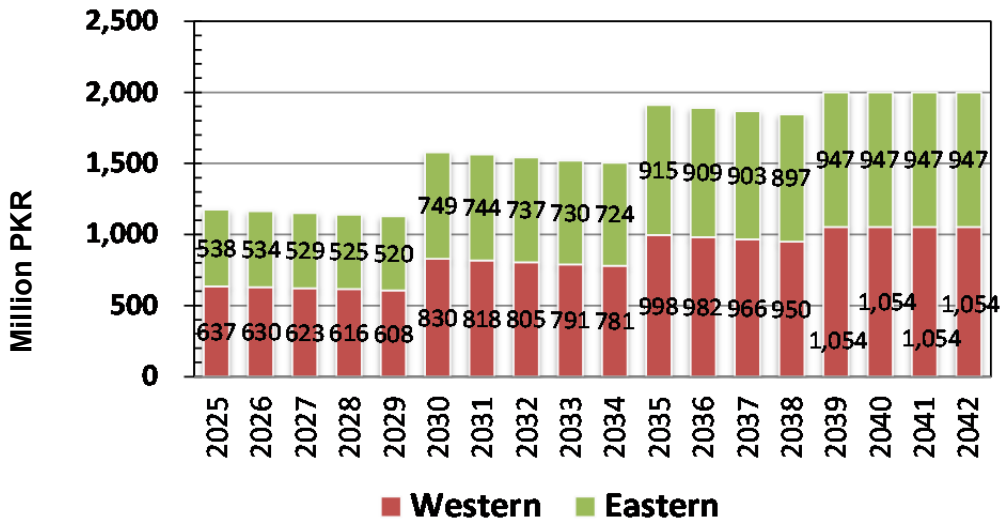
Source: JICA Mission Team

Table 4.7.4 Phased Project Cost Required for the Eastern SWD

(Unit: Million PKR)

Item	Total	Phase 1	Phase 2	Phase 3	Phase 4
Sewers	109,821	34,465	28,165	19,881	27,310
Lift & Influent PS	4,304	3,387	917	0	0
WWTP	7,862	3,931	3,931	0	0
Effluent PS + Pipe System	15,989	0	0	8,904	7,085
Construction Cost	137,976	41,783	33,013	28,785	34,395
Indirect Cost	28,789	12,435	5,613	4,894	5,847
VAT	26,683	8,675	6,180	5,389	6,439
Project Cost	193,448	62,893	44,806	39,068	46,681

Source: JICA Mission Team



Source: JICA Mission Team

Figure 4.7.1 O&M Costs Required for the Western SWD and Eastern SWD

Table 4.7.5 summarizes the estimated cost to construct the proposed drainage system. The plan recommends that the proposed drainage facilities be constructed by FDA with provincial government funding.

Table 4.7.5 Estimated Construction Cost of the Proposed Drainage System

Facility	Western Area (Million PKR)	Eastern Area (Million PKR)	Total (Million PKR)
1. New Stormwater Pumps	239	127	366
2. New Street Drain System	321	58	379
Total	560	185	745

Source: JICA Mission Team

CHAPTER 5 WASA-F's Financial Improvement Plans

5.1 Present Financial Position of WASA-F

With a view to analyzing and assessing managerial capacity of Water and Sanitation Agency-Faisalabad (WASA-F) in financial management to help develop a medium and long-term investment plan which is to provide quality services to meet demands of all beneficiaries in the city, an accrual accounting analysis has duly been undertaken in line with the US Generally Accepted Accounting Principles (GAAP). In so doing, the study highlighted the financial documents/numerical information as recorded and stored at the WASA-F Revenue Division and subordinate IT Section database, while referring to the Auditor's WASA-F Audit Reports (2010-14).

(1) Financial Performance

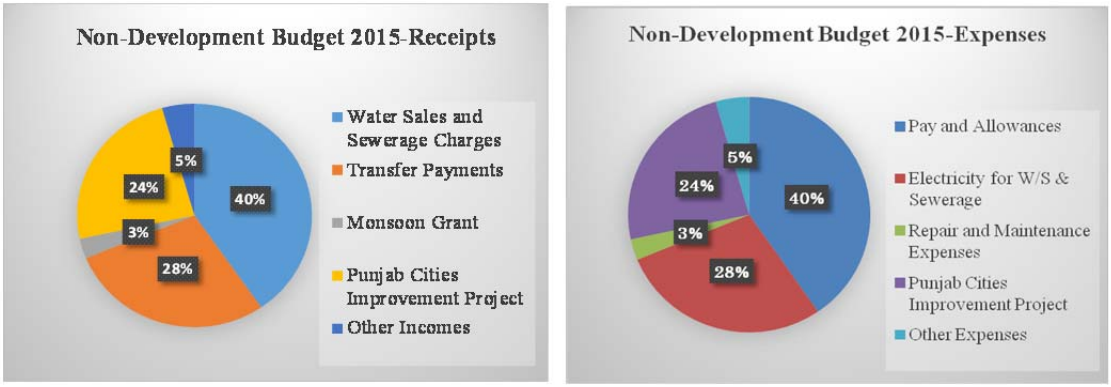
Over the past period of 2012 to 2015, WASA-F posted an annual average growth rate of operating revenue at 15.6% in nominal terms. Given the average inflation rate of 7.9 percent, operating revenue as per 2012 price level grew 7.7 percent. On the basis of net profit/loss, the Agency posted positive output of PKR 2.0 million in 2015, in the wake of continued deficits in the previous years. Yet WASA-F has posted positive results of service operations as reflected in Budget Statements, with net results of development account having been incorporated. Net Profit Ratios (net profit ÷ sales) and Cost Coverage Ratios of the Agency in FY2010-2015 reveal positive particularly after 2012 when WASA-F started craving for profit-earning public service entity **(Table 5.1.1)**. With this, WASA-F would positively be accessed as a financially and operationally sound management-oriented institution.

Table 5.1.1 Net Profit Ratios and Cost Coverage Ratios (2010-15)

	2010	2011	2012	2013	2014	2015
Net profit Ratio	-1.74%	-4.44%	1.59%	6.46%	6.49%	7.35%
Cost Coverage Ratio	0.98	0.96	1.02	1.07	1.07	1.08

Source: WASA-F IT-Database, WASA-F Audit Reports, JICA Mission Team

Meanwhile, WASA-F has confined its operations within the size of revenue regardless of the quality and the needs of beneficiaries. As depicted in **Figure 5.1.1**, actual receipts and expenditure of the Agency operating (Non-development) budget have almost been as par by receipts and expenditures.



Source: WASA-F IT Section Database

Fig. 5.1.1 Operating (Non-Development Budget) Receipts and Expenditure (2015)

Detailed analysis of WASA-F financial performance is given in **Chapter A7** of the **Main Report**. Breaking to specific sources in gross revenue, the salient attributes to the Agency's financial position include, among others, the followings.

(a) more than a half of WASA-F operating income (water supply and sewerage/ drainage) emanates from the sewerage sector service, while accounting for 52.4% of the aggregate in 2015;
(b) water supply and sewerage/drainage services received cash- and non-cash revenue respective of PKR 175.9 million and PKR 279.3 million in 2015, with nominal growth rate over the period of 3.6% and 12.6%, respectively. In real price terms, revenues from water supply service over the same period

downsized by 6.4%.

(c) WASA-F has since 2011 posted the annual average growth rate of sewerage at about 11%, whereas the rate of water supply at around 1% over the same period;

(d) WASA-F financial documents do not explicitly reveal the costs accrued to each of the service sectors, thus leading to ambiguity in estimating unit cost of service (Cost Accounting) and relevant managerial decisions of necessity; and

(e) by beneficiary category, households (domestic) sector bears a large part of pecuniary contribution, while accounting for 44.6% of the total in 2015, followed by commercial, industrial, non-operating, and aquifer charges of 24.5%, 15.4%, 11.9%, and 6.5%, in that order[6].

(2) Policy- and Operations-Related Concerns for Discussions

In a bid to expeditiously proceed with the institutional transition of WASA-F to a financially autonomous body while enhancing organizational and human capacity in financial management, an appropriate size and timing of external supports in funding and technical collaboration to the relevant government(s) and WASA-F would be considered. In this regard, major concerns to further be discussed by the concerned parties are summarized below in **Tables 5.1.2** and **5.1.3**

Table 5.1.2 Policy-related Concerns

FACTS	Policy Implications
WASA-F Modified Cash Accounting System in place	In a bid to provide quality services on an appropriate costing and pricing, the introduction and internalization of accrual accounting system at the earliest opportunity possible will be suggested. This transition eventually makes the entity transfer to a financially autonomous body on a financially sound management
Consolidated Account in the Provincial Government which does not separate WASA-F public services from other administrative services	In a bid to secure financial and operational transparency and accountability in WASA-F, the establishment of *Special Revenue Account* for water supply and sewerage/ drainage services will be suggested, while splitting the concerned service account from the government consolidated account and budgeting system
Shortfalls in financing capacity on Pakistani-side and impediments to expeditious Project aid by Development Partners	In the implementation of the envisaged investment scheme, the World Bank/ the Asian Development Bank/ the UK DFID-advocated quick and a large-scale disbursement of funds to the Pakistani counterpart by providing sector budgetary support type collaboration to facilitate efficient and quick implementation of the Project

Source: JICA Mission Team

Table 5.1.3 Operations-related Concerns

FACTS	Operational Implications
Deficiency in accounting system by the current modified cash accounting system hampers appropriate costing and pricing, leading to inefficient and discretionary performance in service offerings	Expeditious introduction of accrual accounting system, associated with equipment and human assets, would be in need with a view to assuring timely and correct information to managerial decision-makings for quality services and beneficiaries' satisfaction. Also, well-managed accounting practices give confidence to external financiers and oversighting Provincial government in the case of the entity's borrowings for development projects.
Internal as well as external audit systems are far behind what they should be in a sense of *Public Financial Management*	WASA-F will set up internal audit section to watch financial management, as well as enhancing capacity of performance evaluation of the entity within its own institutional framework
A large chunk of non-cash current assets (Accounts Receivables) and unpaid tariff remain lead to cash-crunch within the entity, thus leading to limited capacity to provide quality services.	Realigning the entity's assets by reinforcing accounting system (accrual accounting) as well as tariff recovery from customers' payment evasion will profoundly be recommended for reinstalling sound and transparent financial management and financing capacity of the entity
Tariff collection rate still running behind the actual revenue amounts	The needs for enhancing WASA-F IT-based tariff billing and collection system will be reiterated to WASA-F management in a bid to quickly and efficiently collect service recoveries from users

Source: JICA Mission Team

[6] Source: WASA-F IT section database, realigned by JICA Mission Team, May 2017

5.2 Long-term Financial Plan

(1) Water Supply

The overall policy orientation of WASA-F in enhancing financial management on a sound and sustainable basis is to have the entity eventually shift to a financially autonomous public service undertaking by taking steps of (i) realigning tariff system duly in line with the entity's appropriate supply costs + retained earnings, (ii) internalizing accrual accounting system for managerial accounting with Costing particularly in view, (iii) duly capturing non-equitable tariff evasion while installing volumetric tariff system and IT-oriented billing and collecting systems, and (iv) enhancing the entity's financial basis which would be robust enough for external borrowings and debt servicing.

