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

COMPLETION REPORT

OF

PILOT ACTIVITIES

MAY 2019

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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COMPLETION REPORT

(This report is a supplementary volume of the Final Report prepared in February 2019.)

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ABBREVIATIONS AND TERMINOLOGY

AC	Asbestos Cement
ACP	Asbestos Cement Pipe
BC	Branch Canal
CLC	Citizen Liaison Cell
CRC	Customer Relations Center
DMA	District Metered Area
FESCO	Faisalabad Electric Supply Company
FY	Fiscal Year
GBC	Gugera Branch Canal
GIS	Geographic Information System
GR	Ground Reservoir
GST	Ground Storage Tank
HDPE	High Density Polyethylene
HWL	High Water Level
IT	Information Technology
JBC	Jhang Branch Canal
JICA	Japan International Cooperation Agency
JK	Jhal Khanuana
JMT	JICA Mission Team
JPY	Japanese Yen
LWL	Low Water Level
MD	Managing Director
MGD	Million Gallon* per Day (*1 gallon = 4.546 liters)
M/P	Master Plan
NRW	Non-Revenue Water
OHR	Over Head Reservoir
OJT	On the Job Training
O&M	Operation and Maintenance
PBC	Performance Based Contract
PKR, Rs.	Pakistan Rupee
R&R	Revenue & Recovery
SMART WASA	Supply Management and Revenue Team WASA Faisalabad
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
TR	Terminal Reservoir
USD	US Dollar
UU	The Urban Unit
VAT	Value Added Tax
WASA	Water and Sanitation Agency
WASA-F	Water and Sanitation Agency Faisalabad
WB	World Bank
WDM	Water Distribution and Management
WTP	Water Treatment Plant

CHAPTER 1 OUTLINE OF PILOT ACTIVITIES

1.1 Purposes of Pilot Activities

Pilot activities are parts of "the Project for Water Supply, Sewerage and Drainage Master Plan (hereinafter M/P) of Faisalabad in the Islamic Republic of Pakistan."

In order for Water and Sanitation Agency Faisalabad (hereinafter WASA-F) to become a model for other water supply and sewerage utilities in Pakistan, WASA-F needed to realize a virtuous circle of improvement of their services and sound business operation in water supply and sewerage.

The purposes of the pilot activities were to verify the measures for improving water supply services, and form a basis of the volumetric water tariff system.

WASA-F currently practices intermittent water supply (6 hours in a day, 2 hours x 3 times) and water pressure is low throughout the city. Intermittent supply and low pressure constitute a risk of contamination. Customers are dissatisfied with the low service level of WASA-F and reluctant to settle water bills even at the current low flat rate.

The basic principle of water supply services is to supply a sufficient amount of safe drinking water at proper water pressure at all times. First of all, it is necessary for WASA-F to improve the three major elements water supply services: quantity (including supply time), pressure, and quality, and establish a water supply system accessible to all citizens of the existing water supply area. Only after offering satisfactory services can WASA-F charge customers properly, recover operating cost, and improve its financial status. As a result, WASA-F can prepare a fund for the next investment. This is a virtuous cycle of sound business operations.

Thus, it is important for WASA-F to provide appropriate water supply services. Without it, WASA-F could not discuss appropriate tariff structure and conversion to metering system from flat-rate.

1.2 Concept of Pilot Activities

Purposes of pilot activities included:

- To assess the existing facilities and current water supply conditions,
- To separate the areas hydraulically from the surrounding areas,
- To improve water supply services, and
- To examine the attitudes of customers regarding improved services in the selected pilot areas.

In addition, after services improvement, JMT plans to install water meters on all connections and shift to metering system from the current flat-rate. The activities also include forming a proper action unit to extend improved services to the entire WASA-F service area in the future.

Since the conditions of existing facilities, water supply conditions and customers are different in the three pilot areas, JMT verifies different contents suitable for each area.

Before starting activities, Pilot Activities Plan was formulated by JMT. (see **Appendix AF1.1** for details).

In this plan, three pilot areas were selected from Faisalabad city and the final goal was set as WASA-F's financial improvement. In pilot activities, what to contribute to the financial improvement of WASA-F will be examined and its cost-effectiveness and feasibilities will be verified.

In order to realize this goal, the pilot activities will proceed with the workflow shown in **Figure 1.2.1**.

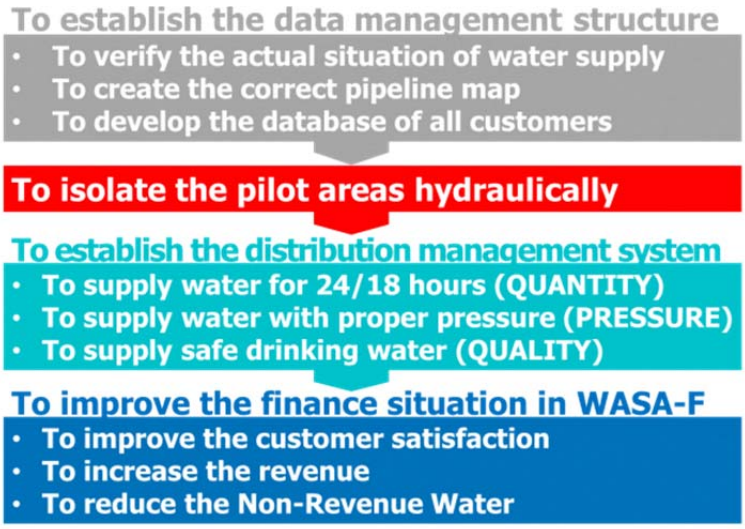


Figure 1.2.1 Work Flow of Pilot Activities

To ultimately improve the financial situation of WASA-F, it is necessary to improve water supply services. WASA-F should build good relationships with customers and improve customer satisfaction. As a result, it is expected that new customers increase and unpaid customers decrease. Illegal and unregistered customers are one of the components of Non-revenue water (NRW), so changing them to regular and legal status will also have a big influence on the financial situation.

To achieve these goals, however, it is essential to collect accurate information and develop a data management system such as creating a customer database, accurately grasping a water supply situation and developing pipeline maps. Then, it is necessary to establish a water distribution management system within hydraulically isolated areas; that is, to carry out proper management for water quantity, pressure and quality.

The **Figure 1.2.2** shows the vicious spiral of WASA-F.

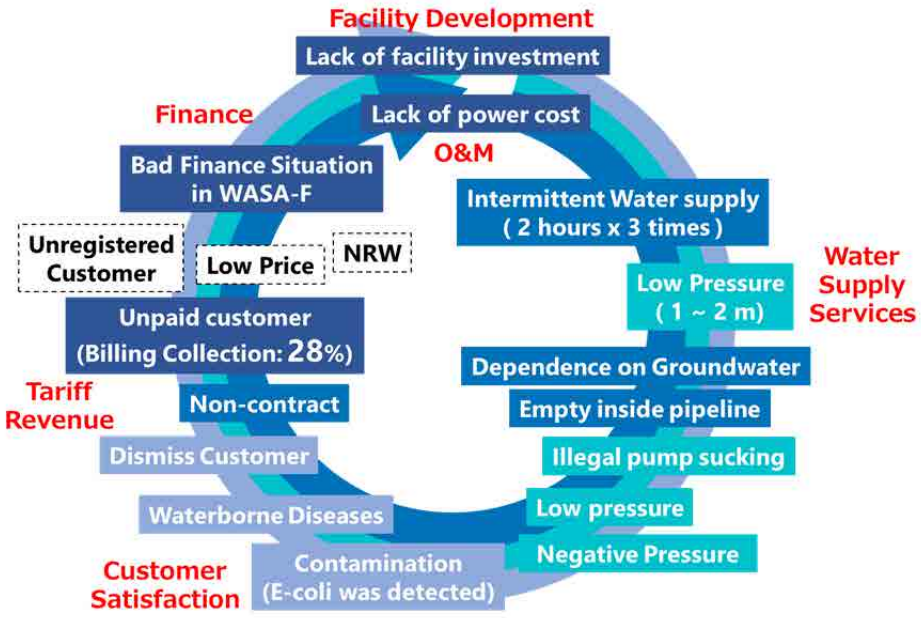


Figure 1.2.2 Vicious Spiral in WASA-F

Due to intermittent water supply, many customers rely on groundwater. Accordingly, they do not use water supply services of WASA-F. Many residents do not contract with WASA-F, even if there is pipeline in front of their houses (these residents may be potential customers). Also, due to intermittent water supply with low pressure, customers install illegal sucking pumps leading to emptying pipeline outside of service hours and causing air sucking into the WASA-F distribution network and frequent negative pressure. As a result of both empty pipeline and negative pressure, wastewater could enter into the pipeline system and the risk of waterborne disease rises. Thus, WASA-F's water supply service has problems in terms of water supply time, water pressure and water quality.

There are issues such as distrust of customers to water service provided by WASA-F, unpaid customers who do not intend to pay water tariff, and customers leaving due to deterioration of water quality. Due to these reasons, WASA-F cannot get sufficient revenue from customers and financial situation is getting worse.

Improvement of water supply services is urgently needed, However, WASA-F cannot improve the situation due to lack of funds for pumps operation and facility investment for improvement of water supply services. The budget of WASA-F was relying heavily on subsidy from the Punjab government every year.

WASA-F needs to break this vicious spiral.

The pilot activities showed an image of a virtuous circle as **Figure 1.2.3** in order that WASA-F can get out of this vicious spiral and to improve its financial situation.

Figure 1.2.3 Image of Conversion to Virtuous Spiral

The final goal of the pilot activities is to improve the financial situation of WASA-F. To achieve this goal, it is necessary to improve water supply services. WASA-F needs to establish the proper distribution management system in pilot areas, and extend water supply time to at least 12 hours a day, ensure proper pressure (more than 12 m) and provide drinkable water to customers. By investing in improving water supply services, WASA-F can improve customer satisfaction, increase tariff revenue, and ultimately lead to financial improvement. When financial improvement is achieved, the next investment will be possible and WASA-F can expand the activities of improvement of water supply services. Pilot activities will verify this virtuous circle in pilot areas.

1.3 Pilot Area Selection and their Features

Five sites were selected from Faisalabad city as candidate sites where water supply time can be extended and proper water pressure can be secured; such as Sarfraz Colony, Madina Town, Sitara Sapna City, Gulberg Colony and G. M. Abad. These five candidate sites were evaluated in three stages from the viewpoints of water source, water storage, water distribution, sewage and drainage facilities and customer information (Pilot Area Selection are shown in **Appendix AF1.2**). Finally, three areas; Sarfraz Colony, Madina Town and Sitara Sapna City, were selected as pilot areas.

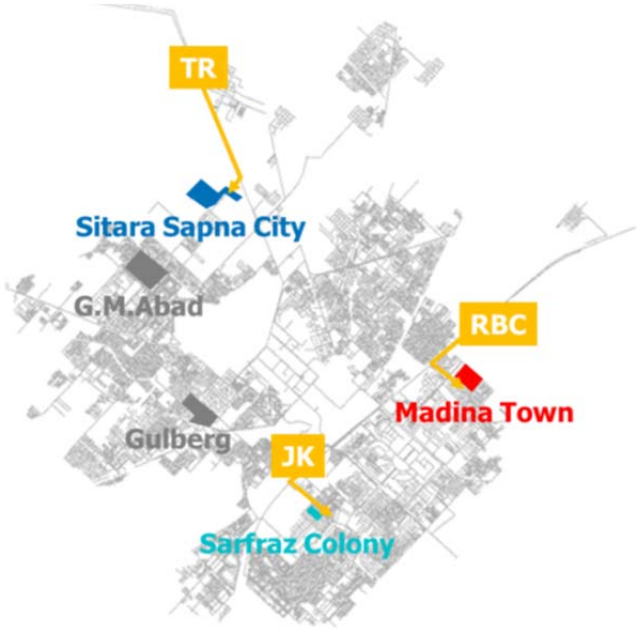


Figure 1.3.1 Location of Pilot Areas

Features of the three pilot areas are shown in **Table 1.3.1**. This information is as of November 2016 when pilot activities started. Details of each item are described in the relevant chapter.

Table 1.3.1 Features of Three Pilot Areas as of November 2016

		Sarfraz Colony	Madina Town	Sitara Sapna City
Nos. of Customers		478	1,774	265
Customer Income		Middle	Middle & Poor	Rich
Bill Collection Ratio		48.2%	55.1%	64.7%
Water Source		TR, New JK WTP	RBC	TR
Facilities : Unit		GST: 100,000 OHR: 50,000	(GST: 400,000)*1 OHR: 100,000	-
Water Supply Time		3-3.5h	6-7h	6-7h
Water Pressure		Very low (Pump Suction)	Low (Pump Suction)	Low
Water Quality	Chlorine	High	Low	High
	E. Coli	Not Detected	Detected	Not Detected
Metered connection (Year of Installation, funding source)		121 (2015, FR)	145 (2017, FR)	46 (2015, FR) 78 (2012, UK)
Groundwater (quality of shallow wells)		Brackish	Brackish	Brackish
Electric Power Supply		18h	18h	18h

*1: Under construction

The number of customers and the bill collection ratio in **Table 1.3.1** are collected from the data of WASA-F Revenue Department. Since the boundary of the water distribution system does not necessarily

correspond to the administrative district, it is needed to extract these data only for the pilot areas. Concentration of residual chlorine in Madina Town was low in November of 2016 because chlorine was not injected in water from Rakh Branch Canal well-field (hereinafter RBC). Since chlorine injection facility was installed in RBC groundwater source in 2017, the situation of chlorine in Madina Town has been improved. Power infrastructure is gradually developing throughout the city, and power supply has improved to 20 to 22 hours a day as of March 2018.

1.4 Outline of Pilot Activities

In the pilot activities, the objective was to improve water distribution management such as: extension of water supply time, improvement of water pressure, reduction of non-revenue water, installation of water meters, shifting to metering system and improvement of tariff collection in the hydraulically isolated pilot areas, in order to demonstrate the concepts of the M/P and its feasibility.

In these activities, three pilot areas (Sarfraz Colony, Madina Town, Sitara Sapna City) with different conditions in the city were selected as pilot areas, and appropriate methods were considered for solving the problems in each district.

1.5 Strategies for Promoting Pilot Activities

1.5.1 Setting of Final Goal

In promoting the pilot activities, discussing with WASA-F, the final goal of the activities was set as "financial improvement." To get out of the vicious spiral, it is necessary for WASA-F to promote investment that contributes to financial improvement, and it should link to further investment. However, improvement of water supply services is necessary for its backbone. The reason for low tariff revenue is obviously that customers are not satisfied with the current WASA-F water supply services. Due to this, there are many non-contract (unconnected) customers and many unpaid customers. By establishment of distribution management system, safe drinking water will be supplied at the proper water pressure at any time. Providing these water supply services improves customer satisfaction. By increasing the number of new customers and increasing the paid customers, WASA-F gets tariff revenue and lead to financial improvement. Shifting to metering system from flat-rate also contributes to financial improvement, however in order to shift to the metering system, it is necessary to increase the water consumption volume by customers through improvement of water supply services.

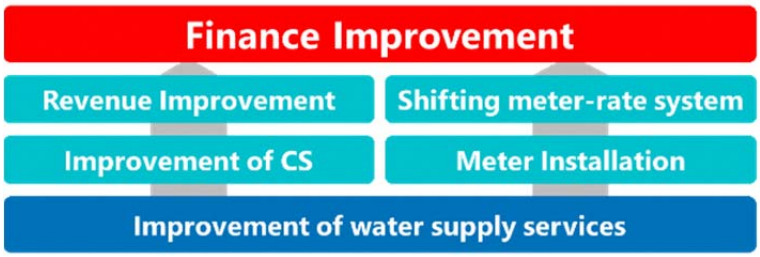


Figure 1.5.1 Image of Final Goal Setting in Pilot Activities

Therefore, it is necessary to establish a system in which investment contributes to financial improvement. By setting the final goal of all activities to "financial improvement", the direction to proceed is clarified so all the staff of WASA-F can move forward towards the same goal.

1.5.2 Establishment of the Taskforce Team of "SMART WASA"

Up until now, the Managing Director had been solving all issues as they were reported and there was no structure for solving problems across organization within WASA-F. Each department reported each issue

individually and solved the problem by some executives of the relevant department, and it was not a comprehensive but partial solution. This made it difficult to learn from past issues and to avoid them in the future. In November 2016, a taskforce team, "SMART-WASA (Supply Management And Revenue Team WASA Faisalabad)" was established to achieve the final goal of pilot activities effectively. This team was intended to be a cross-organizational team of clerical (billing collection) and technical staff (water distribution management), and a cross-hierarchical team by mixing headquarter and field staff. The objectives of the team for the three pilot areas are listed below.

Objectives of SMART WASA:

- To develop the database of all customers
- To verify the actual current situation of water supply
- To create the correct pipeline map
- To hydraulically isolate the pilot areas
- To achieve the 18 hours water supply
- To ensure the proper water pressure
- To supply safety water (to guarantee the supply water quality)
- To achieve the water distribution management system
- To improve the billing collection
- To improve the customer relation
- To reduce NRW

SMART-WASA aims to establish the data management structure and the distribution management system, and finally improve financial situation through the pilot activities. So, to achieve these targets, it is necessary to unite the Revenue and Water Distribution Department in order to solve the problems such as grasping of actual water supply situation, collection of customer data and establishing actual pipeline network, establishment of water distribution management system, re-building of good relationship with customers, revenue improvement and NRW reduction etc. With the establishment of this team, vertical administrative structure by job type was eliminated. Information sharing system within WASA-F was strengthened and organization system was established to allow revenue staff and distribution staff to consider together from water distribution management to revenue improvement. Also, in WASA-F, there is a huge gap between the head office and field staff. In the pilot activities, JMT focused not only on the desk activities by head office staff but also on on-the-ground activities involving field staff. It can be said that it is a rare team among the strict hierarchies of Pakistan. In the pilot activities, SMART WASA always adopted a method of thinking together with the staff of revenue and water distribution, head office and field, towards one purpose, and making an action plan. A remarkable increase in revenue appeared in the revenue improvement campaign after SMART WASA formation. JMT believes that continuing this cross-sectional and cross-hierarchical taskforce team will be a useful for future organizational improvement. As of March 2018, SMART WASA became an organization to plan all activities of pilot activities.

Kick-off meeting in November 2016


Bi-weekly meeting of SMART WASA

CHAPTER 2 CURRENT SITUATION AND EFFORTS IN ACTIVITIES

2.1 Customer Management

In WASA-F, there are approximately 113,000 households registered as water supply customer as of FY2017. On the other hand, according to previous customer surveys by the World Bank (hereinafter WB) and Urban Unit (hereinafter UU), there are about 400,000 households in the WASA-F Service Area (unfortunately, this result has not been shared to WASA-F). Pipeline water supply was developed for about 50% of the WASA-F Service Area, but there is still a large gap between the actual number of households and the number of contracted households.

In WASA-F, the contract rate of water connection is low, even in areas where water supply is available (Water Served Area). Customers are not satisfied with the current water supply services of WASA-F (especially intermittent water supply and bad water quality) and rely on their own groundwater sources. For this reason, there are many customers who are not connected to the water pipeline system, even if the option is readily available. These non-contracted or unconnected customers are potential customers when water supply services are improved.

In addition, there are many customers who have not been billed because they are not registered in the billing system even though they are connected to the water supply system and consume water. These unregistered customers are due to failure of WASA-F's customer management.

WASA-F did not have a firm understanding of unregistered customers and potential customers. Therefore, JMT proposed WASA-F implement a city-wide customer survey in order to grasp the numbers of customers. WASA-F carried out the customer survey from November 2016 to June 2017 and the number of customers of “water supply”, “sewerage”, “water supply and sewerage” was determined for all customers of the WASA-F Service Area. This result is shown in **Table 2.1.1**.

Table 2.1.1 Customer Survey Result of Whole WASA-F Service Area

	Households	Evaluation
Faisalabad City	400,000	
WASA-F Service Area	250,000	
Contracted Customer for Water Supply	113,000	
Contracted Customer for Sewerage	246,000	● Sewerage is more conscious of serious problems than tap water
Unregistered Customer for Water Supply	16,000	● Accounted for as an illegal connection
Unconnected Customer for Water Supply (Potential Customer)	120,000	● Intermittent water supply (2-6 hours) ● Low pressure ● Contamination of wastewater ● Groundwater dependent

From the result of this city-wide survey, it was found that the total number of households in Faisalabad City is 400,000. Among them, about 250,000 households are in the WASA-F Service Area. About 16,000 unregistered households for water supply were identified and they should be changed to regular customers. Based on this result, it is estimated that there are approximately 120,000 potential customers. This means that there is a huge possibility to be able to improve financial status of WASA-F if they incorporate these potential customers into regular customers by improving water supply services.

2.2 Water Supply Services

2.2.1 Current Situation of Distribution Management in WASA-F

For water supply business, the water distribution management is to control water quantity, water pressure and water quality. In other words, it means to supply the sufficient amount and safe drinking water to the customers with the proper water pressure at any time.

(1) Water supply time and water quantity

At present, WASA-F supplies water three times a day; once each in the morning, the afternoon and evening. The total water supply time is six hours a day. The main cause of this intermittent water supply is the limitation of pump operation due to high electric power cost. Because WASA-F has adopted the flat-rate system, increasing water distribution does not directly affect their income. Therefore, WASA-F adopts to supply the minimum necessary water for civic life at the necessary time. However, customers are largely dissatisfied with this intermittent water supply, and is considered to be the major contributor to the high rate of non-payment.

Due to this intermittent water supply, WASA-F actually used only about half the water source while retaining 110 MGD (500,000 m^3/day) water resource.

In addition to these issues, some areas such as G. M. Abad receive water supply for only 1 or 2 hours a day due to unstable power supply. This is also considered to contribute to the high rate of non-payment.

Moreover, all city networks are connected and it is not possible to control water volume and water pressure to different areas. While customers near water sources have good access, customers further away have difficulty receiving sufficient water.

(2) Water pressure

As for water pressure, on the west side of Faisalabad City close to the Terminal Reservoir (hereinafter TR), adequate water pressure is secured with TR pumps, and WASA-F can supply water directly to the two-storied building in many areas. On the other hand, in areas farther away from the TR, especially in the east side, issues of low water pressure or no water are experienced.

As observed in Sarfraz Colony and Madina Town, customers illegally connect small pumps directly to the water service pipe and suck water from the water distribution pipe. This pump water suction causes negative pressure inside the pipe and it has a risk of contamination.

In order to prevent contamination inside the pipe, WASA-F operates the water intake pumps at the Chiniot well-field for 18 hours a day in an attempt to keep the pipelines filled with water. However, pipes still become empty in some areas like Peoples Colony and Sarfraz Colony outside of supply hours due to suction pumping activity by customers during non-supply hours. So at the present time, it has not necessarily achieved satisfactory results. Resolving the low water pressure is very important for WASA-F.

(3) Water quality

To check the water quality, the project briefly investigated residual chlorine levels at the tap at three sites; Shahbaz Nagar, Sarfraz Colony and Clock Tower Market. The survey confirmed that there was sufficient concentration of residual chlorine (more than 2.0 mg/L) at these sites.

In addition, from interviews with customers in these areas, tap water of WASA-F is used for drinking for some customers and the project confirmed that customers recognize WASA-F's water as "drinkable".

WASA-F Laboratory is in charge of water quality control. The Laboratory staff conducts water quality inspection at 4,000 sample points per year, especially 2,000 sample points for residual chlorine, and they commented that they do not have any particular big problem with water quality especially about chlorine. Therefore, in most areas, it is judged that there are no significant water quality issues. However, from customer complaints in Madina Town, such as “sewage mixed smell” and “dust contamination into tap water” were received, and the residents are skeptical about the water quality. At the pipe ends in Sarfraz Colony, “sewage mixed smell” is also reported.

In addition, JMT conducted a water quality survey of four water taps in Madina Town. E. coli. was detected at two sites.

In some areas, WASA-F has water quality problems in the distribution piping network.

JMT also conducted an analysis for present service conditions in WASA-F service area as presented in **Appendix AF2.1**.

2.2.2 Actual Condition of Customer Water Use in WASA-F

In the process of pilot area selection and customer survey in three pilot areas, the actual condition of water use in WASA-F was surveyed. The way customers use water in Faisalabad is mainly categorized in two cases shown in the **Figure 2.2.1** or a combination of both cases.