In this light, financial analysis to overlook the fiscal impacts of the envisaged water supply Master Plan (M/P) has been carried out. In undertaking the analysis, Japan's public water supply business-advocated accounting method over the time of whole MP period is used to numerically estimate the said impact. A set of variables and parameters are given immediately below.

As may well be aware, the said accounting scheme comprises the following two accounts to measure the overall balance of cash-outflows and -inflows over the period of project life. Provided that the accumulated cash available to WASA-F (Profit/ Loss Account Reserve) remains positive while covering all through the Project life, the concerned M/P numerically be assessed as profitable and feasible. In an accounting estimation of net profit, financial cost with the interest rates of 1 percent, 3 percent, and 5 percent is applied to simulate the result (**Table 5.2.1**).

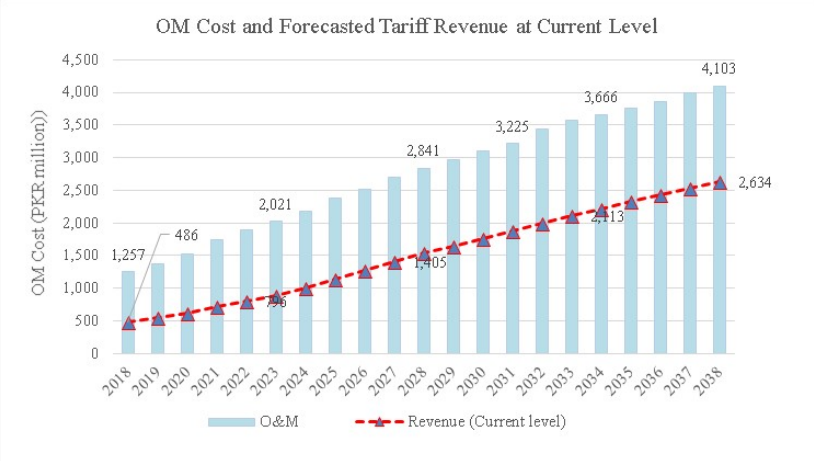
Table 5.2.1 Water-Supply Accounting

	Cash-Inflow	Expenditures	Remarks
Capital Account	(1) Fiscal subsidy (2) External Borrowing (3) WASA-F Equity	(1) Construction (2) Loan principal repayment	Since cash-inflow is as par the cost of construction, capital account posts deficit all through the Project life
Operating (Current) Account	(1) Tariff revenue	(1) O&M ost (2) Depreciation (3) Interest payments (4) Others (5) WASA-F budget	Non-cash cost of depreciation is to be transferred back to EBIT (earnings before income tax) to post C*ash-available to WASA-F* in the wake of one year-business operation

Source: JICA Mission Team

In carrying out the analysis, the variables and parameters applied to the current analysis are summarized and given in **Main Report B6.6.1** (**Table B6.6.2**).

The allocation of initial investment (construction) and O&M cost is depicted below in **Figure 5.2.1**, with four (4) phases of the Phase one (1), two (2), three (3), and four (4) standing at PKR 33,581.3 million, PKR 37,013.2 million, PKR 26,520.0, and PKR 14,012.5 million, in that descending order.



Source: JICA Mission Team

Figure 5.2.1 O&M Cost and Revenue Envisaged at Current Level

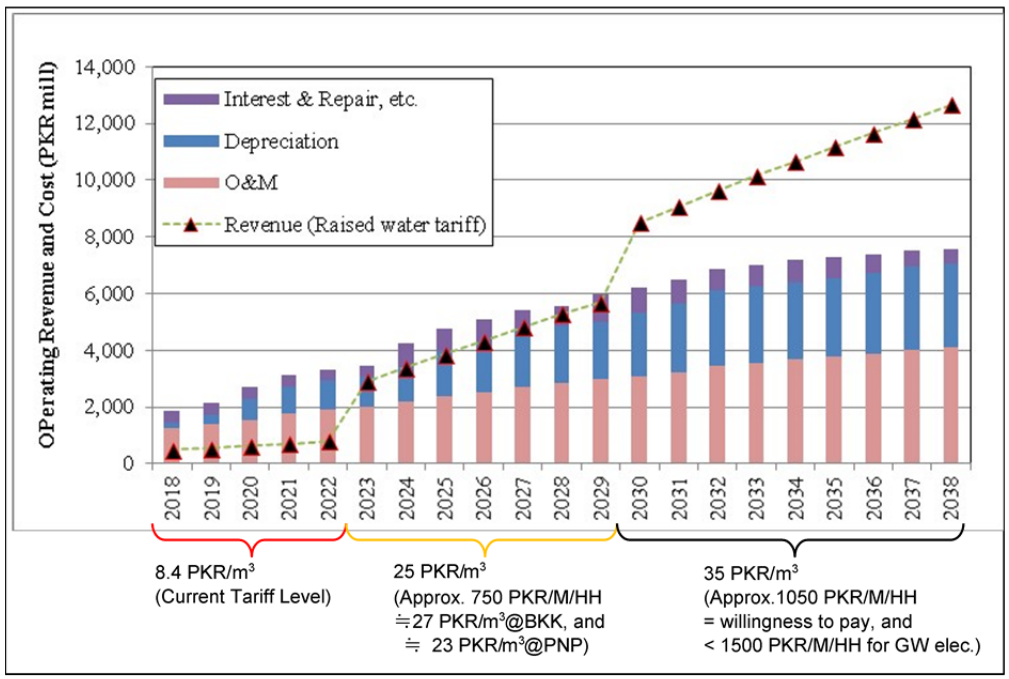
Net cash position of WASA-F in the wake of one year-business efforts is estimated with all of the assumptive variables and parameters in the **Main Report Table B6.6.1** being incorporated. Numerical results as borne out by Profit and Loss Account Reserve (cash retained and depreciation) turned out to be positive in the cases of the financial costs of 1 percent and 3 percent. Due to a large chunk of construction and O&M costs which are allotted all through the period of the Plan, retained earnings in each case of interest rate have been negative. (**Table 5.2.2,** and **Figures 5.2.2** and **5.2.3**)

Table 5.2.2 Profit and Loss Account Reserve by Interest Rate (PKR million, 2018-38)

	Net Profit	Principal Repayment	Depreciation	P/L Account Reserve[7]
P/L Account Reserve (Interest rate 1%)	20,270.6	44,450.8	39,947.8	16,756.2
P/L Account Reserve (Interest rate 3%)	9,589.1	44,450.8	39,947.8	6,179.3
P/L Account Reserve (Interest rate 5%)	∇1,092.5	44,450.8	39,947.8	∇4,397.6

Source: JICA Mission Team

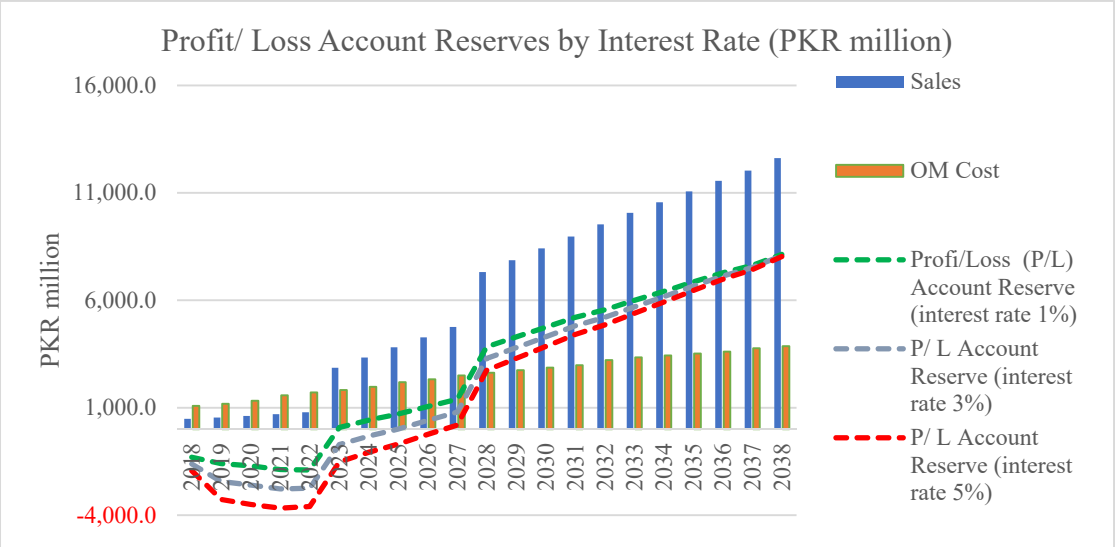
In the meantime, WASA-F Master Plan financial projection in operational revenue and expenditure is given below in **Figure 5.2.2**, where operational revenue start exceeding accounting expenditures inclusive of depreciation in the wake of the assumptive two-stage water tariff increase in due course of implementation. Note that the revised tariff levels being incorporated in the current analysis are set at 25 PKR/m^3 and 35 PKR/m^3 for households which are almost as par the water cost of 750 PKR and 1,050 PKR per household per month, respectively.



Source: JICA Mission Team

Figure 5.2.2 Operating Revenue and Costs on Tariff-Increase Basis (PKR billion)

[7] Profit and Loss Account Reserve is cash available to WASA-F deducting all the accounting costs from sales, while being defined as (Net Profit – Principal Repayment +Depreciation).



Source: JICA Mission Team

Figure 5.2.3 Profit/ Loss Account Reserve by Interest Rate (PKR Billion)

In view of the foregoing, some of the policy and operational issues will be discussed between all of the parties concerned and reached to the agreements for actions. This includes, among others, the followings.

(a) Policy Issues

- Firm commitment of the Provincial Government
- Concerned long-term investment plan is assuming a half of the capital investment cost (construction) emanate from the coffer of Provincial Government in the financing for implementation. In this light, the Provincial Government is to commit allotment of development budget continuously for a long time, while profoundly responding to the funding request from the Agency's Board Directors.
- Current Budget support during the initial stage of the Plan
- Also, the Provincial Government will provide, as appropriately, recurrent budget support to WASA-F during the initial stage of the Plan when the Agency posts deficits in cash position
- Setting up Special Revenue Account for Sector management and investments
- WASA-F would consider Special Revenue Account in the preparation of the Long-term Plan so that the budget and cash management be much easier and visible for recording and reporting
- Concessional loan
- Loan conditionality as stipulated in Loan Agreement would profoundly be soft and concessional so that financial burden of WASA become lighter

(b) Operational Issues

- Securing tariff collection
- WASA-F has since 2016 been on the way to collect tariff from unpaid and illegal customers to diminish huge amount of arrears. In this connection, the Agency would further spur to secure its revenue basis for sound and robust cash management and associated investment actions during the implementation time-span
- Reinforcing accounting system, water pricing, and IT database
- The Agency will further make efforts to enhance institutional and human capacities in installing and operating accrual accounting system for setting up appropriate water pricing, while being side-supported by the computerized IT database

(2) Sewerage

Long-term financing analysis took place herewith to overlook and assess the fiscal impacts of the envisaged water supply Master Plan (M/P) on WASA-F service profitability during the elongated long-term period of 2019-2048. In carrying out the analysis, *discounted net profit (Net Present Value of accumulated net profit)* emanating from the 30 year-MP construction and sequential operation periods has been selected as an profitability/ financial feasibility indicator, with explanatory variables of (i) Provincial Government fiscal transfer (grant fund) to the cost accrued to the M/P construction (%), (ii) revenue (sewerage service tariff), and (iii) interest rate of external loan to help initiate the M/P in the beginning. Note that the *NPV* of the M/P is to be figured out from the prospective Master Plan *Profit and Loss (P/L) Statement,* while duly complying with the *US Generally Accepted Accounting Principle (GAAP)*[8].

The aggregate M/P costs (construction and operation and maintenance, O&M) and benefit (as denoted by pecuniary-basis of service revenue) are estimated at PKR 344,437 million, PKR48,533 million and PKR 231,467 million, in that order, with the four phase-subcomponent projects each of which costs and revenue as summarized in **Table 5.2.3** below. Note that the initial investment costs are substituted for *depreciation* in this analysis, duly in compliance with the above-noted *GAAP*.

Table 5.2.3 Model Configuration (Project Period of 2018-38)

	Variables	Parameters
1	Aggregate Construction, O&M Cost, Revenue	PKR 344,437 mill, PKR 48,533 mill, PKR 231,467 mill
2	Phase 1 Project Construction, O&M Cost, Revenue	PKR 100, 687 mill, PKR 22,138 mill, PKR 106,619 mill
3	Phase 2 Project Construction, O&M Cost, Revenue	PKR 74,982 mill, PKR 14,455 mill, PKR 76,231 mill
4	Phase 3 Project Construction, O&M Cost, Revenue	PKR 79,907 mill, PKR 7,342 mill, PKR 28,164 mill
5	Phase 4 Project Construction, O&M Cost, Revenue	PKR 88,861 mill, PKR 4,598 mill, PKR 20,453 mill
6	Unit Service Charge (PKR/ m^3)[9]	Domestic: 17.5 (2019-29),24.5 (2030-39), 29.40 (2040-48) Non-Domestic: 26.3 (2019-29), 36.8 (2030-39), 44.1 (2040-48)

Source: JICA Mission Team

Financing Plan by funding source is now presumably set as given in **Table 5.2.4** below, while following the Sewerage long-term financing analysis.

Table 5.2.4 Financing Plan by Funding Source

	Financing Source	Financing Share for Construction Cost Coverage
1	Provincial Government Transfer (Grant aid to WASA-F)	50 percent (PKR 172,218.5 million)
2	External Concessionary Loan	40 Percent (PKR 137,774.8 million)
3	WASA-F Own Equity Investment	10 percent (PKR 34,443.7million)

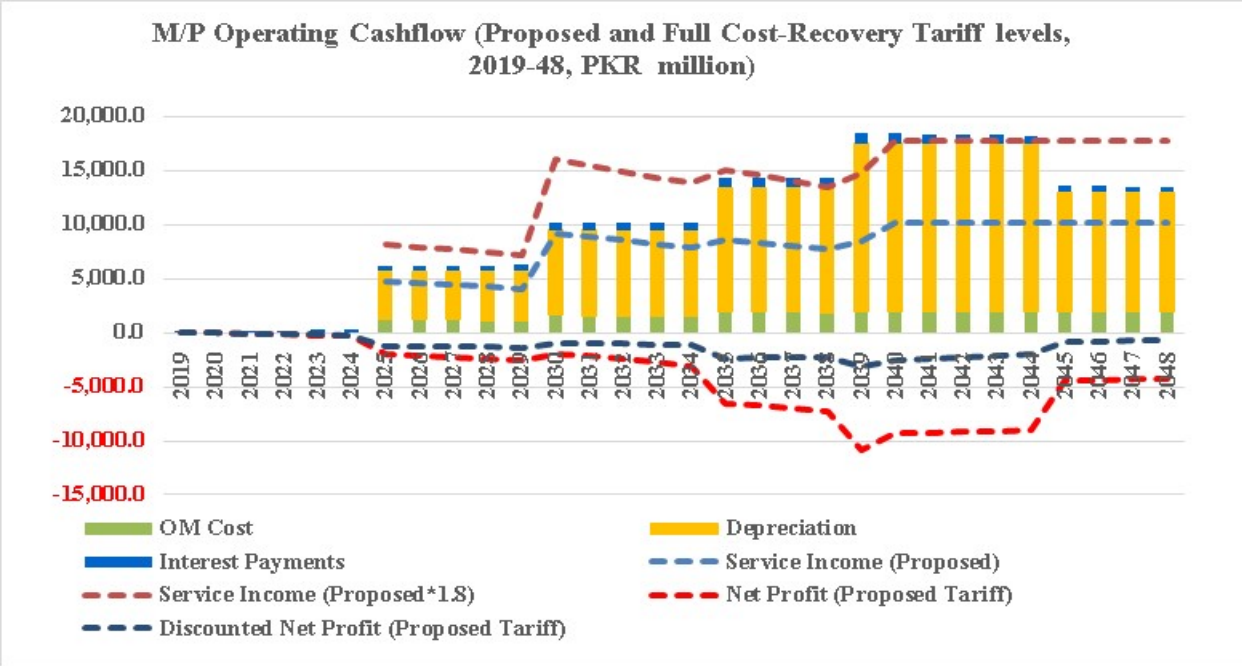
Source: JICA Mission Team

Analytical result is that discounted net profit (*Net Present Value* of revenue) and the nominal net revenue in the wake of the long-term M/P operating efforts are estimated at respective of PKR -44,617.4 million and PKR -166.284.0 million, with all of the assumptive variables and parameters in the **Main Report Table C11.7.5** being incorporated. Due to a large chunk of construction (as given in *depreciation*), which are allotted all through the period of the Plan, retained earnings in each case of nominal and discounted, net profits have been negative. (**Figures 5.2.4**)

As seen in the profit and loss cashflow over the elongated M/P period of time, service revenue well exceeds O&M cost and interest payments, while revealing somewhat robust tariff level (**Table 5.2.3** above raw 6) to financially cover the O&M cost and external borrowing cost (interest payments).

8 On the other hand side in the analysis of the water supply M/P, *Profit Loss Account Reserve* which is specifically applied to Japan's public water supply service entities and defined as (net profit + depreciation).

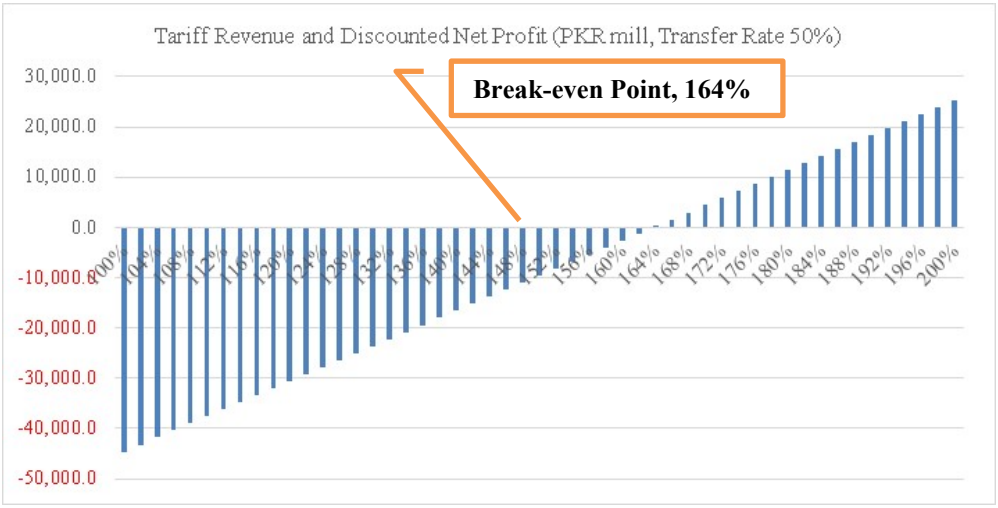
9 Sewerage service tariff (70 percent of water tariff) has presumably been set in line with the current analysis on water supply sector project analysis in Part B B6.6.



Source: JICA Mission Team

Figure. 5.2.4 Operating Revenue and Costs on Tariff-Increase Basis (PKR billion)

Now we turn our eyes on the variables which critically gives impacts on the M/P cash position during the planned period. Amongst the variables of (i) the Provincial Government transfer rate, (ii) interest rate, and (iii) revenue (service tariff level), service tariff comes in a very first place to consider provided that the M/P is to be financially sustainable. Numerically, M/P costs (construction, O&M, and financial costs) are financially recovered (reaching the net present value of profit reach the break-even point) provided that the service tariff be increased by 64 percent from the currently assumed tariff structure, on a *ceteris paribus basis* (**Figure 5.2.5**) .



Source: JICA Mission Team

Figure 5.2.5 Break-even Point of Service Tariff for Positive Discounted Net Profit

Two other variables, *i.e.*, (i) fiscal transfer (grant aid to WASA-F for construction) and (ii) external loan interest rate do not positively affect the M/P cashflow position (see detailed analysis and results in **Main Report C11.7.3**)

In view of the foregoing, some of the policy and operational issues will be discussed between all of the parties concerned and reached to the agreements for actions. This includes, among others, the followings.