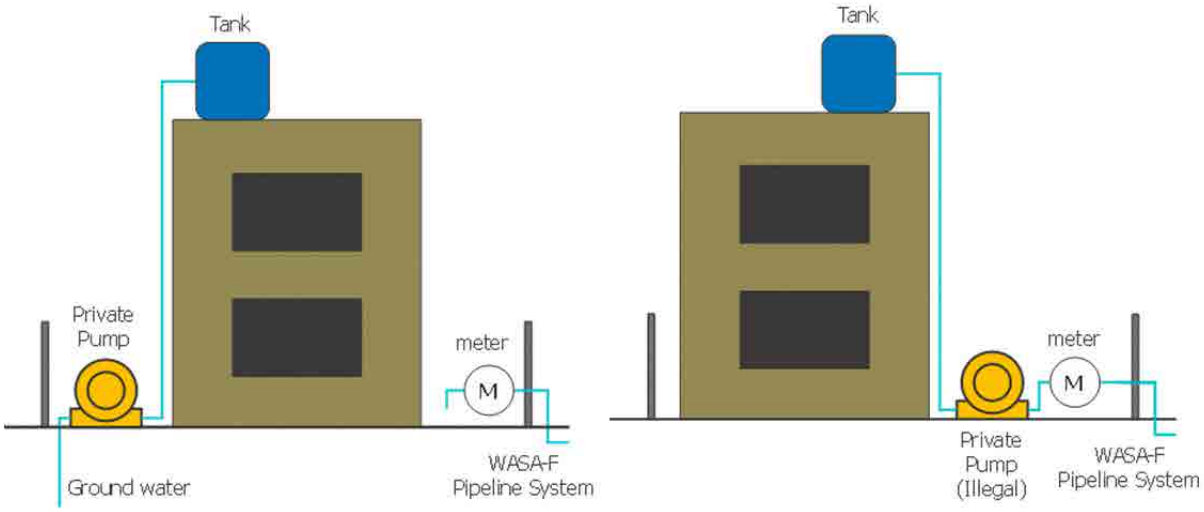


Figure 2.2.1 Groundwater Dependent Type (left) and Pump Water Suction Type (right)

(1) Groundwater dependent type

Due to intermittent water supply, many customers rely on their own groundwater (Groundwater Dependent Type). Customers pay electricity bills of 800 to 1,500 PKR per month to FESCO, an electric company, to pump up groundwater to their own rooftop tanks for later use.

However, most groundwater in Faisalabad is brackish water (average TDS: 2,000) and not suitable for drinking. It is mostly used for domestic, non-drinking purposes such as cleaning. For drinking uses, customers purchase bottled water or they use the tap water of WASA-F. Brackish water is also not suitable for gardening. WASA-F tap water is often applied.

In many cases, the in-home plumbing is not connected with the tap water of WASA-F. WASA-F water is only used for drinking and gardening, and is rarely used for other domestic purposes. At this stage, even if shifting to metering system, WASA-F cannot expect increasing income over the flat-rate system.

In Shahbaz Nagar and Sitara Sapna City for example, most customers take this Groundwater Dependent Type of water use.

Situation of Groundwater Dependent Type
(In-home piping connect to groundwater pump)

Groundwater Pump
(It is provided by electric company cheaply)

Because the underground water pump requires expensive electricity, the customers are actually paying the cost for obtaining water to the electric company.

(2) Pump water suction type

On the other hand, the water pressure is only 2-3 meters in many areas away from the water source. There is not enough pressure for water to reach the upper floors of the second and third story buildings. (Especially on the east side of the Rakh branch canal) In areas where the water pressure is remarkably low, Pump Water Suction Type is normal water use.

Customer connects his own pump to water service pipe directly, draws water from WASA-F distribution pipe to the rooftop tank for storage and later use. This pump connection is illegal and removal should be enforced. However, WASA-F cannot supply enough water with proper pressure to customers at the moment and has no recourse to the current situation.

The electricity bill is 800 to 1500 PKR, same as in the case of Groundwater Dependent Type. However, there is a high risk of contamination due to the negative pressure inside the water distribution pipe during suction. Actually, in Sarfraz Colony and Madina Town, “sewage mixed smell” and “dust contamination into tap water” were reported.

In addition, pump water suction causes a reduction in water pressure in the water distribution system of WASA-F, which leads to further customer pump installation and results in a vicious circle.

In particular, during intermittent short water supply time, majority of customers use suction pumps at the same time. For this reason, the water pressure in the distribution pipe drops significantly. Pressure within water pipes can become negative. When this occurs, the buried pipes actually start to suck in water from the surround soil and household drainage from leaking sewer pipes can become mixed in the water distribution pipes at various places in the city.

In addition, customers rarely consider saving water due to flat-rate tariff system adopted by WASA-F. During the water supply time, the water suction with illegal pumps was started all at once, leading to a situation where all customers could not receive water equally.

In some areas, French made water meters have already been installed. A number of installed meters are already out of order due to the sudden rise in water pressure by pump operation, mixing of air, or pump vibration.

In Sarfraz Colony, most customers are using this water use style, and it is considered a normal practice. Also, part of Madina Town is same as Sarfraz Colony.


Situation of Illegal Pump Suction


Situation of Illegal Pump Suction

Some customers have adopted a combined water use of Groundwater Dependent Type and Pump Water Suction Type. The tap water of WASA-F and the groundwater are mixed in the rooftop storage tanks and they use it.

(3) Necessity of establishment of proper distribution management system

In any case, these types of water use are caused by the intermittent water supply and low water pressure. An empty pipe by intermittent water supply and a drop in water pressure by an illegal water suction pump have caused many problems. The drainage pipes in various places in the city were chronically mixed with domestic wastewater, and the water quality of WASA-F was unfit for drinking. Therefore, citizens' confidence in water safety for WASA-F is low. On the other hand, there is also increase in salinization of underground water, and bottled water (20 litre) is commonly used.

Customers cannot be satisfied with the tap water of WASA-F at this service level and sufficient billing collection cannot be expected without improvement of these situations. Based on this, in the pilot activities, it is necessary to promote the establishment of the appropriate water distribution management system such as extension of water supply time and improvement of water pressure.

2.2.3 Establishment of Distribution Management System in WASA-F

Initially, the water supply service of WASA-F was extremely low. In order to improve the water supply service, establishment of an appropriate water distribution management system in the pilot area was needed. Specifically, the following goals were set:

i) Continuous water supply for more than 12 hours during the day time.
ii) Ensuring water pressure of 12 m or more at consumer tap (design guidance of the state government).
iii) Eliminating the contamination of the water with domestic wastewater which is very common.

In Faisalabad, the water supply and distribution pipes of the whole city are interconnected and the block system (DMA) is not very effective. Therefore, the water pressure pumped by the water source (water treatment plant and TR) quickly disperses into a vast water distribution network and is unmanageable.

The pilot activities utilize existing underground storage tank (hereinafter GST) and over-head reservoir (hereinafter OHR) and according to the size of the GST and OHR, decide the proper number of households to serve and the water distribution area. This will create the hydraulic separated area, and water quantity, water pressure, and water quality inside this area will be controlled.

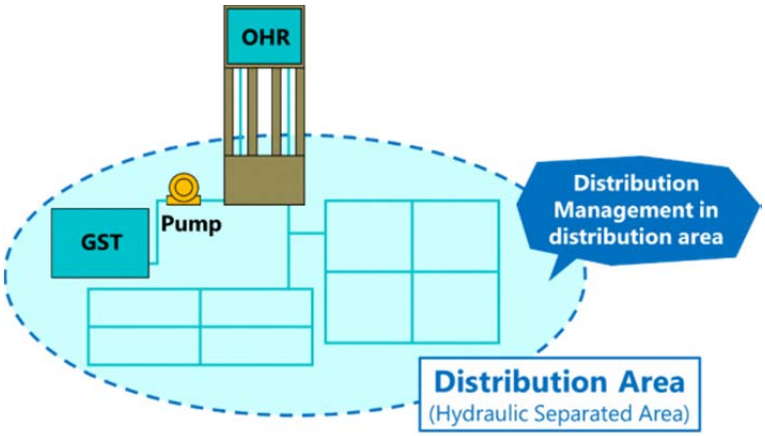


Figure 2.2.2 Image of Establishment of Distribution Management System

The pilot activities promoted the establishment of water distribution management system such as extension of water supply time and improvement of water pressure as a top priority, and improved the water supply services in pilot areas. After extension of water supply time and improvement of water pressure, water quality problem was inevitably resolved.

The mappings constructed by WASA-F were incorrect. Field visits and surveys confirmed that there were many unknown multiple pipelines in the city. The details are described in Chapter 3 Section 1. In the Sarfraz Colony Pilot Area, it was not possible to achieve the hydraulic separation according to the concept. For this reason, it was demonstrated that reliable hydraulic separation could be achieved for Madina Town Pilot Area by installing a new pipeline that goes around the water distribution management area. The details of this activity will be described in Chapter 3 Section 2. In this way, the pilot activities started from the Sarfraz Colony Pilot Area to Madina Town Pilot Area and then Sitara Sapna City Pilot Area continued to improve based upon the experience with preceding pilot area.

2.3 Meter Installation and Meter Reading

2.3.1 Meter Installation

20,000 water meters were procured in French Project in 2015 for WASA-F. All meters were purchased by Punjab government and distributed to WASA-F. WASA-F installed 14,087 meters in phase 1 (e.g. Sarfraz Colony). After that, WASA-F installed 4,429 meter as phase 2 (e.g. Madina Town). In phase 2, in view of the issues of Phase 1, all meters were installed outside the premises using Mild Steel cage. For promoting to install further meter, WASA-F procured additional 11,000 meters in 2017.

For shifting to metering system, meters should be installed and read properly by meter readers. These meters were installed following guidelines from manufacturer’s manual; however, they were not always properly installed.

For example, because GIS and customer ledgers were not developed correctly, there were discrepancies between the installed address and the actual installation location. In Sarfraz Colony, 121 meters had been installed, but as a result of field investigation, only 71 meters could be found.

Many meters were not installed at proper location. In many locations, meters were installed after the branch of water supply pipe. In this installation, only a part of water consumption can be measured and total water consumption cannot be recorded. Although this meter is recommended to be horizontally installed, most of them were installed vertically to save space.

Installation of these meters does not consider the meter reading. When shifting to metering system, it is necessary to consider the efficiency of meter reading. The meters were installed in a state of being scattered, and it was in a situation where it was not possible to efficiently read meter. Also, almost all meters were installed inside the premises, and it was not always easy to access because of absence of owner or refusal to enter. Indeed, in Sarfraz Colony, JMT carried out meter reading to grasp the water consumption, but about half of the meters could not be accessed and read.

Furthermore, there were cases of installing meters only for one tap. In the situation of dependent on groundwater, it is impossible to collect the expected revenue even if shifting to the metering system. Such customers' water use situation has not been considered.

As mentioned above, JMT had concluded that, it is impossible to shift to metering system under existing meter installation as this meter installation does not consider to grasp the actual water consumption or meter reading. In July 2017, JMT proposed the immediate discontinuation of meter installation to WASA-F and it was approved. WASA-F decided to resume installing meter after preparing a meter installation manual and SOP in this project.

Meter installation after the branch

Meter installation after the branch

Meter installation in landscape direction

Meter installation in vertical direction

The accuracy of the water meter is important because the amount billed to the customer is determined based on the meter reading result. Therefore, in the pilot activity, a manual for installing the meter and a standard operating procedure (SOP) were prepared. In November 2017, for making meter installation

manual and SOP, the trial meter installation was carried out in the Sarfraz Colony Pilot Area, and piping material and workability, meter reading were verified. After that, SMART WASA made the meter installation manual and SOP. In January 2018, these were adopted by WASA-F as official meter installation standard (for the meter installation manual and SOP, refer to **Appendix AF2.2**).

There are three major changes:

i) Meters were installed outside the consumer houses to enable easy reading by meter readers.
ii) Check valves/NRV (to prevent backflow from the roof tank) and stop valves (to prevent overflow from the roof tank) were installed.
iii) Mild steel cages were installed to prevent meter theft.

In order to carry out proper management, a checklist was prepared so that it could be confirmed on site whether there was a branch upstream of the meter or if the meter was installed horizontally.

In the three pilot areas, WASA-F decided to remove all existing meters and re-install meters outside the premises according to the manual and SOP. In addition, WASA-F decided to comply with this manual and SOP in not only pilot areas but also whole of Faisalabad city, and proceed with installing meters that can be shifted from the flat rate system to metering system.

For all WASA-F staff, from field to head office, to understand the new meter installation standard, trial meter installation area was selected in Sarfraz Colony Pilot Area and WASA-F itself installed 43 meters according to new meter installation standard in February 2018. During these activities, JMT carried out the meter installation training and OJT for staff, and trained staff installed meters himself. After meter installation, effect measurement training was carried out and improvement points were collected. Through two training and OJT, knowledge on meter installation of staff has remarkably improved.


Meter installation (on the surface)


Meter installation (on the wall)


Meter installation OJT (lecture)


Meter installation OJT (in the field)

2.3.2 Establishment of Meter Reading System

As of 2018, WASA-F did not have an organization that is responsible for meter reading. Since the meters so far were installed without considering shifting to metering system, it does not make sense for the meter function. In order to respond to requests from foreign donors, R&R and IT only read these meters as reference data. There was no meter installation or meter reading for billing and grasping the water consumption.

Since February 2018, in order to achieve shifting from flat rate system to metering system, SMART WASA discussed many times with all of the relevant departments to finalize the meter readers, meter reading method, meter reading book (meter reading record book) and data management structure. For meter reading training, each of WDM and R&R selected two persons and meter reading OJT were carried out five times in the trial meter installation area in Sarfraz Colony Pilot Area where 43 meters were installed. For meter reading procedure, the case of Yokohama city was used as reference.

SMART WASA divided the pilot areas into several zones, and set the meter reading zones so that the meter reader can easily carry out meter reading. In addition, meter reading book and meter reading and inspection SOP were prepared for meter readers by SMART WASA (for meter reading book including meter reading and inspection SOP, see **Appendix AF2.3**). In this SOP, the same concept as the Yokohama Waterworks Bureau is described. Thus, the responsibility of meter reader not only read the meter but also inspection of the circumstances around the meter, such as checking the meter function, confirming the surface water leakage, detecting illegal connections, etc.

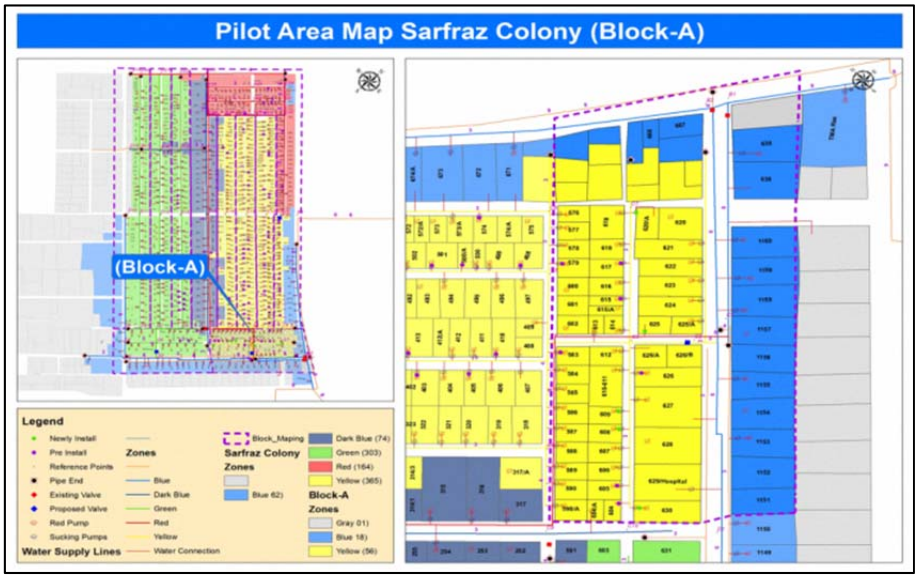


Figure 2.3.1 Image of Meter Reading Zone

In addition, to read meters by meter readers, proper customer list is required. Address, Account No. and meter ID should be linked with each other. Regarding this, there was no data management system in WASA-F. Therefore, JMT and SMART WASA created mapping including these information for meter readers. Finally, a meter reading system was established in WASA-F.

2.4 Billing Collection and Customer Satisfaction

2.4.1 Billing Collection

The method of billing collecting is simple. The contracted company distributes bill to customer, and in general, customer pays at a bank. In Pakistan, there are 48 banks, and WASA-F is associated with 14

major banks. In recent years, a method of paying via a mobile phone has also been adopted, and WASA-F promotes it. In addition, customers can pay at government department such as NADRA (National Database & Registration Authority) and Pakistan Post (Postal Service Company). At the moment, bank account transfer is not adopted.

Payment information is confirmed from each bank. However, there are inefficient parts, such as the time lag. Centralized management by database is necessary.

Based on the city-wide customer survey started in November 2016, the overall situation of WASA-F was learned. Many unregistered customers were identified for both water supply and sewerage. For this reason, in March 2017, WASA-F comprised a taskforce team with R&R staff for revenue recovery. They implemented action plan of billing collection improvement for all customers including three pilot areas.

To improve the bill collection rate, this taskforce team promotes customers to pay WASA-F bills, increase the number of staff to handle activities such as implementation of campaign activities and identification the areas where improvement can be expected. Before forming taskforce team, the achievement rate of the billing collection for the budget for FY 2015 was 68.4%. However, for FY2016, the achievement rate for the budget has improved to 77.5%. The collection situation was analyzed by classification, and it was concluded that it is effective to improve the collection rate for both water supply and sewerage.

Table 2.4.1 Operating Income for The Year Ended 2016–17 (Unit: mil. PKR)

Particulars	Budget FY2016	Total Income FY2016	Achieved Quantity
Water Supply Charges	257.600	196.739	76.3%
Sewerage Charges	419.400	323.562	77.1%
Recovery of Water Supply & Sewerage Arrears from Defaulters	240.000	174.894	72.8%
Infrastructure Charges	80.000	18.914	23.6%
Annual Income from Leasing of Land and Auction of Waste Water	5.500	7.308	132.8%
Income from Leasing out Roofs of OHRs	12.970	16.900	130.3%
Income from Letting out of Crane & Fork Lifter	0.100	0.000	0.0%
Income from Profits on Deposits	2.500	6.000	240.0%
TOTAL	**938.070**	**727.417**	**77.5%**

In addition, in FY 2017, following the good practice of Sarfraz Colony Pilot Area, WASA-F informed the new policies related to water supply to customers and contined activities to improve billing collection. Good results have been obtained in the first six months of FY 2017; System to tackle the improvement of billing collection systematically with WASA-F's potential is developing gradually. Deficiency in billing collection (amount basis) affected the budget execution of operation and maintenance cost and was in a vicious spiral of difficulty in improving customer satisfaction.

There are still 120,000 unconnected households (potential customers) still in the city. These potential customers are very important part of revenue recovery. Once water supply services are improved, it is expected that these potential customers will be changed to new regular WASA-F customers.

2.4.2 Customer Satisfaction

In the past, WASA-F has actively carried out public relations to residents. Many pamphlets have been prepared and distributed to citizens. Also, WASA-F promotion songs have been composed and the necessity of tariff payment has been appealed.

However, at the beginning of the project, the trust between WASA-F and the customer was very weak. There were many unregistered customers. It did not function as an organization to increase customers and improve toll revenue, but was only dealing with complaints.

Since the water distribution management system was established in the pilot activities and the water supply service has been improved, customers have begun to support the new WASA-F services. Actions have been taken to investigate unregistered customers throughout the city and regularize potential customers. Unregistered customers are identified with door-to-door visits to check the water supply status. It is checked by matching the customer number with the address and dropping the customer information on the mapping. A careful survey on this site was conducted.

In Sarfraz Colony Pilot Area and Madina Town Pilot Area, three improvements for water supply services were officially announced, such as 12-hour water supply, guarantee of proper water pressure, and drinkable water supply. In order to appeal to the residents of the start of the new services, a new services commemorative ceremony was held at each OHR. In this ceremony, delegates from the area, as well as newspapers and television, were invited and new services were widely announced. In addition, Urdu language brochures explaining the new services were distributed to all customers. Banners were also set to announce new services on the roads in each pilot area. The mosque also provided information on water supply services and carried out public relations in many places.

JMT provided training for all WASA-F staff in charge of Sarfraz Colony Pilot Area to understand the purpose, concept and effect of new services. After that, the staff visited each house, checked the water supply situation by door and confirmed the new service and made careful public relations such as asking for the charge payment.

WASA striving hard to provide safe drinking water to masses: Eng. Faqir

Mian Rashid Asghar

FAISALABAD: Engineer Faqir Muhammad Chaudhary MD WASA Faisalabad has said that WASA Faisalabad will launch certain projects in collaboration of overseas support whereby clean and safe drinking water would be available to the citizens continuously for 24 hours. In an exclusive interview with Daily Parliament Times here on Wednesday MD WASA said, "This continuous supply of clean drinking water would save the public from any contamination as compared to intermittent water supply". He said that work has already been initiated in different areas of Faisalabad in this regard. "WASA will soon flourish as self-sustained organization and a role model", the MD said adding that people of Faisalabad will have to cooperate honesty and pay the utility bills regularly. "Since the ground water in the most industrialized city is not safe for drinking and WASA is going to supply sweet drinkable water in place of salty water", he said adding that a number of tube Wells have been installed in the peripheries of River Chenab and Jhang branch along a 40 KM stretch of Faisalabad. He said that there was a dire need of 160 MGD water supply daily for 3.2 million people, whereas the production is 110 MGD including French phrase 1 project supply 15 MGD. "There is further need of 50 MGD more drinkable water for the citizens of Faisalabad", the MD WASA said. He pointed out that ACENIC PC- 1 project costing 14 crore rupees has been approved in which 11 billion and 3 billion rupees will be respectively provided by the French and Punjab Governments respectively. "The project will help to meet the requirements of nearly 6 lakh population settled at Eastern side of Faisalabad in addition to already running system of WASA Faisalabad. "Last approval of French board will be held in March 2018 for which the needed request has been sent in this regard to high officials", he said adding that the Note Agreement will get signed in this financial year (July/August 2018). Engineer Faqir Muhammad Chaudhary elaborated that, WASA was determined to save the ground water too. He said that 30 MGD Clean drinking water will be availed from Gogera Branch near Jarranwala 40 KM away from Faisalabad. "WASA Faisalabad is approaching now for surface water not the ground water in which there may be or may be not Arsenic metal which causes Cancer", he maintained. "WASA will contain surface water by irrigation department on conditional bases and provide waste water after purification that will be useable for irrigation", the MD said. He pointed out that waste water feasibly with the cost of 10 Crore will be completed in June 2018 and an agreement has been signed in this regard. Another water treatment plant he said was being installed at the cost of 100 million Euro (12 Arb) at Madsana area of 150 MGD capacity and this waste water will run in the direction of Lower Gogera Canal. Appreciating Jaika protects and mega support of Japan for WASA Faisalabad, MD pointed out that Jaika is preparing the master plan for next 20 years with the cost of 40 Crore on priority base within 4 /5 years in which Jaika will grant 5.8 billion. "We are making our all out efforts to improve the supply and sewerage system to fulfill the needs and necessities of the public as per their expectations", he said saying that the WASA faced deficit and there was a huge disparity in its income and expenditures. He further said that, WASA is paid back by various sectors with the ratio of 95% by industrial, 60% commercial and 25% by domestic. "So domestic and commercial sectors will have to pay back bills in time with due responsibility and honesty", he concluded.

Public Relations utilizing News Paper
(MD explained water supply services and safety water)

Public Relations utilizing TV

Display of banner

PR billboard for new service

2.5 NRW Reduction

Official NRW rate of WASA-F is 33% as of FY 2017. For "System Input Volume" which is the denominator of NRW rate, the facility capacity of 110 MGD is used for calculation because the flow meters are not fully installed. However, due to the low occupancy rate of actual facilities, the system input volume is inaccurate. On the other hand, "Revenue Water Amount" which is the numerator is also inaccurate because of the flat-rate system. Although revenue water amount is obtained by multiplying the water consumption unit by number of water supply consumers, and WASA-F uses 328 L/c/d for this water consumption unit. In Faisalabad, most of customers rely on their own groundwater and bottled water, this water consumption unit is excessively large (even in Yokohama, even both for domestic and commercial, it is about 300 L/c/d). Therefore, the actual NRW rate is likely to be greater than 33%.

On the other hand, in the 2014 French Funded Project, NRW rate was calculated at 55%. To decide water consumption unit, 1,000 households of customer survey was carried out, water consumption was measured and water consumption unit of 105 L/c/d was obtained. Using this water consumption unit, 55% of NRW rate was calculated. For system input volume, outflow volume was measured at only three points, TR, Tube well along with RBC and New Jhal Khanuana WTP. It can be evaluated that it is a figure that reflects the actual condition of NRW. IWA Water Balance Sheet is shown in **Table 2.5.1**. From next section, water volume will be discussed based on this classification.