(c) Policy Issues

- Service Tariff Restructuring
- As clearly seen above, tariff level is the critical factor for the expeditious and effective implementation of the M/P construction and implementation works over the long period of time. In this light, realigning sewerage as well as water supply tariff structures would be an important and critical policy issue to be discussed for not only M/P investment schemes but also for WASA-F financial management within a plausible independent public service agency schematic framework.
- Firm commitment of the Provincial Government
- Concerned long-term investment plan is assuming a half of the capital investment (construction cost) emanate from the coffer of Provincial Government. A very large chunk of initial investment cost imposes a hard-line pressure on the Plan's profitability and financial sustainability, as such, the Provincial as well as the Federal Governments are to firmly commit to continuous and timely allotment of development budget for a long time, while quickly responding to the funding request from the Agency's Board Directors.
- Current Budget support during the initial stage of the Plan
- Also, the Provincial Government will provide, as appropriate, current budget support to WASA-F during the initial stage of the Plan when the Agency posts deficits in cash position
- Setting up *Special Revenue Account* for Sector management and investments
- WASA-F would consider Special Revenue Account in the preparation of the Long-term Plan so that the budget and cash management be much easier and visible for recording and reporting
- Concessional loan
- Loan conditionality as stipulated in Loan Agreement would profoundly be soft and concessional so that financial burden of WASA become lighter

(d) Operational Issues

- Securing tariff collection
- WASA-F has since 2016 been on the GO to collect tariff from unpaid and illegal customers to diminish huge amount of arrears. In this connection, the Agency would further spur to secure its revenue basis for sound and robust cash management and associated investment actions during the implementation time-span
- Reinforcing accounting system, sewerage service pricing, and IT database
- The Agency will further make efforts to enhance institutional and human capacities in installing and operating accrual accounting system for setting up appropriate water pricing, while being side-supported by the computerized IT database

5.3 Economic and Financial Evaluation

(1) Methodology and Analytical variables and Parameters for EIRR Estimation

Economic and Financial analyses have duly been carried out in a bid to quantitatively articulate the economic impact of the selected water supply projects from the Phase 1 and Phase 2 on the country's allocative efficiency and financial viability attributed to the concerned investment scheme. In so doing, *time-discounted cashflow analysis* on a *with-/ without- project (incremental) basis* took place with the indices of Internal Rate of Return (IRR) and Net Present Value (NPV). A set of variables and assumptive parameters are summarized as **Table B6.7.1 in the Main Report B6.7. EIRR and FIRR of Water Supply Projects**

1) GBC Tubewells-1 (selected from Phase 1 projects)

EIRR is figured out at 3.0 percent, while incorporating the aggregate economic costs of construction and O&M costs at PKR 4,580.9 million and PKR 905.6 million, respectively, as well as the overall economic

benefit of PKR 7,032.4 million (**Main Report Table B6.7.1**). Sensitivity analysis with the variation of (i) cost increase (+10%), (ii) benefit downsize (-10%), and (iii) one-year delay in construction turned out to be 1.8 percent, 1.7 percent, and 1.2 percent, in that order (**Table 5.3.1**). Economic Net Present Value (ENPV) was figured out at PKR -1,669.0 million with the Social Discount Rate of 10 percent (Social Discount Rate).

Table 5.3.1 EIRR Result (GBC Tubewells-1)

	Base Case	Cost △10 %	Benefit ▽ 10 %	1-year Delay	ENPV (mill)
EIRR	3.0 %	1.8 %	1.7 %	1.2 %	PKR -1,669.0

Source: JICA Mission Team

Likewise, Financial Internal Rate of Return (FIRR) was estimated with the given cost and benefit flows as specified in **Main Report Table B6.7.3**.

In due course of analysis, Financial Internal Rate of Return (FIRR) turned out to be negative (-) 1.9 percent. Sensitivity analysis with the variation of (i) cost increase (+10%), (ii) benefit downsize (-10%) and (iii) one (1)-year delay in construction[10] are estimated at respective of negative (-) 2.9 percent, negative (-) 3.0 percent, and negative (-) 3.0 percent, in that order. Financial Net Present Value (NPV) is figured out at PKR negative (-) 2,351.2 million with the discount rate of 6.1 percent (Opportunity Cost of Capital).

The Project's FIRR implies a very feeble or negative impact of financial viability on the entity's financial position, with the analytical result being summarized in **Table 5.3.2** below. Note that FIRR estimates in the cases of level (unrevised)-tariff level turned out to be non-eligible for estimation.

Table 5.3.2 FIRR Result (GBC Tubewells-1)

	Base Case	Cost △10 %	Benefit ▽ 10 %	1-year Delay	FNPV (mill)
FIRR	-1.9 %	-2.9 %	-3.0 %	-3.0 %	PKR -2,351.2

Source: JICA Mission Team

2) Jhang WTP-1 (selected from Phase 2 projects)

In line with the technical specification as given in **Main Report Table B6.8.1**, EIRR is figured out at 9.3 percent based on the afore-mentioned parameters. The estimate would seem good enough with the said economic feasibility cut-off rate of six (6) percent in view. In addition, it would be considered acceptable that the Project well deserve to expeditiously be implemented because of the project's important attributes which include, among others, (i) large-scale investment cost with lesser pecuniary returns, (ii) implicit rippled effect on regional health and sanitation by upgrading water quantity and (iii) reducing groundwater pumping which leads to environment protection inclusive of decreasing infectious disease by curbing the use of contaminated groundwater, avoiding infrastructure damages by keeping ground level, and others of relevance. These unquantified benefits will assuredly shift EIRR upward when they could numerically be incorporated into the current EIRR analysis. Economic Net Present Value turned out be PKR -422.5 million as discounted by the Social Discount rate of 10 percent. Analytical result is summarized in **Table 5.3.3** below.

Table 5.3.3 EIRR Result (Jhang WTP-1)

	Base Case	Cost △10 %	Benefit ▽ 10 %	1-year Delay	ENPV (mill)
EIRR	9.3 %	7.8 %	7.7 %	7.0 %	PKR -422.5

Source: JICA Mission Team

Likewise, Financial Internal rate of Return (FIRR) was estimated with the given cost and benefit flows as specified in **Main Report Table B6.8.3**. FIRR turned out to be 2.2 percent. Sensitivity analysis with the variation of (i) cost increase (+10%), (ii) benefit downsize (-10%) and (iii) one (1)-year delay in construction are estimated at respective of 0.9 percent, 0.8 percent, and 1.5 percent, in that order. Financial Net Present Value (NPV) is figured out at negative (-) 3,104.8 PKR million with the discount

[10] Assumptive allocation of initials investment over the elongated period of 5 years are set at 25%, 25%, 30%, 15%, and 5%, in the chronologically descending order.

rate of 6.1 percent (Opportunity Cost of Capital). The Project's FIRR implies a very feeble or modest financial impact on the entity's financial position, with the analytical result as summarized in **Table 5.3.4** below. In the meantime, FIRR estimates in the cases of level (unrevised)-tariff level turned out to be *non-calculable for estimation*. Financial Net Present Value is estimated at PKR -3,104.8 million with the discount rate of opportunity cost of capital at 6.1 percent.

Table 5.3.4 FIRR Result (Jhang WTP-1)

	Base Case	Cost △10 %	Benefit ▽ 10 %	1-year Delay	FNPV (mill)
FIRR	2.2 %	0.9 %	0.8 %	1.5 %	PKR -3,104.8

Source: JICA Mission Team

3) Conclusion

Economic and financial feasibilities of the GBC Tubewell-1 project as measured by the IRRs indicated that the concerned project would not be feasible for public investment, with EIRR being less than cut-off rate of 6-8% whereas FIRR being less than 6.1% cut-off rate. In this connection, it would be considered acceptable to conclude that the concerned investment scheme would be financed by the Pakistani government as well as external ODA resources.

In the meantime, Jhang WTP-1 project posts higher EIRR than the cut-off rate of 6-8% (Social Discount Rate), revealing high economic feasibility for public sector funding. On the other side, FIRR is figured out at somewhat lower profitability, as such appropriate policy setting would be in need including subsidiary transfer from the local Government and revision of tariff to at least meet the operation and maintenance cost.

As regards the prioritization issue of the alternative projects of GBC Tubewell-1 and Jhang WTP-1, IRR analysis indicates the latter investment scheme would come in first place. Besides IRR, non-time discounted cost efficiency analysis justifies this prioritization, while taking in view the ratio of the change in benefit (quantity of service water=revenue) over the change in cost by project by Project. Analytical result of the concerned ratio is 1.4 (exceeding the cut-off rate of 1.0), revealing that Jhang WTP-1 project earns 1.42 times more revenue than GBC Tubewell-1 project over one (1.0) unit of cost increase. In other words, Jhang WTP-1 project is more cost efficient than GBC Tubewell-1 project. Logic of the ratio is detailed in **Main Report Table B6.8.3**. Summary of cost efficiency analysis is given below in **Table 5.3.5**.

Table 5.3.5 Cost and Benefit by Priority Project

	π : Service Water (m^3 mill)	C: Financial Cost (PKR mill)	Cost Efficiency $\left(\frac{\partial \pi}{\partial C}\right)_{GBC}^{Jhang}$
GBC Tubewell-1	136.7	5,699.0	
Jhang WTP-1	564.0	16,707.8	1.42

Source: JICA Mission Team

(2) EIRR and FIRR of Sewerage Projects in Phase 1 of Western and Eastern Zones

1) Analytical Methodology

In a selection of the Priority Project by comparing economic and financial feasibility and viability, time-discounted cashflow analysis took place with the indices of Internal Rate of Return (IRR) and Net Present Value (NPV). As may well be aware, EIRR measures economic feasibility (efficient allocation of scare resources in the national economy), whereas Financial Internal Rate of Return (FIRR) denotes financial viability (profitability) attributable to the Project. Note that EIRR analysis is carried out by the World Bank-advocated Long-run Marginal Cost (LRMC) pricing method which assumes economic benefit being equivalent to LRMC[11]. Theoretical background is given in **Main Report section C11.9.1**. A

[11] References: The World Bank, *Handbook on Economic Analysis of Investment Operations*, 1998, The Asian Development Bank, *The Guidelines for Economic Analysis of Development Projects*, 1987 and 1997, *The Guidelines for Preparation and Presentation of Financial Analysis*, 1989, Ozaki, T. and Hashida, A., *Manual of IRR Analysis of Yen-Loan Projects*, JBIC, 2003

set of variables and assumptive parameters are summarized and given in respective of **Main Report Tables C11.9.1** and **C11.9.3** for EIRR and FIRR estimation.