Table 2.5.1 Water Balance Table in IWA

System Input Volume	**Revenue Water**	Billed metered consumption
		Billed unmetered consumption (**flat-rate system**)
	Non-revenue Water	Unbilled metered consumption
		Unbilled unmetered consumption (**used by utility**, **authorized unbilled**, **excess use of flat-rate**)
		Unauthorized consumption (**illegal connection**, **Unregistered**)
		Customer meter inaccuracies (**faulty meter**)
		Real losses (**leakage**, **overflow**)

2.5.1 System Input Volume

Facility capacity of water source in WASA-F is maximum 110 MGD. However, Occupancy rate is very low and distributed water volume is estimated about 55 MGD based on pump operation records.

2.5.2 Revenue Water

WASA-F adopts flat-rate system, so there is no billed metered consumption. For billed unmetered consumption, French Fund Project carried out the water consumption survey by installing the temporary flow meters to 1,000 house connection. This project utilizes this result and estimates the billed unmetered consumption by multiplying the number of customers by the water consumption unit estimated. Though water consumption unit was estimated to be 105 L/c/d, a big difference of water consumption unit depending on the site was observed.

Pilot activities estimated the water consumption unit to be 144 L/c/d utilizing existing meters in three pilot area. As new service is started now, water consumption is increasing, but 144 L/c/d is appropriate as average water volume in the city.

2.5.3 Non-revenue Water

(1) Unbilled Metered Consumption

In Japan, there are several systems to exempt customer payment, even if water utilities supply water and the amount of water is measured through water meter. For example, when water not suitable for drinking such as turbid water and rusty water has been supplied, customers will be exempted from payment.

Alternatively, some water utilities exempt the amount of in-house leakage. These water amounts are considered as the unbilled metered consumption in Japan.

On the other hand, since WASA-F has not adopted the metering system at the present, there is no item corresponding to the unbilled metered consumption.

(2) Unbilled Unmetered Consumption

(a) Used by Water Utilities

This corresponds to pipe washing when installing pipeline. WASA-F does not consider it, and not make pipe inside clean after construction.

(b) Authorized Unbilled Water

The staff of WASA-F can use water for free, it is authorized unbilled consumption. Some mosques and special schools for the handicapped are offered 30% discount. This 30% is also NRW and these amounts are organized as authorized unbilled consumption. In addition, WASA-F has sixteen Free Water Stations adjoining the OHRs (see **Table 2.5.2**). Citizens can use water from the faucet installed there for free. Many residents of the water supply uncovered areas use these Free Water Stations. Sometimes, users visit the facility with large trucks and transport large quantities of water.

Table 2.5.2 Free Water Station in WASA-F

Free Water Station	Remarks
Karkhana Bazar	Operational
Islam Nagar Near Riaz Shahid Chowk	Operational
Adam Chowk OHR	Operational
Gulfishan Colony OHR	Operational
OHR PC-1	Operational
Dogar Basti	Operational
OHR Babar Chowk	Operational
OHR Waris Pura	Operational
OHR Allama Iqbal	Operational
OHR D-Type	Operational
OHR Samanabad (Police Chowki)	Non-Operational
OHR Samanabad (Qadri Chowk)	Non-Operational
OHR Chamra Mandi	Operational
OHR Nazimabad	Operational
OHR Fatehabad	Operational
OHR Batala Colony	Operational

(c) Excess Use of Flat-rate system

Tariff table for domestic customer is shown in **Table 2.5.3** and **Table 2.5.4**.

Table 2.5.3 Tariff Table of Flat-rate for Domestic

Area			Rate	Assumed Consumption
marla (= 25.3 m^2)			PKR/mon.	m^3/mon.
	-	2.5	83	9.7
2.5	-	3.5	124	14.5
3.5	-	5.0	145	16.9
5.0	-	10	242	27.5
10	-	20	322	36.6
20	-	40	644	61.0
40	-		966	91.5

Table 2.5.4 Tariff Table of Metering System for Domestic

Water Consumption gal.			Rate PKR/1,000 gal.
	-	5,000	39
5,000	-	10,000	40
10,000	-		48

By comparing the flat-rate system with the metering system, the assumed water consumption of flat-rate system can be calculated.

For example, in the tariff table of the flat-rate for domestic customers and plot size of 5 – 10 marla (126.5-252.9 m^2) is 242 PKR/month. On the other hand, for same customer in the metering system, water tariff is 40 PKR/1,000 gallons for water consumption up to 10,000 gallons. Comparing these two tariffs, the assumed amount of water consumption of this flat-rate customer is 6,050 gallons/month, because 242 divided by 40 multiplied by 1,000 is equal to 6,050, this is 27.5 m^3/month. Therefore, when this customer uses more than 27.5 m^3/month of water, if WASA-F shifts to metering system, they will be able to bill a higher amount.

Because flat-rate tariff is set very low compared to the metering system, by improving water supply services, shifting to metering system leads to increased revenues for WASA-F. There is an idea to organize the excess use of flat-rate based on the assumed water consumption as one element of the NRW.

In the pilot areas, proper water distribution management system was achieved, and overflow from rooftop tanks occurred as water pressure improved. Since “too much water” was never an issue for customers, they had not installed overflow prevention functions on their rooftop tanks. With no incentive to save water in the flat-rate billing, there is a high possibility that these overflows will continue and become excessive.

WASA-F, requested customers to cooperate with the provision of “Water Supply Ordinance” to impose a fine on the waste of drinking water, and encouraged customer behavior change that customer close the inlet valve to rooftop tank. Also, in meter installation manual and SOP, it was added that WASA-F installs stop cock upstream of the meter when installing meter so that customers themselves can now stop incoming water.

(3) Unauthorized consumption

(a) Illegal Connection

In WASA-F, exposed piping of individual service connection is common, so the installation condition of service pipeline can be easily grasped. While conducting customer satisfaction survey and water supply situation survey, JMT visited many customers in the pilot areas, but there were no visually illegal connections. Therefore, it is judged that there is little illegal connection in Faisalabad. This is considered to be due to the fact that the water rate is flat-rate and inexpensive, that it can easily access their groundwater and that water supply services in WASA-F is not sufficient.

On the other hand, since commercial and industrial rate are not necessarily inexpensive, there is a possibility of illegal connection for commercial and industrial users.

(b) Unregistered Customers

In WASA-F, there were many unregistered customers. The unregistered customer can be defined as a form of stolen water, but JMT defined it as an unregistered customer, because this is due to failure of customer management of WASA-F. To grasp the actual situation, JMT proposed for WASA-F to

implement the city-wide customer survey, and WASA-F carried out the survey from November 2016 to June 2017. As a result, for water supply, almost 16,000 households of unregistered customers were detected and then, changed to regular customers. They have likely accounted for quite a large weight in non-revenue water. Along with these activities, WASA-F's revenue increased about 15 to 20 million PKR monthly.

(4) Customer meter inaccuracies (Faulty Meter)

At the moment, since WASA-F adopts flat-rate system, accuracy of the water meters is not discussed. However, after shifting to metering system, it will become issue for WASA-F.

Currently, the meter provided by France is a rotary piston type. The pilot activity also utilized this meter. However, during the pilot activities, around 5% of the meters were found to be stuck and malfunctioning. The water distribution network lacks proper drainage and flushing equipment and particulates introduced during construction remain and build up in the network. It is thought that these particulates penetrate the delicate mechanisms of the French water meters, causing them to get stuck and malfunction.

(5) Real Losses (Leakage)

JMT could not achieve hydraulic separation in Sarfraz Colony Pilot Area due to incorrect GIS and duplicated pipelines. This situation is common throughout Faisalabad. It will be impossible to estimate the leakage volume by implementing the minimum night flow measurement. For the same reason, step test cannot be carried out. Even when conducting field survey, JMT hardly found any surface leakage. Under intermittent water supply and low water pressure, leakage is considered not to be critical in non-revenue water.

However, since it was observed that the level of construction management of contractor in Faisalabad was low in pilot activities, there is high possibility of small underground leakage. In addition, every time receiving complaints of water quality from customers, WASA-F has installed new pipes called “pipe renewal”. At that time, the existing AC pipe is not removed, and it is kept operated. Since these pipelines are old and buried deeply, it is assumed that there are many leakage from these old pipelines.

However, underground leakage detection is difficult and significant improvements cannot be expected due to the difficulty of hydraulic separation, the limit of the time for leakage survey due to intermittent water supply, the difficulty of capturing the sound of water leakage due to low pressure, the burying of deep pipelines, and the paving of multiple layers.

CHAPTER 3 ACTIVITIES IN EACH PILOT AREA

3.1 Sarfraz Colony Pilot Area

Sarfraz Colony is the area where water is distributed from Fawara Chowk GST and OHR. Main water source is TR but very far. After French Fund Project constructed New Jhal Khanuana WTP in 2015, new water source was added for this area.

WASA-F supplied water from Fawara Chowk OHR not only to Sarfraz Colony but also Peoples Colony. However, height of this OHR is 18 m at deck slab and even if it is full, water level is secured only 21.6 m. In addition, capacity of this OHR is only 50,000 gallons (227.3 m^3) and so small for these water supply areas. Therefore, it was difficult to control water quantity and water pressure using this OHR, WASA-F could not distribute water to both colonies at the same time, and distributed alternately. Although it was officially 6-hour water supply, it was practically 3.5-hours water supply in these areas.

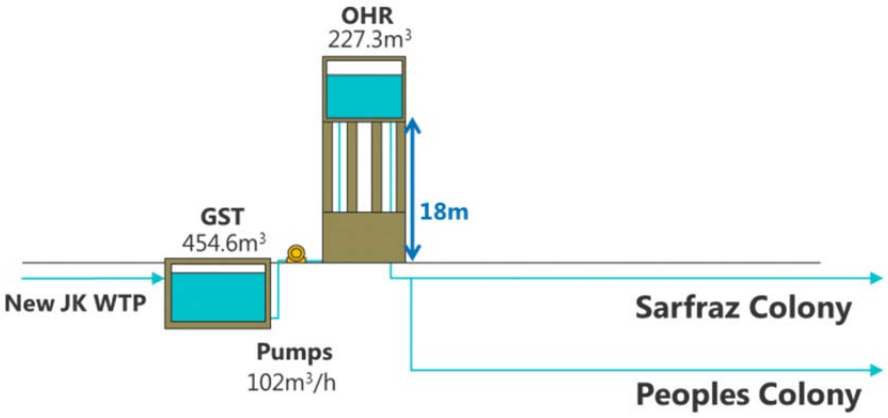


Figure 3.1.1 Water Operation of Fawara Chowk OHR

Since Fawara Chowk OHR distribution area was not separated hydraulically, any water pressure was quickly lost to the vast distribution system. For this reason, even during water supply time, only 2-5 m of pressure was secured in Sarfraz Colony and only 1-2 m of pressure was secured in Peoples Colony. Though almost all customers install their own rooftop tank, WASA-F water could not reach to their rooftop tanks with this pressure. So almost every customer has installed water suction pump, directly connect to WASA-F's distribution system and suck water illegally. Due to intermittent water supply and illegal pump suction, it was observed that wastewater was mixed in the tap water at the end of the distribution system in Sarfraz Colony and Peoples Colony.

In the Sarfraz area, the existing Fawara Chowk OHR was used, and only the Sarfraz Colony Pilot Area was set as its distribution management area. Locations where pipes were thought to cross the boundary of the distribution management area were excavated, aiming for hydraulic separation.

However, the pipeline network mappings of WASA-F were incorrect. Multiple unknown pipes not marked in the mapping were found. With unknown pipes connecting to pipes outside of the distribution management zone, hydraulic separation could not be achieved until the end, and the target water pressure of 12 m was not achieved.

The drilling/excavation and cutting work of hard roads in order to find connection pipes for hydraulic separation was difficult work and the staff were exhausted.

3.1.1 Establishment of Data Management System

Regarding GIS development, UU was already building GIS, setting Parcel ID in each parcel. Therefore, SMART WASA started to create mapping and customer ledger utilizing this GIS and billing system of IT section.

However, Parcel ID of UU and customer information of WASA-F did not correspond properly because UU arbitrarily changed Parcel ID while WASA-F is building GIS.

In addition, Parcel ID is a number that UU set freely for convenience of GIS build, and what the customer and staff are normally using in the field is House No. that is set by the Land Administration. Therefore, when creating mapping, it was also necessary to enter House No.

Regarding pipeline information, a certain pipeline map was created by French Fund Project. However, in Faisalabad, there are many duplicated pipelines and unplanned expansion. Discrepancy from the field was large and the maps were not useful. It was necessary to confirm each pipeline at the site.

For these reasons, SMART WASA organized a team for field survey combining GIS section, revenue section and water distribution section and started the field survey in Sarfraz Colony Pilot Area. While interviewing customers in the field one by one, the situations were checked and information was collected such as contract status of water supply and sewerage, branching position of service connection, presence or absence of groundwater pump, illegal water suction pump, meter, etc. In addition, House No. was re-numbered to GIS by field survey result.

As a result, mapping of Sarfraz Colony Pilot Area was developed as shown in **Figure 3.1.2**. At the moment, there are still many unknown pipes and still inaccuracies remain. However, mapping was dramatically improved than the map initially held by WASA-F. Specifically, House No. is stated rather than Parcel ID on the mapping, so that the field staff can easily identify the customer's house. Through this survey, contracted customers for water supply, unregistered customers and unconnected customers (potential customers) were identified, and also water supply situations such as installation of groundwater pumps, illegal suction pumps, meters were collected. All information was reflected on mapping and visualized. So, various data can be easily found from mapping such as pipe size of distribution pipe, location of service connection, branching point, valve location, etc.

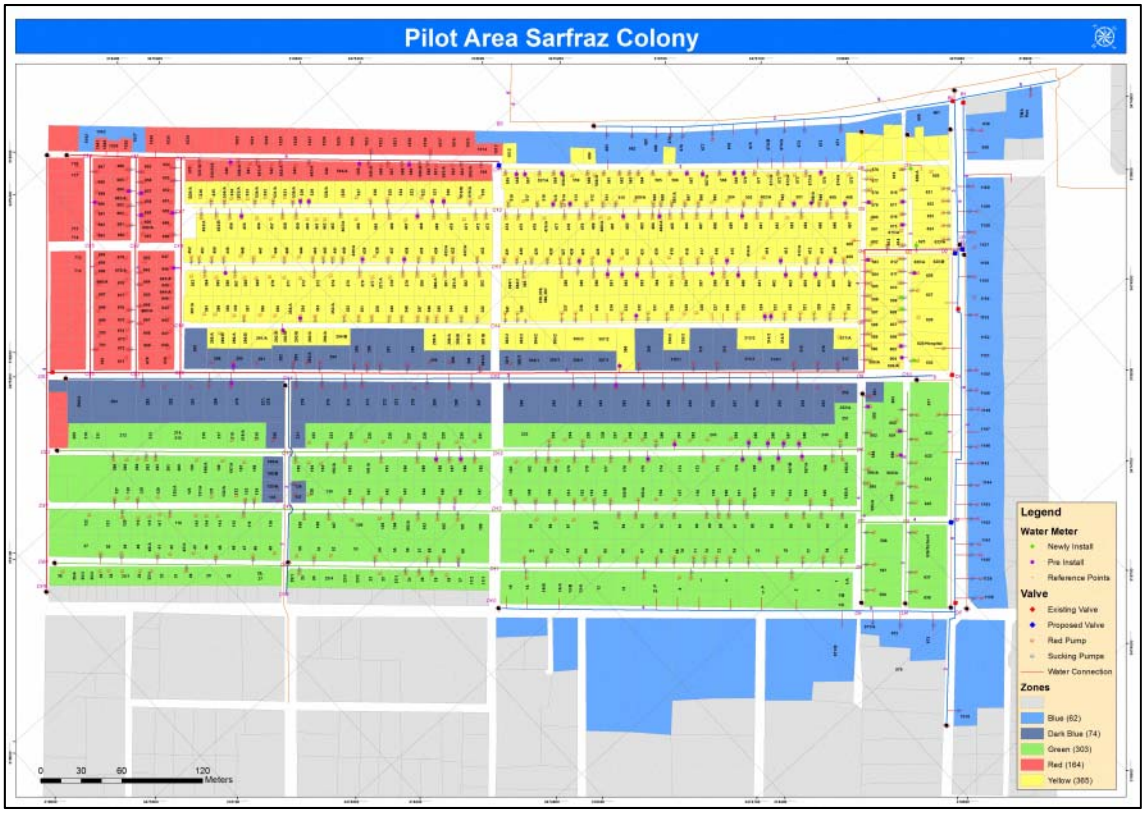


Figure 3.1.2 Mapping of Sarfraz Colony Pilot Area

Through this field survey, information of billing system and customer ledger were also modified to accurate one. During these processes, 37 unregistered customers were detected and changed to regular customers.

As described above, by developing the maps and the customer ledger, an appropriate mapping and customer management system were established in Sarfraz Colony Pilot Area, and data management platform was also constructed.

It already became habit for field staff to bring this mapping to the field at all times and engage in day-to-day operation. And even when changes in mapping occurred in the field, such as new installation, repair work and meter installation, a system was also established to constantly record new information on their mapping and report it to the GIS Cell.

3.1.2 Improvement of Water Supply Services

(1) Extension of Water Supply Time

WASA-F operates TR 3 times for 2 hours in a day, and operates New JK WTP for 12 hours with one pump. However, outside of operating hours of TR, water could not flow into Fawara Chowk GST from New JK WTP only with one pump. Therefore, SMART WASA decided to operate two pumps in New JK WTP and achieved 12-hour water supply in Sarfraz Colony Pilot Area.

In addition, it was analysed that proper water distribution management system in both, Sarfraz Colony and Peoples Colony was very difficult because capacity of OHR is small. Therefore, Peoples Colony was separated from distribution area supplied from Fawara Chowk OHR. New pump and outlet pipe were installed and it was switched to direct pump supply system from Fawara Chowk GST to Peoples Colony (for tank operation simulation in Fawara Chowk GST and OHR, see **Appendix AF3.1**).

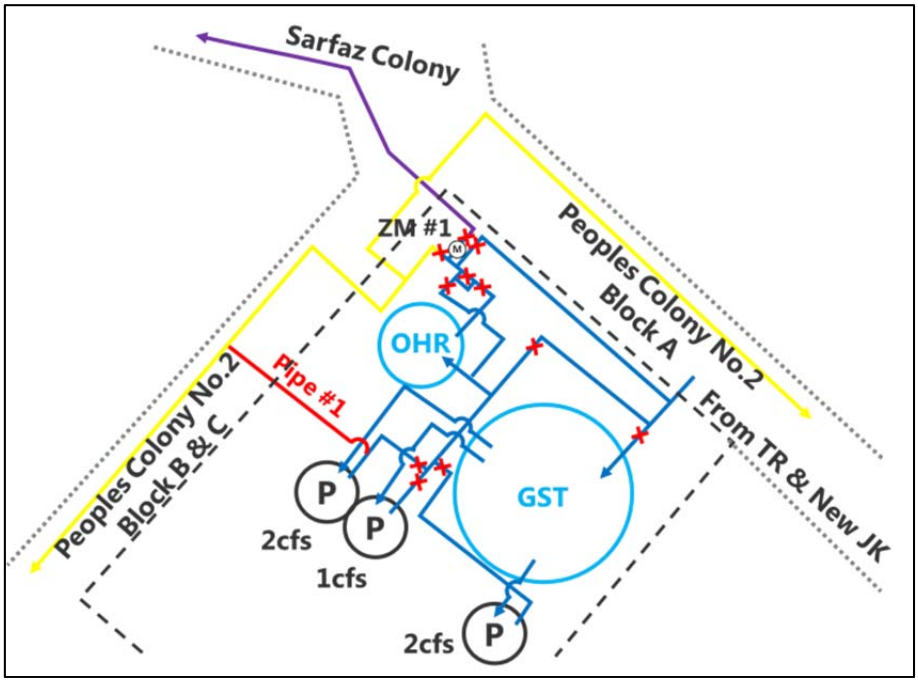


Figure 3.1.3 Pipelines inside Fawara Chowk GST

(2) Ensuring of Proper Water Pressure

Height of Fawara Chowk OHR is not enough and even if it is full, only 21.6 m of water level is secured. In Punjab design criteria, it was described that terminal pressure should be secured more than 12 m. Hydraulic analysis was conducted when hydraulic separation in pilot area was achieved, and it was confirmed that proper water pressures will be secured in pilot area (for hydraulic analysis result in Sarfraz Colony Pilot Area, see **Appendix AF3.2**).

(3) Ensuring of Safe Drinking Water

When regular water supply and proper water pressure are ensured and pump suction is eliminated, risk of wastewater contamination will drop significantly. Therefore, safe drinking water should be achieved by 12-hour water supply and proper pressure.

(4) Establishment of Water Distribution Management System

For achievement of 12-hour water supply, SMART WASA made “Fawara Chowk OHR Log book” for pump operator and the OJT for pump operators was implemented (for Fawara Chowk OHR log book, see **Appendix AF3.3**). Initially the operation had to be suspended for a while due to water leakages in pilot area, power suspension and lowering of water level in OHR, however, by using log book and OJT for about two weeks, it became possible to continue 12-hour water supply.

To achieve the hydraulic separation of distribution area, pipelines connected to the outside of pilot area were sequentially disconnected. Construction record sheet was prepared by SMART WASA and all disconnection works and repair works were recorded (for construction record sheet, see **Appendix AF3.4**). However, as a result of excavation, many unknown pipes not shown in GIS (duplicated pipelines) were found. It took a considerable cost and time for these disconnection works. Considering water supply amount and leakage amount, initially, outflow of Fawara Chowk OHR to Sarfraz Colony Pilot Area was assumed to be 100 m^3/h, however, 200 m^3/h of water is still flowing out from OHR. It is obvious that not all the pipelines connected to the outside were disconnected, and it cannot be said that hydraulic

separation has been achieved at present. Since pilot activities increased the number of operating pumps at New JK WTP from one to two, stored energy was wasted. It is necessary to take measures such as achieving hydraulic separation.

Duplicated Pipeline

Duplicated Pipeline

To establish proper distribution management system, many pipes connected to outside were disconnected. Many duplicated pipelines were also disconnected to make only single pipelines operable.

Outline of DMA creation work is as shown in **Table 3.1.1**. WASA-F spent 5.37 million PKR, however hydraulic separation has not been achieved yet because of inaccurate GIS data and unknown duplicated pipelines.

Table 3.1.1 Outline of Construction for DMA Creation in Sarfraz Colony Pilot Area

Actions	Quantity	Budget (million PKR.)
Valve Installation	DN200:1, DN150:2, DN75:4	0.30
Pipe Disconnection	13 points	0.10
Pipe Installation	DN200:500m, DN150:600m, DN75= 200m	0.97
Connection Shifting	12 places	0.10
Pump Installation	2 x 204m^3/h	3.20
Zonal Meter Installation	DN200	0.30
Leakage Repair	28 points	0.15
Pump Repair		0.10
Valve Repair		0.05
Pipe Repair		0.10
Total		5.37

(5) Starting of New Services

Though hydraulic separation was not achieved, by cutting 13 points of connection to outside, WASA-F could reduce water outflow from OHR to achieve 12-hour water supply. In this way, all customers won't be using water at the same time as in the case of short water supply hours, therefore, water pressure was improved. Securing more than 12 m at terminal pressure described in the Punjab design criteria has still not been achieved, but now it is possible to secure water pressure of about 7-10 m on average in Sarfraz Colony Pilot Area. The contamination observed at pipe ends in the past was solved and has not been reported.

Therefore, in September 2017, official new services (at least 12-hour water supply, more than 7m of water pressure and no contamination) in Sarfraz Colony Pilot Area were announced to customers and ceremony was held.

The activities for the start of new services is as shown in **Table 3.1.2.**

Table 3.1.2 Activities up to New Services in Sarfraz Colony Pilot Area

Date	Action	Pressure	Outflow from OHR	Evaluation
2016/10/27	Pressure Survey	1.7m (Block A)		Difference between GIS data and the actual field conditions was confirmed.
2016/11/10	Pressure Survey	0 m (St. #2 pipe end)		No Water at pipe end and contamination was observed.
2017/7/12	Pressure Survey		200 m^3/h	Identified the cause of low water pressure as customers' water use behavior. 200m^3/h of outflow from OHR was observed.
2017/7/14	Pressure Survey	3m (St. #7)		Because 8 inches of valve was closed, it open and there was still water in St. #7.
2017/7/22	Completion of Valve Installation			Seven valves installation for step-test was completed.
2017/7/24	Trial Operation of Bypass Supply	16m (Block A)		Good pressure was observed.
2017/7/27	Trial Operation of 12-hour Supply		230 m^3/h	OHR became empty. Trial was failure.
2017/8/1	Trial Operation of 12-hour Supply			10-hour water supply was achieved.
2017/8/2	Step-test			Water escaping was confirmed at block A.
2017/8/7	Trial Operation of 12-hour Supply		260 m^3/h	16-hour water supply was achieved.
2017/8/9	Pipe Disconnection			Two pipes (3 inches, 4 inches) were disconnected.
2017/8/12	Pipe Disconnection			Two pipes (6 inches, 8 inches) were disconnected.
2017/8/15	Water Flow Survey		185 m^3/h	185 m^3/h of outflow from OHR was confirmed and it was confirmed that a new service can be started.
2017/8/23	Pipe Disconnection			Many duplicated pipelines were found.
2017/8/28	Pressure Survey			Pipe was connected internally, no water in St. #2, #3 was solved.
2017/8/29	Pressure Survey	At least 7m		At least 7 m of pressure was ensured in all Sarfraz Colony Pilot Area.
2017/9/15	New services			Official new services were started in Sarfraz Colony Pilot Area.