2) Western Zone

The aggregate economic costs of construction and O&M costs turned out to be PKR 34,984.2 million and PKR 6,879.6 million, respectively in the Western Sewerage District (SWD). With these and the overall economic benefit of PKR 9,987.2 million, EIRR is figured out at 6.1 percent for the Western SWD, with economic net present value of PKR 162.9 million (Social Discount rate of 10.0%). Sensitivity analysis with the variation of (i) cost increase (+10%), (ii) benefit downsize (-10%), and (iii) one-year delay in construction[12] resulted in the figures presented in **Table 5.3.6**.

Table 5.3.6 EIRR Results (Western Zone)

	Base Case	Cost △10 %	Benefit ▽ 10 %	1-year Delay	ENPV (mill)
EIRR of Western SWD	6.1 %	5.2 %	5.1 %	5.6 %	162.9 mill

Source: JICA Mission Team

Likewise, Financial Internal Rate of Return (FIRR) turned out to be 1.3 percent which implies somewhat feeble impact of financial viability on the entity's financial position. Sensitivity analysis with the variation of (i) cost increase (+10%), (ii) benefit downsize (-10%) and (iii) one (1)-year delay in construction are estimated at respective of 0.6 percent, 0.3 percent, and 1.0 percent, in that order. Financial Net Present Value (NPV) is figured out at PKR negative (-) 17,032.1 million with the discount rate of 6.1 percent (Opportunity Cost of Capital). Results are summarized in **Table 5.3.7** below. Note that FIRR estimates in the cases of level (unrevised)-tariff level turned out to be non-eligible for estimation.

Table 5.3.7 FIRR Result (Western Zone)

	Base Case	Cost △10 %	Benefit ∇ 10 %	1-year Delay	FNPV (mill)
FIRR	1.3 %	0.6 %	0.3 %	1.0 %	PKR -17,032.1

Source: JICA Mission Team

In the meantime, financial robustness of the West SWD Project in the light of profitability and financing (funding) capacity to proceed with the prospected investment scheme is articulated in the **Main Report C11.10**. Discounted net profit which denotes *Net Present Value (NPV)* has been figured out at PKR 4,978.4 million, while revealing robust financial profitability. In the wake of the 30-year project operation, WASA-F coffer is to retain Pakistani cash in value (NPV) and PKR notes (non-discounted net profit), although the agency has covered financial burden of (i) own funds (10% of the total investment cost), (ii) O&M costs, (iii) interest payments, and (iv) principal repayments.

3) Eastern Zone

As for the Eastern Sewerage District (SWD), the aggregate economic costs of construction and O&M costs were estimated at PKR 59,092.3 million and PKR 5,644.8 million, respectively. Same as that of the Western SWD, analytical variables and assumptive parameters for EIRR and FIRR analyses are summarized in **Main Report Tables C11.9.1** and **C11.9.3**, respectively. With these and the overall economic benefit of 10,893.8 million, EIRR is figured out at 6.0 percent, while economic net present value being estimated at PKR -247.4 million. Sensitivity analysis with the variation of (i) cost increase (+10%), (ii) benefit downsize (-10%), and (iii) one-year delay in construction resulted in the figures presented in **Table 5.3.8** below.

Table 5.3.8 EIRR Results (Eastern Zone)

	Base Case	Cost △10 %	Benefit ▽ 10 %	1-year Delay	ENPV (mill)
EIRR of Eastern SWD	6.0 %	5.1 %	5.0 %	5.5 %	PKR -247.4

Source: JICA Mission Team

Chapter 2, and others of close relevance

[12] Assumptive allocation of initials investment over the elongated period of 7 years are 4.9%, 5.3%, 10.0%, 20.0%, 25.0%, 15.0%, and the remaining 19.8%, in the chronologically descending order

Financial Internal Rate of Return (FIRR) turned out to be negative (-) 1.3 percent. Sensitivity analysis with the variation of (i) cost increase (+10%), (ii) benefit downsize (-10%) and (iii) one (1)-year delay in construction[13] are estimated at respective of negative (-) 3.3 percent, negative (-) 3.5 percent, and negative (-) 1.9 percent, in that order. Financial Net Present Value (NPV) is figured out at PKR negative (-) 38,181.6 million with the discount rate of 6.1 percent (Opportunity Cost of Capital). The analytical result being summarized in **Table 5.3.9** below. Note that FIRR estimates in the cases of level (unrevised)-tariff level turned out to be non-eligible for estimation.

Table 5.3.9 FIRR Result (Eastern Zone)

	Base Case	Cost △10 %	Benefit ▽ 10 %	1-year Delay	FNPV (mill)
FIRR of Eastern SWD	-1.3 %	-3.3 %	-3.5 %	-1.9 %	PKR -38,181.6

Source: JICA Mission Team

4) Conclusion

The EIRRs of the West and East Sewerage Plan Area projects would seem a bit lower than the said cut-off rate of eight (6.0-8.0) percent which is commonly applied to the environment sector projects, as such M/P could be perceived as non-feasible. Nonetheless, it would be considered acceptable that the selected project well deserve to expeditiously be implemented because of the project's inherent features and attributes which include, among others, (i) large-scale wastewater treatment investment for lesser pecuniary returns, (ii) implicit rippled effect on regional healthy and agricultural production by upgrading quality of discharged waste water and increased quantity to the canals, and (iii) building social integrity and citizenship in the vicinity.

Meanwhile, FIRR attributed to both of the SWD project remain low, and as such any forms of financial transfer from the internal as well as external funding sources would be in need for financial sustainability In tandem, firm commitment of WASA-F as well as the Provincial Government/ policy makers to realign tariff structure to raise WASA-F own service revenue will definitely be in need. Cultural resetting of people's mind to financially help support their community service of water supply and sanitation will also be called for.

In prioritizing the projects among the West and the East SWDs, comparative advantage of economic and financial feasibilities will rest on the West SWD project, thereby leading to the conclusive remark of placing the West SWD project on top of the investment funding list.

5.4 Conclusion

In view of the above, major issues will come in place for further discussions and agreements amongst the parties concerned, while taking closely in view the previous analyses on the project feasibility and financing capacity (plan) of both the water supply and sewerage sectors. These, among others, are summarized in the following **Table 5.4.1** and **Table 5.4.2**.

Table 5.4.1 Policy-Related Conclusion

	Discussions	Conclusive Remarks
Concessional Loan	Current analysis presumably set terms and conditions of loan favourably for borrower (s). In this connection, WASA-F management and Provincial government would seek for concessional loans together with technical assistance from development partners	WASA-F management should pay close attention to debt management and cash management to assure transparency and accountability. WASA-F management would also be careful to distinguish ODA fund from *other-ODA* financial collaboration. For instance, Norwegian interest-free loan (2018) is an export credit with tied procurement, thereby leading to a possible high-cost project implementation.

[13] Assumptive allocation of initials investment over the elongated period of 5 years are 25%, 25%, 30%, 15%, and 5%, in the chronologically descending order

	Discussions	Conclusive Remarks
Firm commitment and budget support during the initial stage from Provincial Government	WASA-financial position is tight during the construction period because of no income (revenue) and continued cash-outflow (expenses)	Concerned long-term investment plan would assume a large chunk of capital investment from the coffer of Provincial Government in financing. In this light, the Provincial Government would need to commit to continued allotment of development budget for long time, while promptly responding to funding request from the Agency's Board Directors. Also, the Provincial Government will provide, as appropriate, recurrent budget support to WASA-F all through during the project initial stage of the Plan when the Agency posts deficits in cash position
Fiscal Transfer from Federal and Local Governments	Cash allocation and quick disbursement of development budget at the very initial stage of the project implementation is a critical issue for continued project effort. In this regard, close consultation and policy discussions among WASA-F and provincial government is imperative.	WASA-F management will consider opening the *Special Revenue Account* for the concerned and other sewerage/ drainage services within WASA-F accounts. This will surely facilitate the agency's transparent management of project funds for administering government and external financier.

Source: JICA Mission Team

Table 5.4.2 Operations-Related Concerns

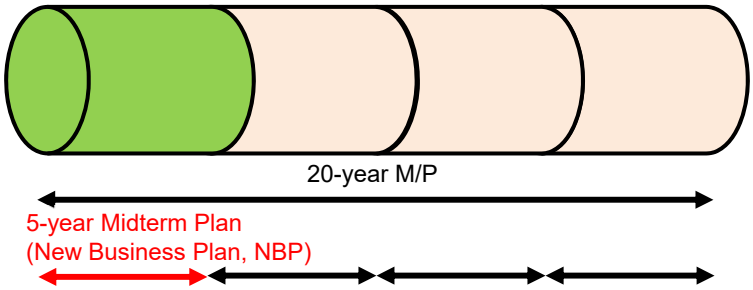
	Discussions	Conclusive Remarks
WASA-F own fund	Although WASA-F development and recurrent budgets are under the following binding constraints: (i) non-cost recovery administrative service tariff, (ii) a paucity of financial information (revenue and cost) for management decision-making, and (iii) limited amount of transfer payments for new development project	WASA-F budget allotment of actual cashflow for investment scheme from the very beginning of the Project is critical and definitely in need. As such, the agency's firm commitment to medium-/ long-term development plan associated with steady preparation/ implementation is definitely in need
Project Revenue	Base tariff level (70 percent of water price) and service volume are the key factors for assuring financial viability of the Project. As such, careful project administration and professional discussions among the concerned parties is a *MUST*. Structure and level of service charge will also be revised over the long-period of project life to maintain financial basis and equity among users.	Appropriate allotment and associated disbursement on time, as well as allocation of professional human capital and equipment should be assured by WASA-F and Provincial Government. In this regard, IT-linkages between Project Implementation Unit and relevant authorities should be installed for securing project Governance

Source: JICA Mission Team

CHAPTER 6 WASA-F OPERATION AND MANAGEMENT IMPROVEMENT PLANS

6.1 Approaches

The steady implementation of the 20-year M/P will require steps to improve the operation and develop the capacity of WASA-F. To ensure this improvement and development, the Project proposes dividing the M/P into four 5-year Mid-term Plans. Under this arrangement, the WASA-F O&M improvement plan should be reviewed every 5 years to assess the progress towards the goals of the 20-year M/P. To carry out the 5-year Mid-term Plan, meanwhile, WASA-F is to first review the current Business Plan (October 2013) and then prepare a New Business Plan (NBP) as a driving force toward the goals of the M/P. That is, WASA-F should promote its O&M improvement by carrying out the Action Plans described in the NBP. The NPB is revised every 5 years based on the progress so far achieved (See **Figure 6.1.1**).