3.1.3 Meter Installation and Establishment of Meter Reading System

(1) Meter Installation

To shifting to metering system, meter should be installed properly and meter readings should be recorded carefully by meter readers. 121 meters were installed in Sarfraz Colony by French Fund Project but only 71 meters were able to be detected from field survey. Many improper meter installations were also observed. So, in pilot activities, all meters were re-installed according to new meter installation manual and SOP.

In November 2017, meter installation method was examined, and manual and SOP were prepared by SMART WASA. After that, the cost of meter installation was calculated, and WASA-F began installing to all households in pilot areas from February 2018. The total 566 meters installation was completed in the end of September 2018. Since then the customers has increased, total 577 meters were installed in Sarfraz Colony Pilot Area.

Many stuck/faulty meters were detected (at least 12 stuck meters were reported), WASA-F had to replace them, so it took more time to install meter than the initial schedule. If the contractor did not comply with the SOP, JMT made them re-install the meters and thoroughly comply with the installation standards.

From meter installation activity in Sarfraz Colony Pilot Area, it became clear that, 10 to 12 meters a day could be installed for exposed pipeline and 2 to 3 meters a day when excavation was required, following the meter installation SOP. This performance was reflected on the meter installation plan in Madina Town Pilot Area.

(2) Situation of meter installation following new standard (SOP)

New SOP was strictly followed, all meters were installed to outside the premises with a check valve and a stop-cock. Installation of meters was completed keeping in mind the meter reading conditions.

Installing meter outside the premises is a standard, installation cost per household took about 3,000 PKR. Often the installation of the meter required excavation. There were Ramadan and the national elections during the meter installation activity so progress of meter installation was slow. On the average, number of installations was almost 4 points per day.

Straight connection

Narrow space connection

Connection on a slope

(3) Establishment of Meter Reading System

Since WASA-F has not had experience of implementing meter reading so far, meter reading and inspection SOP were created by SMART WASA. Meter reading zones were determined. Sarfraz Colony Pilot Area was divided into 18 meter reading zones and meter reading books (meter reading record sheet) were prepared for each zone. It is one page per customer, and meter reading history can be recorded for one year. For pilot activities, two meter readers were selected from WASA-F in the examination and meter reading OJT was carried out in Block A meter reading zone utilizing trial installed 43 meters.

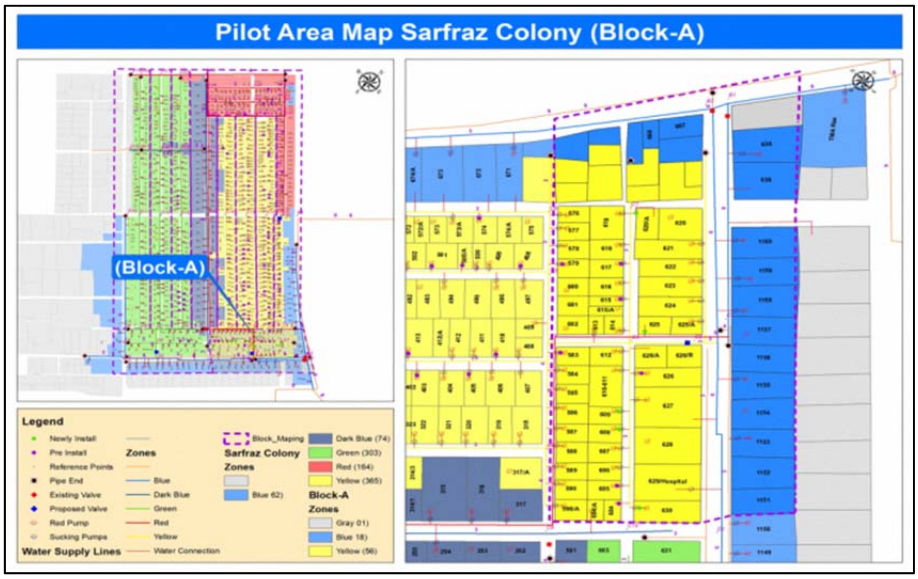


Figure 3.1.4 Meter Reading Zone in Sarfraz Colony Pilot Area (Block A)

(3) Meter Reader Training

In February 2018, official first meter reading was implemented in Sarfraz Colony Pilot Area Block A. Considering the importance and accuracy of meter reading, Revenue & Recovery staff was assigned for meter reading. At the beginning of March 2018, meter reading was started for each meter reading block.

In September 2018, six months meter reading results were obtained and unfortunately, more than 10% of meter reading results highlighted abnormal water consumption including faulty meter, meter stuck and misreading, etc.

JMT confirmed the meter reading results one by one together with R&R staff and training was conducted for checking the meter reading results. The checking system was finally established in WASA-F.

Also, from July 2018, WASA-F printed on the invoice not only the current flat-rate tariff but also the tariff for the case of shifting to metering system individually for reference and announced the shifting to metering system to customers.

3.1.4 Billing Collection and Customer Satisfaction

In Sarfraz Colony Pilot Area, three improvements for water supply services were officially announced, such as 12-hour water supply, proper water pressure and drinkable water quality. In order to appeal new services to the residents, in September 2017, a new services commemorative ceremony was held in Fawara Chowk OHR. In this ceremony, delegates from the area, as well as newspapers and television, were invited and new services were widely announced. In addition, Urdu language brochures were created for target customers of the new services and distributed to all customers. Banners were also set to announce new services to the roads in Sarfraz Colony Pilot Area.

Along with the improvement of the water supply service, the implementation of various campaigns such as distributing brochures, displaying banners, and promoting new services by door-to-door visits made it possible for customers to realize that WASA-F services are improving. This has resulted in sharp increase in newly registered customers.

The number of new customers increased as customer satisfaction improved, the billing collection rate has improved much more than before.

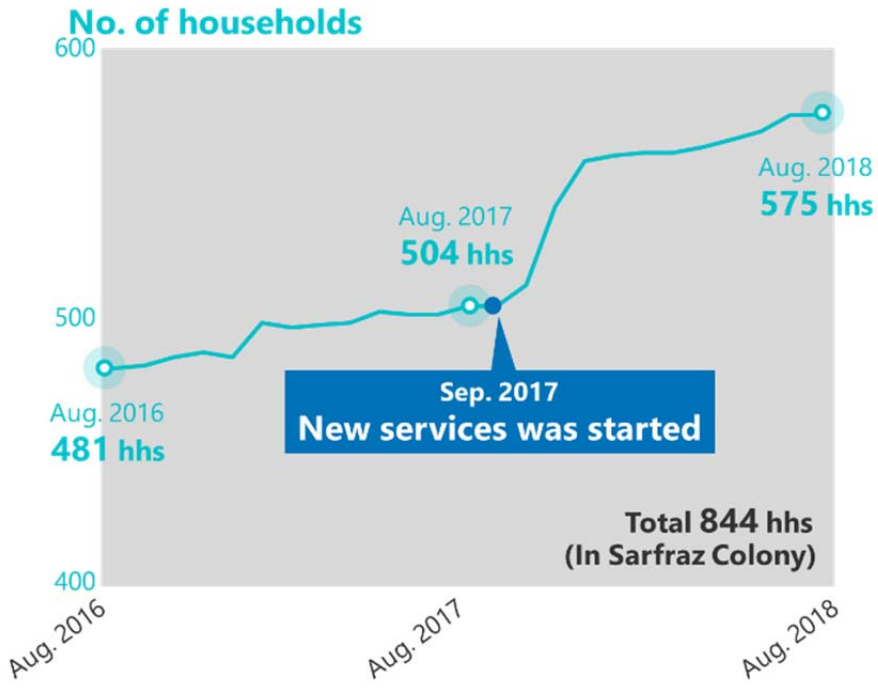


Figure 3.1.5 Start of New Service and Change in the Number of Customers

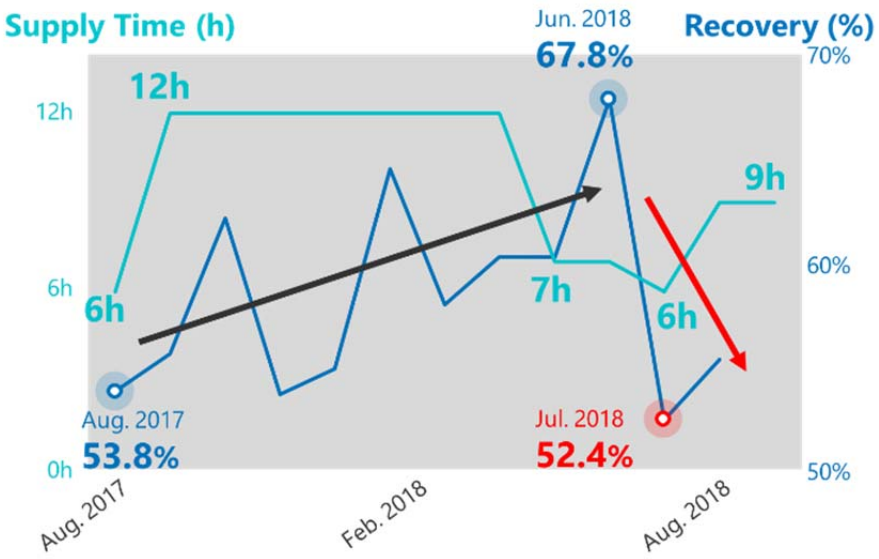


Figure3.1.6 Relationship between Water Supply Time and Customer Payment

According to **Figure 3.1.6**, payment rate of customers was particularly high when 12 hours of water supply was achieved.

The increase in the number of customers improved total revenue (about 15% improvement in the Sarfraz area) without shifting to metered rates tariff. On the other hand, in the Sarfraz area, there was a time when it was not possible to secure water supply for 12 hours due to the issues such as canals closure period leading to non-operation of water treatment plants, power failures, or low awareness of staff to handle the operation after the start of the new service. At this point, the improved revenue recovery rate dropped significantly. It was an opportunity for WASA-F staff to feel the importance of continuing the water supply service which can satisfy customers.

Customer situations in Sarfraz Colony Pilot Area as of January 2018 were organized as shown in **Figure 3.1.3**.

From November 2016 when the pilot activities were started, 37 unregistered customers were detected and changed to regular customers and 45 new customers were added. There are still 290 potential customers in Sarfraz Colony. For revenue recovery, it is important not only to reduce unpaid customers, but also to incorporate these potential customers as new customers.

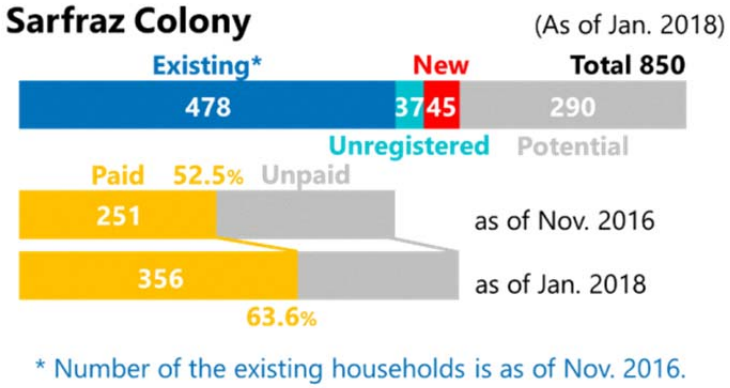


Figure 3.1.7 Customer Status in Sarfraz Colony Pilot Area

Based on the expected increase in the number of customers, a survey was conducted to explore the possibility of shifting to metered rates, and as the water supply service improved, customers understood that water for living could only be provided by WASA-F. At the beginning, the transition to metered rates was also positive.

Even in the unannounced door-to-door interview survey by JMT, no critical complaint was received from customers.

WASA-F decided the schedule of shifting to metering system after the completion of meter installation.

Since the transition from flat to metered rate was new system for WASA-F, they needed more time to make preparations for implementation. After a lot of experience, it was shifted to metered rate system in December 2018. Since the preparation period was set for about one year, it was possible to shift without major confusion. In addition, the motivation of the staff to acquire new customers and increase the tariff collection was improved. As a result, the tariff collection rate was increased to 170% in the whole city.