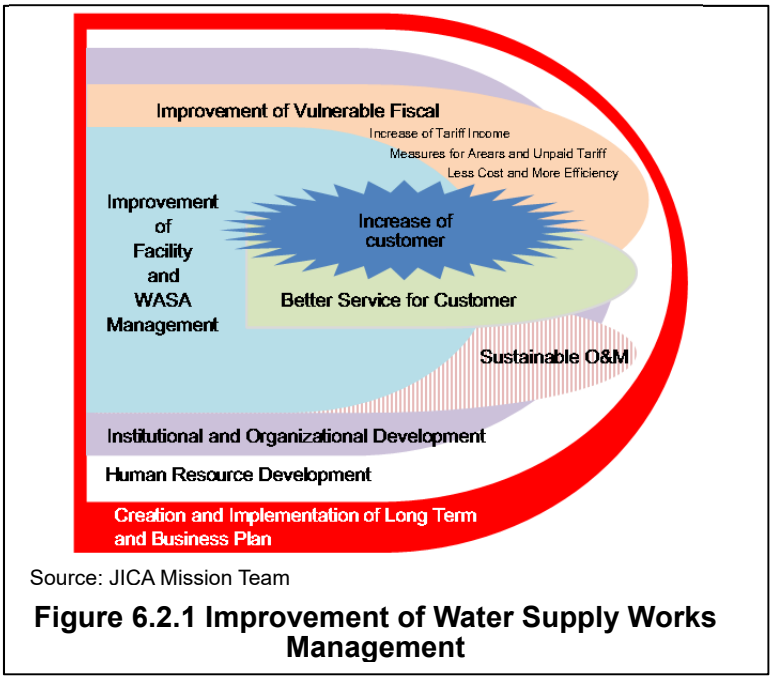
Source: JICA Mission Team

Figure 6.1.1 Relation of M/P and NBP

6.2 Basic Policies

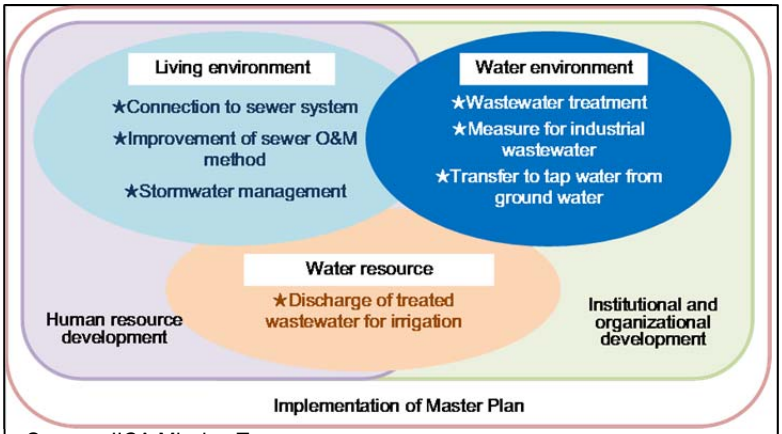
(1) Water Supply Works

The works to improve the operation and management of the water supply works should be first addressed by WASA-F. Shoring up against financial vulnerabilities is regarded as a top priority issue to be realized by the following: development of human resources, development of the institutions and overall organization, improvement in the functions of the facilities and O&M, improvement in the water supply service level, increased revenue (increased bill-collection ratio + increased customers). The entire aforesaid are to be implemented according to the business plan, as illustrated in **Figure 6.2.1**.



Source: JICA Mission Team

Figure 6.2.1 Improvement of Water Supply Works Management



Source: JICA Mission Team

Figure 6.2.2 Improvement of Improvement of Sewerage/Drainage

(2) Sewerage and Drainage Works

The O&M of the sewerage/drainage works will be improved by works to improve the water environment, living

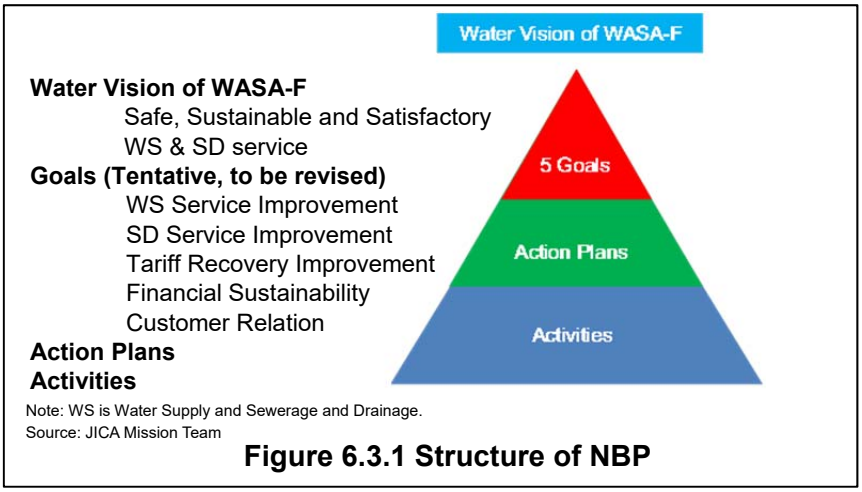
environment, and water resources, as illustrated in **Figure 6.2.2**.

6.3 Methodologies

In promoting the M/P, the O&M of WASA-F should be improved through steps to upgrade the financial condition and service level while establishing sustainable O&M, etc. As a driving force to attain these activities, it will be necessary to prepare a New Business Plan (NBP) encompassing Action Plans to be tackled to achieve the goals and target outcomes, along with methods to steadily and effectively perform them. Organizational reforms and human resource development at WASA-F will also be essential to the effective implementation of the NBP.

(1) Proposal for the New Business Plan

In order to implement the 20-year MP steadily, a New Business Plan (5-year mid-term plan) will be prepared and implemented for O&M improvement.



Note: WS is Water Supply and Sewerage and Drainage.
Source: JICA Mission Team

Figure 6.3.1 Structure of NBP

The NBP sets out a "water vision" for WASA-F with the overall goal of realizing conditions such as safe, sustainable, and satisfactory water supply and sewerage/drainage services. A few to several goals (e.g., improved water supply services, higher tariff recovery rate, etc.) are positioned underneath this water vision, and Action Plans and action plan activities are devised to achieve them. The structure of the NBP is illustrated in **Figure 6.3.1.**

Next, a WASA-F O&M improvement plan is promoted by carrying out the Action Plans described in the NBP. While the current business plan evaluates the outputs of the PIs or Key Performance Indicators (KPIs), the NBP evaluates the outputs of the Action Plans and activities.

The Action Plans are categorized by purpose (e.g., better operation and management, sound financial condition, etc.), as illustrated by the examples given in **Table 6.3.1**.

Table 6.3.1 Examples of Action Plans under the New Business Plan

Category	Action Plans (Examples)
Efforts for Better Operation and Management	Improved water supply service level
	Maintenance and improvement of facilities
	Buildup of the Management Information System (MIS)
	Measures to improve customer service
	Living and environmental improvements
	Strengthened safety management
Measures for Sound Fiscal Condition	Increased revenue (collection efficiency, tariff increase)
	Meter installation and transition to a metered-rate tariff system
	Division of water supply and sewerage/drainage accounts
	Switchover to an accrual accounting system aiming for fiscal autonomy
	Higher-efficiency operations and reduced costs

Source: JICA Mission Team

(2) Proposals for Organizational Reform

The new proposed organization is shown in **Figure 6.3.2**. The specific improvements proposed are as follows:

- Make the Managing Director (MD) and Deputy Managing Directors (DMDs) decision-making members,
- Establish DMDs for Administration & Finance, Service (Water), and Service (Wastewater),
- Put all directorates under the direction of DMDs,
- Place the directorates of Administration, Revenue (domestic), Revenue (Industry & Commercial), Finance, Private Housing Society, and MIS under the DMD of Administration and Finance,
- Separate the service into Water Distribution, Sewer, Industrial Waste Water, and Drainage,
- Rename the Directorates to better clarify the actual work they do,
- Appoint new Directorates of MIS, Water Treatment Management, Wastewater Treatment Management, and Industrial Wastewater at the necessary times.

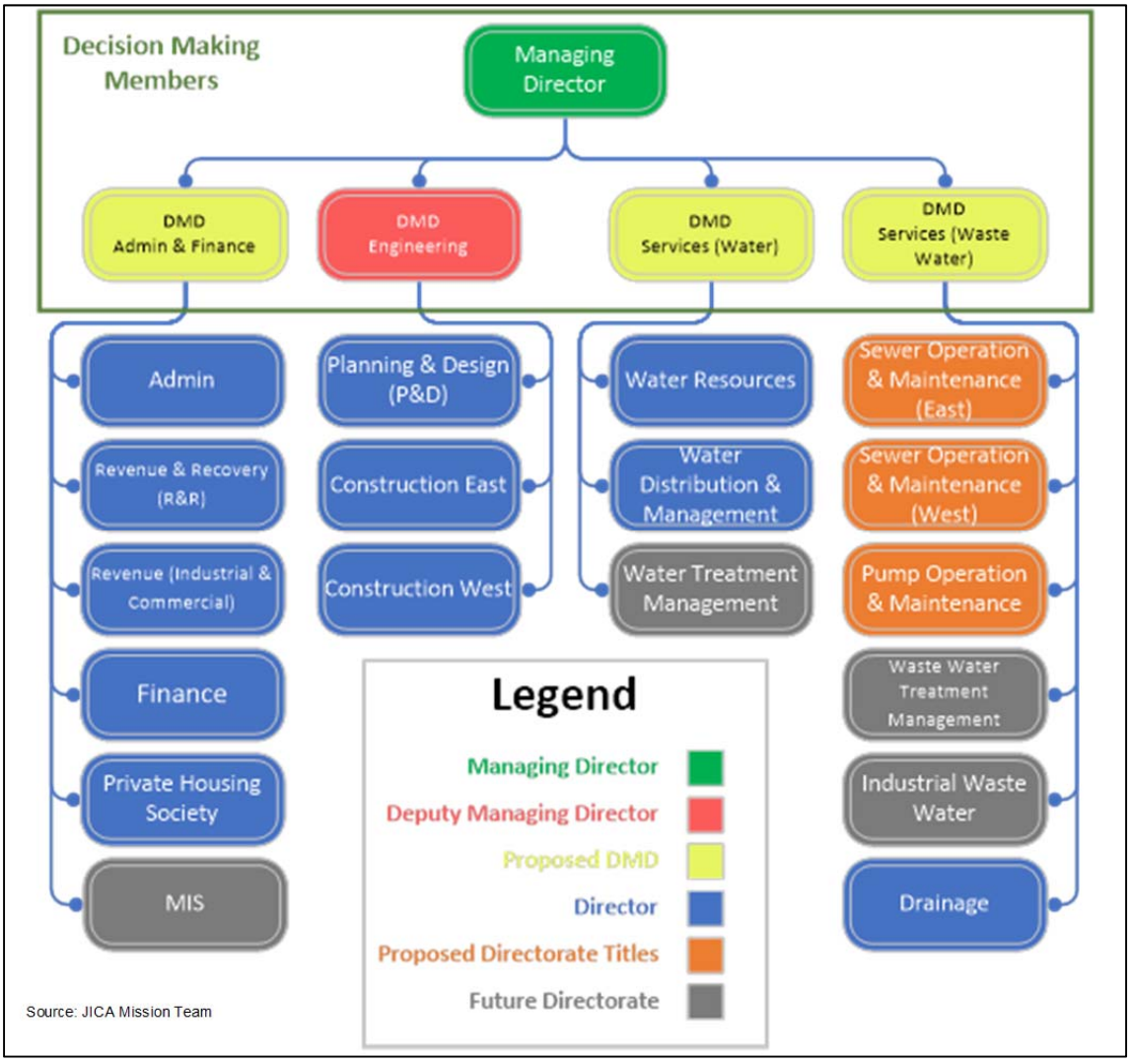


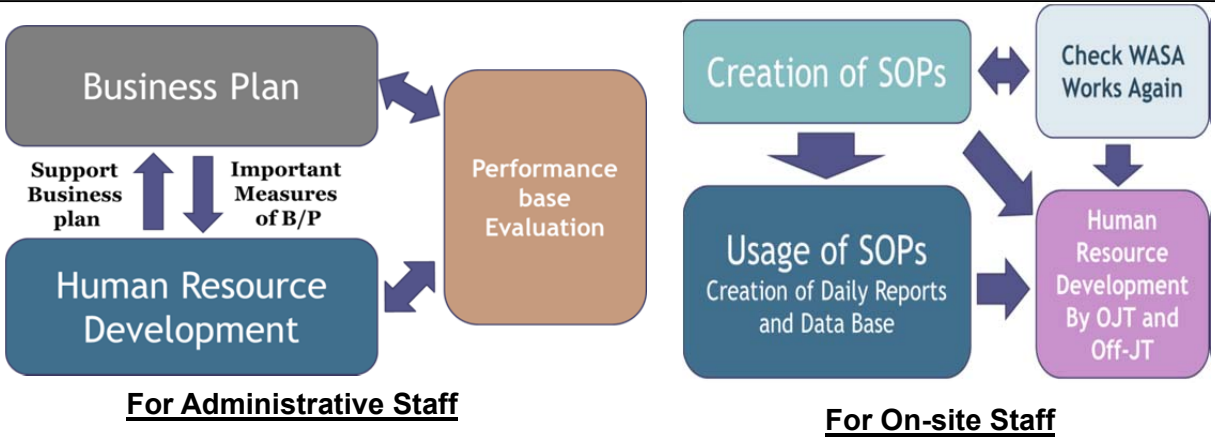
Figure 6.3.2 Proposed New Organization of WASA-F

(3) Proposal for Human Resource Development

Human resource development is an important element to support new business plans. Business plans and human resource development plans are both promoted based on performance evaluations. **Figure 6.3.3**

shows the relation between business plans and human resource development plans based on performance evaluations. The performance evaluations of management-level WASA-F staff are particularly important and help to reform the awareness of the same.

Looking at the actual circumstances of WASA-F O&M, there seem to be quality issues such as shoddy work and inconsistencies in what is being accomplished, etc. through the small amount of training offered for on-site staff. The preparation/operation of Standard Operation Procedures (SOPs), something not created for the most part so far, is proposed as a solution. Speaking more broadly, SOPs should be prepared for all WASA-F works. Before considering the use of SOPs, the process to prepare them should be recognized as an opportunity for human resource development. The Formation of a Task Force composed of members from management and field staff from across the organization is recommended for the preparation and operation of the SOPs.



Source: JICA Mission Team

Figure 6.3.3 Proposal for Human Resource Development for WASA-F

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

(1) Water Supply Plan

1) Water Source Development

Since the groundwater taken from deep aquifers is brackish in and around Faisalabad City, surface water from the irrigation canals (i.e., JBC, RBC, and GBC) has been proposed as the main water source in the future, with groundwater being continuously developed in parallel as a supplemental water resource (see **Table 7.1.1**). Irrigation water, however, is also in severely short supply, and the handling of the canal closure period for three consecutive weeks every year remains an essential hurdle to overcome towards achieving a sure source of water intake in the future.

Table 7.1.1 New Water Source Development

No.	Name of Scheme (Tentative)	Water Source		Capacity		Ratio
		Type	Name	MGD	m^3/day	
1	New JK WTP Expansion	Surface Water	RBC	5.0	22,700	
2	Gugera WTP Construction and Expansion	Surface Water	Lower GBC	75.0	341,100	
3	Original JK Renewal	Surface Water	RBC	6.5*	29,400*	
4	Allama Iqbal WTP Construction	Surface Water	RBC	1.5	6,800	
5	Jhang WTP Construction and Expansion	Surface Water	JBC Upper	60.0	272,700	
Sub Total of New Surface Water Source Development				**148.0**	**672,700**	83%
6	GBC Tubewells Construction and Expansion	Groundwater	Lower GBC	10.0	45,400	
7	JBC Tubewell Construction and Expansion	Groundwater	JBC Upper	20.0	90,900	
Sub Total of New Groundwater Source Development				**30.0**	**136,300**	13%
Grand Total of New Water Source Development				**178.0**	**809,000**	100%

* The existing Original JK WTP, a slow sand filter plant with a design capacity of 16,000 m^3/day (3.5 MGD), will be renovated into a rapid sand filter plant with a capacity of 45,400 m^3/day (10.0 MGD). The increased physical capacity after renewal will be 29,400 m^3/day (6.5 MGD).
Source: JICA Mission Team

2) Water Supply Facilities

The distribution network in the M/P is separated from transmission mains and arterial mains, and the supply area is divided into seven (7) water supply zones (WSZs). Due to the topographically plain features of Faisalabad City, 56 Distribution Centers (DC) with terminal reservoir pumping stations are planned for water supply in the city (one now existing, 55 to be newly installed). Each DC consists of an underground reservoir (GR) and an overhead reservoir (OHR) in the city, and is divided into several District Metered Areas (DMAs) that enable water distribution management in each DC zone. This restructuring includes the introduction of a metered-tariff system that will make it possible to grasp accurate water volumes (accounted-for water, unaccounted-for water) at the DMA level also.

3) Improvement of Water Supply Management

As a practical lesson for the M/P, the results and experience obtained from the pilot activities carried out under this Project are expected to be very useful to WASA-F. Looking towards the future of WASA-F water service management, the M/P aims to enable WASA-F to operate autonomous business by first implementing a conversion model from a vicious cycle to a virtuous one in the pilot areas, and then expanding this scheme horizontally expanded to other areas.

4) Economic and Financial Evaluation

In the analytical framework of the Water Supply Accounting for the envisaged M/P, the cash available to WASA-F, that is, the net cash income emanating from all throughout all of the M/P period, turns out to be positive (profitable). With this in view, it could be considered acceptable, at a deep level, to expeditiously implement the concerned M/P, with backing by the strong will and commitment of WASA-F, together with the timely and appropriate borrowing of low-interest concessional loans (1-3 percent) and fiscal transfers from the Provincial Government.

In this context, a water-tariff increase, together with future investment, will surely be required to secure the Agency's financial basis for sound operation and management (O&M). Further, WASA-F and the Provincial Government must seriously consider a switchover to an *accrual accounting* system from the current *modified-cash accounting* as a prerequisite for successful implementation of the M/P.

Economic and Financial Internal Rates of Return from Specific Projects

Economic and Financial evaluations were conducted for the two selected water supply sector Phase 1 and Phase 2 projects, *namely*, GBC Tubewell-1 (from Phase 1 projects) and Jhang WTP-1 (from Phase 2 projects), in the framework of IRR analysis. The analytical variables and parameters applied to these projects are given in in the **Main Report B6.7 Tables B6.7.1** and **B6.7.3,** as well as in **B6.8 Tables B6.8.1** and **6.8.3**.

The analytical results on the economic (allocative) efficiency and financial viability of these projects are briefly condensed below in **Table. 7.1.2**.

Table 7.1.2 Water Supply Sector IRR Analysis Results

	EIRR	ENPV (PKR)	FIRR	FNPV (PKR)
GBC Tubewell-1	2.2 %	-1,669.0 million	-1.9 %	-2,672.0 million
Jhang WTP-1	9.3 %	627.1 million	2.2 %	-3,104.8 million

Source: JICA Mission Team

Economic and financial IRRs of the GBC Tubewell-1 project turned out to be lower than the cut-off rates of 6-10 percent (Social Discount Rate) and 6.1 percent (Opportunity Cost of capital, The State Bank of Pakistan, Interbank Rate), respectively. With this in view, the priority of this project should be lowered.
Economic IRR of the Jhang WTP-1 project was calculated at 9.3 percent, coming in above the JICA and the World Bank-advocated cut-off rate of 8 percent for environmental projects. In light of this, the project could primarily be evaluated as feasible. Nonetheless, the Financial IRR came in well below the profitability bottom-line, leaving the Project somewhat behind in financial credibility and sustainability.
The analytical result reveal high economic feasibility and weak financial viability. As such, the concerned Phase 1 projects will generally be considered appropriate for implementation within the schematic framework for collaborative works by the Provincial/Federal Governments and Development Partners.

Long-term Financing Plan

An analysis of the financial status of WASA-F implies that WASA-F cannot afford to pay even the annual O&M cost if the tariff stays at the current level for many years. A higher tariff level is thus desired.
A simulation for a long-team financing plan for WASA-F was attempted with staged increments of the water supply tariff. With some conditions and assumptions, this simulation showed that WASA-F would be able to be operate as a financially autonomous body, i.e., without subsidies from GoPb, after 2033.

(2) Sewerage and Drainage Plan

1) Sewerage Plan

The proposed sewer system is planned and designed as a separate sewer system, that is, as the same system designed in the former M/Ps. The trunk sewers are planned and designed for installation at deeper positions for the conveyance of the wastewater by gravity flow to the WWTPs to avoid the direct wastewater discharge to the drainage channels, Paharang Drain, and Madhuana Drain. Under this plan, the disposal pumping stations are to finish their roles. Most of the lift pumping stations are to be used continuously with necessary rehabilitation work to avoid any unnecessary deeper installation of new trunk sewers. Two influent pumping stations are to be constructed near or within the sites of the WWTPs to pump up the influent to the wastewater treatment facilities, one in the Western SWD and the other in the Eastern SWD. The treated wastewater is to be discharged by gravity to the Paharang Drain or Madhuana Drain until the effluent pumping stations with transmission pipelines are constructed at the Chokera WWTP and New East WWTP.

The treated wastewater is to be supplied to irrigation canals and used as irrigation water after it is mixed with irrigation water under strict wastewater quality monitoring to satisfy the Pakistan's quality standards for effluents discharged to Inland Waters (BOD5 of 80 mg/L) and WHO guidelines for irrigation water.

A four-phase development plan targeting improvements of the healthy living environment is proposed over the period from 2019 until 2038.

The industrial wastewater is received by sewers, and WASA-F is responsible for treating the industrial wastewater to satisfy the quality standards for effluents discharged to inland waters. The establishment of an industrial wastewater management unit in WASA-F to manage and monitor the industrial wastewater, complete with specified missions and staffing plans, is proposed.

2) Drainage Plan

Considering that no serious damage is caused by inundation or rainfall characteristics, two major plans are proposed as realistic stormwater drainage plans: 1) using the existing sewers, pumping stations, and drainage channels and 2) using a street drain system. Both of these plans, however, focus on measures to mitigate inundation.

The first plan allows the sanitary sewers to receive some portions of the stormwater within their capacity allowances: collect stormwater from house inlets or sewer manholes by opening the covers or using mobile pumps, to mitigate the inundation.

The second plan proposes a street drain system for the areas where inundation occurs even though drainage channels exist nearby. The proposed system consists of curbs, inlets, manholes with/without mobile pumps, and flap gates. Some infiltration effects may be expected, depending on the site soil conditions and maintenance work performed.

3) Pollution loads and Target Water Quality in Rivers

To improve the water quality in rivers, pollution load reduction measures are required based on a basin-wide pollution loads analysis. Industrial wastewater treatment will be the key for improving the water quality in the Chenab River and Ravi River.

4) Economic and Financial Evaluation

Project revenue will not cover the aggregate construction, operation and maintenance (O&M), and financial costs, although the tariff level (presumably set at 70 percent of the water tariff) will triple over the period of the long-term investment plan. In light of this, government intervention to finance a half of the construction cost would inevitably be required to keep the WASA-F M/P account positive, together with Agency financing to cover the both the O&M costs and interest payments.

Phase 1 project of the Western SWD is selected as the Priority Project based on a comparison of the economic and financial evaluations: the resulting IRRs and NPVs indicate that the concerned project is economically acceptable but financially infeasible. The financial feasibility of the phase 1 project of the Western SWD, however is superior to that of the Eastern SWD, as shown in the table below.

Table 7.1.3 Sewerage Sector IRR Analysis Results

Project	ENPV (PKR mill)	FNPV (PKR mill)	EIRR	FIRR
Phase 1 Project of the Western SWD	162.9	-17,032.1	6.1 %	1.3 %
Phase 1 Project of the Eastern SWD	-247.4	-38,181.6	6.0 %	-2.7 %

Source: JICA Mission Team

7.2 Recommendations

From the above conclusions, the following are proposed as necessary and recommended measures and activities.

(1) Water Supply

1) Water Source and Water Supply Facility Development Policy

As the groundwater in and around Faisalabad city is brackish, it will be important to shift from groundwater to surface water in the future. Improving the efficiency of the existing facilities is another important task, as well as expanding the water capacity.

2) Water Tariff Revision and Internal Aid to Low-Income People

It will be essential to revise the water tariff by setting appropriate prices. While it will be possible to raise the tariff for high- and middle-income groups (affordability), a tariff system encompassing cross subsidies tailored to payment capabilities shall be considered for low-income groups.

3) Importance of Securing Funds

It will be important to secure funds to sustain the steady progress of facility development while raising revenue to cover mainly maintenance expenses, which will surely increase with the installation of new facilities.

4) Improving WASA-F O&M by the Execution of a New Business Plan

WASA-F is expected to become an autonomous body step by step. The transition will be carried out in accordance with a New Business Plan that is to be prepared and reviewed every five years. WASA-F's strong willingness to improve its management will be key to overcoming this challenging process.

5) Recommendations based on Pilot Activities

The knowledge obtained from the pilot activities should be utilized as valuable experience for the implementation of the M/P, improvement of water supply situation, and improvement of tariff collection in the future.

6) Collaboration with the Activities of Other Donors

It will be important for WASA-F to hold regular donor coordination meetings with other donors and collaborate with the programs run by those donors, to ensure the implementation of the M/P.

7) Water Rights

WASA-F must continue coordinating with the Punjab Irrigation Department regarding intake from the irrigation canals of JBC, RBC and GBC by the target year 2038 of this M/P. The idea of a trade-off, of returning the same amount of wastewater treated at the WWTP to the irrigation canal, should be very carefully explained to the Irrigation Department, given that the development timeframes for the water supply system and sewerage system are totally different.

8) Canal Closure

The period of canal closure is usually three weeks but has tended to approach nearly one month in recent years. WASA-F needs to coordinate with the Irrigation Department both to shorten the closure periods and to prevent multiple canals from closing at the same time. As measures to mitigate water shortages during canal closure, the M/P also recommends the construction of raw water reservoirs (RWRs) to store water and the linkage of each water distribution zone with different water sources to complement the inadequate water volume.

9) Future Water Source

Intake of water from the Chenab River was considered and discussed as an alternative water source, but ultimately was not adopted in this M/P because the scale of the new intake facility and transmission line

will be over capacity both financially and technically. When the Project of the Chiniot Dam is implemented for power generation by WAPDA, however, it may be possible to cover future demand by taking water from the dam.

10) Environmental Permission

According to Punjab EPA/EPD, all projects involving construction work, regardless of magnitude, will be required to implement IEE/EIAs and submit reports for environmental permits from EPA/EPD.

11) Economic and Financial Aspects

WASA-F Management / concerned Provincial Government officials and the JICA mission team commonly understand that measures to improve WASA-F's financial management in the near future will form the very basis of all actions to provide water of high quality and in sufficient quantity to the citizens. Efforts toward those ends are also to closely be harmonized with WASA-F's drive to initiate and materialize its commitment to quality services with a "self-help" mindset. Viewed in this light, it would be preferable for WASA-F to duly consider the specific tactics summarized in the following table with a view to taking sequential fast steps forward in close consultation with the Provincial Government and development partners of relevance.

The 1st Stage	(1)	Enforced payments of both a huge chunk of arrears and monthly bills (*Current Demand*) from mostly the domestic sector beneficiaries;
	(2)	Cutting off service and taking other legal and regulatory enforcement measures to evasions and illegal connections, with non-multi-household dwellings particularly in view;
The 2nd Stage	(1)	Capturing demand through improved service quality and quantity to foster the beneficiaries' willingness to pay (WTP), while requiring or promoting the public's awareness of the need for control through water conservation programs;
	(2)	Installing water meters with a proper monitoring mechanism at households and other beneficiary properties in pursuit of rational and optimal billing/collections and demand control;
	(3)	Duly revising the tariff structure on a full cost-recovery principle (cost + proper retained earnings), while also adopting volumetric pricing/charges, particularly for the domestic sector; and
	(4)	Improving the efficiency of billing and collection through computerized IT systems, pecuniary incentives to tariff collection officials, and eliminating limited access to the commercial banks and post offices for tariff payments

(2) Sewerage and Drainage

1) Early starting issues

Regarding the proposed Priority Project, an early start of land acquisition procedures and budget allocation by WASA-F for the IEE/EIA Study, Environmental Permits, and other permits are highly recommended to avoid any delays in project implementation.

2) Preventive O&M Approach

Regarding the O&M of the sewerage and drainage system, a preventive O&M approach towards better management is recommended. Ideally, inspections will be emphasized, the inspection data will be used to identify problems or prepare repair plans before equipment malfunctions occur, and the efficiency of O&M work will be steadily improved. The following steps are included: i) establishment of a sewer database based on field survey results on the existing sewers and construction documents for new sewers; ii) mechanical sewer cleaning to recover the sewer capacity; iii) improvements in the recording of operation and inspection data using uniformly formatted sheets at a standard level of accuracy; and iv)

preparation of weekly and monthly reports in the form of electric files for sharing the data and information among the divisions concerned.

3) Further studies

The flow rate data during dry and wet weather conditions or detailed pump operation data are very useful for the designs of the sewers, pumping stations, and stormwater pumps in the latter stages. A comparative study on the wastewater treatment process shall be conducted based on more detailed information on construction costs, land acquisition costs, and O&M cost in the later stages such as F/S and D/D.

The pollution load analysis in the study is based on the results of water quality and quantity surveys conducted only once. Further analyses based on several surveys in series to confirm the pollution loads of industrial wastewater and adverse effects on water pollution in the Chenab and Ravi Rivers are recommended. Another highly recommended step is to discuss the proposed target water quality in the future based on flow rate and water quality data collected nationwide or river-basin-wide by EPD/EPA and other relevant government institutions.

Climate change may change rainfall patterns: stronger rainfall, shorter duration, over smaller areas. The preparation of comprehensive stormwater management plans to tackle the changing rainfall patterns will require thorough rainfall analysis using detailed rainfall data. These data will have to be collected at least every ten minutes using automatic equipment installed at several sites throughout Faisalabad.

4) Industrial Wastewater Management

The environmental laws and WASA-F sewerage regulations on industrial wastewater will have to be strengthened, with stricter enforcement of the penal code regarding the installation of wastewater treatment facilities by individual or grouped industrial units, and EPD/EPA-F and WASA-F will have to be granted enforcement authority in industrial wastewater management.

To promote the government policy and plan for industries moving from the urban area to the industrial complex (park) located in the suburban area, WASA-F and EPA-F will conduct public relations programs and activities in collaboration with industrial societies, chambers of commerce, and government bodies overseeing industries.

Technical and financial assistance programs of the German government, WWF, and other international organization are expected to provide knowledge and experience in industrial wastewater management in Faisalabad.

5) Strict Monitoring of Treated Wastewater Discharged to Irrigation Canals

WASA-F is responsible for strictly monitoring the treated wastewater quality at the WWTPs to ensure the quality of the treated wastewater discharged to the designated irrigation canals.