3.1.5 Changes in Situation by Pilot Activities in Sarfraz Colony

The changes in situation of water supply service at the beginning of the pilot activities (November 2016) and the after activities (May 2019) in Sarfraz Colony Pilot Area are shown below.

Table 3.1.3 Changes in Situation by Pilot Activities in Sarfraz Colony Pilot Area

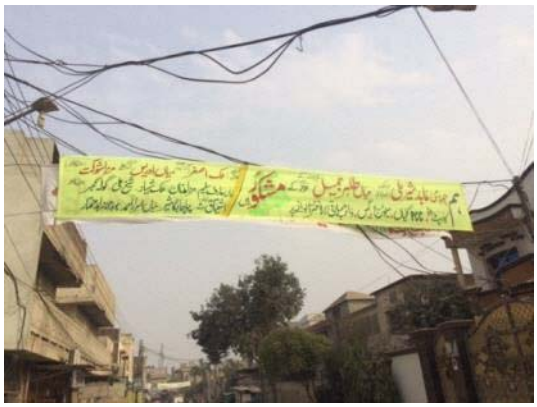
[Sarfraz Colony Pilot Area]

	As of Nov. 2016	As of Mar. 2019	
Water Tariff System	Flat-rate	**Metered-rate**	
Billed Amount	Average: 200Rs Total: 97,304Rs	Average: **271Rs** Total: **160,522Rs**	**+35.5%** **+65.0%, +63,218Rs**
Water Supply Time	3.5 hours	**12 hours**	
Water Pressure	2-3m	**7-10m**	**Water can reach 2nd Floor**
Water Quality	Contamination was observed	**Contamination was not reported**	
Bill Collection	48.2%	**56.9%**	
Nos. of Conn.	487 conn.	**592 conn.**	**+21.6%, +105 conn.**

Ceremony for New Services in Sarfraz Pilot Area

Ceremony for New Services in Sarfraz Pilot Area

Banner posting for New Services in Sarfraz Pilot Area



Banner for New Services in Sarfraz Pilot Area

New Services OJT (field)

New Services OJT (lecture)

3.1.6 NRW Reduction

In the Sarfraz Colony Pilot Area hydraulic separation has not been achieved yet, thus the water distribution analysis cannot be carried out. However, in February 2018, flow measurement and meter reading for 12 hours were carried out on one route (70 meters of length, 9 households) where hydraulic separation in the Sarfraz Colony Pilot Area was achieved, and the NRW ratio was calculated to be 26.8%. In this survey, since all customers were being grasped and all meters were newly installed, there is little commercial loss. Therefore, most of the NRW can be regarded as leakage. In French project, the leakage rate was calculated as 27%, so 26.8% is a relatively reasonable figure.

Several surveys to identify water leakages were conducted at Sarfraz Colony. **Table 3.1.4** evaluates these surveys conducted in Sarfraz Colony and their effectiveness. From the evaluation, it is assessed that the road surface survey with a leak detector is preferable in Sarfraz Colony.

Table 3.1.4 Evaluation of Surveys in Sarfraz Colony Pilot Area

Survey method	Equipment	Effectiveness				
		Good	Fair	Less	Poor	In process
Flow measurement	Flow meter					○
Step test	Flow meter					○
Door to door survey	Acoustic rod			○		
Road surface survey	Leak detector	○				
Correlation survey	Correlator			○		
Leakage identification survey	Leak detector		○			
	Hammer drill				○	
Manhole survey				○		
Meter accuracy check	Test meter		○			
Illegal connection survey	Leak detector					○
Leak repair work			○			
Pipe detection	Pipe locator			○		

Leakage Survey by Acoustic Rod

Leakage Survey by Leak Detector

Locations of road surface survey are shown in **Figure 3.1.8**. Pilot team of Sarfraz Colony detected 46 leakages and performed 37 repairs among them.

Figure 3.1.8 Locations of Leakage Survey in Sarfraz Colony Pilot Area

A total cost for the leakage survey and pipe repairs in Sarfraz Colony was 113,533 PKR as shown in **Table 3.1.5**.

Table 3.1.5 Costs for Leakage Survey and Pipe Repair in Sarfraz Colony Pilot Area

Survey Cost	Repair Cost
10,333 PKR	103,200 PKR

JMT demonstrated the leakage detection procedure in the survey at Sarfraz Colony as OJT. In addition, JMT found that many stuck and damaged water meters exist in the pilot area, although those were newly installed one year ago. Those new meters installed in the pilot area have a certain accuracy according to inspections by JMT; hence, improvement of water meter maintenance system is indispensable in WASA-F in order to control NRW.

3.2 Madina Town Pilot Area

Madina Town is the area where water is distributed mainly from Tube wells along to Rakh Branch Canal and mixed with water from TR. Water is supplied from RBC pumps directly for 2 hours 3 times a day. There is existing OHR in Madina Town Pilot Area; however, OHR was not operated due to structural problems (leakage, etc.) and non-functioning pumps.

Since water amount was insufficient for the huge water distribution area and hydraulic separation was not yet achieved, water pressure was very low (1-3 m).

In 2015, French Fund Project constructed newly 18 tube wells along to RBC to meet the demand. Along with this, a huge GST (400,000 gallon, 1818.4 m^3) was constructed by fund of Punjab government.

In 2016, JMT suggested that there is a possibility to improve water pressure, by closing the gate valves of boundary of TR supply area . WASA-F closed all boundary valves, and water pressure was improved to 4 - 5 m.

Before 2017, chlorine injection facilities had not been installed for tubewells along RBC and WASA-F was handling chlorination by mixing RBC and TR water. However, in Madina Town, water quality issues such as wastewater mixing in the water distribution pipe was repeated many times. Customer's trust in WASA-F was remarkably low. As the evidence of it, in the target area, only 30.1% (322 out of 1,040) of customers have contracts for water supply with WASA-F. To regain trust, WASA-F has implemented pipeline replacement projects (Gastro Project) twice by utilizing Annual Development Program by Punjab Government in the past.

In this pilot area, utilizing huge GST and existing OHR, hydraulic separated area was established, contamination of wastewater was eliminated by extension of water supply time, proper water pressure and good water quality was ensured, and finally, trust recovery was confirmed.

In Sarfraz Colony Pilot Area, due to duplicated pipelines, it was found that DMA creation is difficult. Based on the experience in the Sarfraz Colony Pilot Area, the approach has been changed in the Madina Town Pilot Area. A 100 mm water distribution pipe was newly installed around the water distribution management area. This design was a method to cut the crossing pipe to the outside reliably. As the empirical factor was strong, about 14 million PKR was spent as the project cost of JICA.

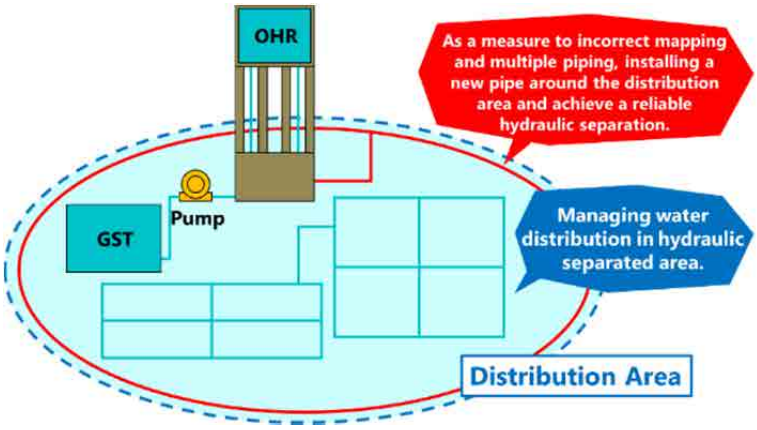


Figure3.2.1 Method for New DMA Creation

Out of multiple pipes on the same line, an appropriate one was selected and made sure that all the remaining pipes are cut and plugged. The water pressure was improved, and all connections of the pipelines within area were connected to the newly installed pipeline surrounding the pilot area to ensure that there was no water outflow and secured water quantity. This has achieved a reliable and efficient hydraulic separation of the distribution management area.

3.2.1 Establishment of Data Management System

In Madina Town Pilot Area, same as Sarfraz Colony Pilot Area, there is a huge gap between GIS, pipeline information and the site. Therefore, SMART WASA started to implement the customer survey. Survey was conducted in Sarfraz Colony Pilot Area before initiating Pilot Activities. As the project proceeded, a lot of re-surveys were necessary. To increase the efficiency of Surveys in Madina Town Pilot Area, using the experience from preceding pilot area, GIS, Water Distribution and Revenue section cooperated, survey manuals and sheets were prepared by SMART WASA. (for customer survey manual and survey sheet, see **Appendix AF3.5**).

As discussed in Sarfraz Colony Pilot Area, duplicated pipelines were also an issue in Madina Town Pilot Area. So, the network maps had also inaccurate pipeline information.

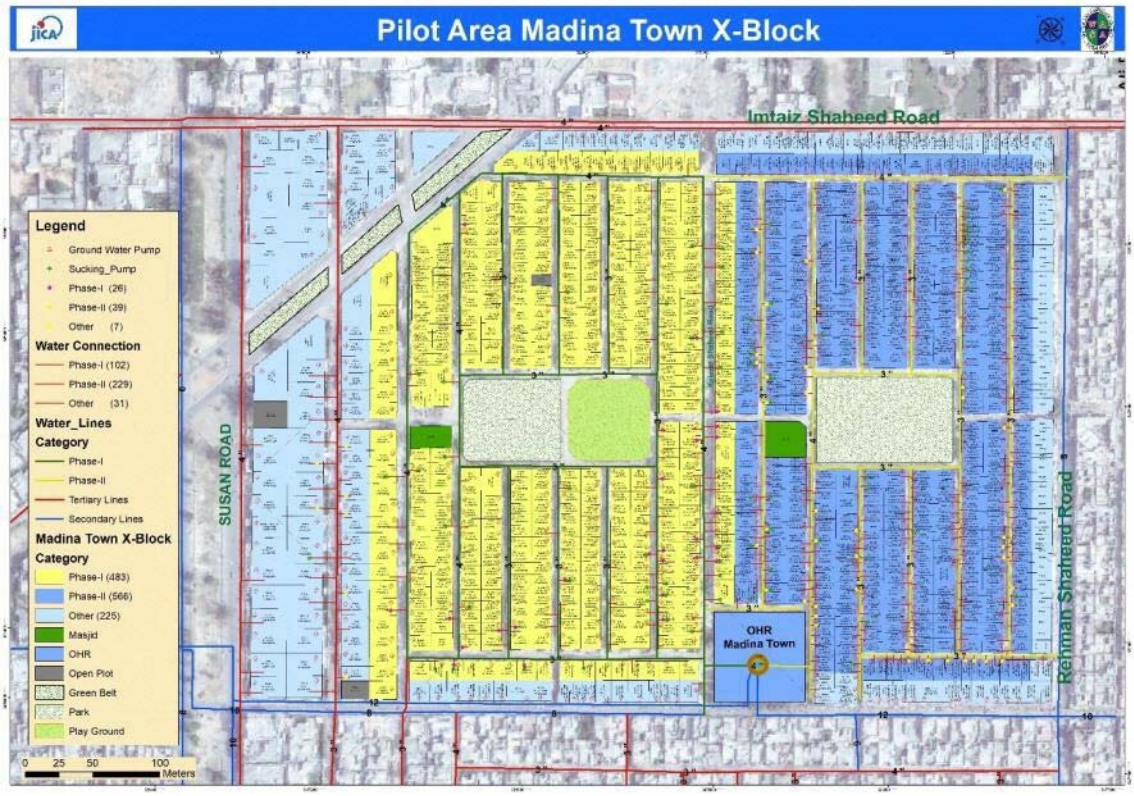


Figure 3.2.2 Mapping of Madina Town Pilot Area

From the results of customer survey, billing system and existing customer ledger were also modified to accurate ones.

As mentioned above, as a result of this customer survey, it was found that the contract rate for water supply in Madina Town Pilot Area was 30.1% (322 out of 1,040 residents). That is, there are about 700 households or more unregistered customers or unconnected residents and these customers are potential customers.

3.2.2 Improvement of Water Supply Services

(1) Extension of Water Supply Time

In Madina Town Pilot Area, water had been directly supplied from RBC using pumps. However, WASA-F constructed a huge capacity GST (400,000 gallon, 1818.4 m^3) by using budget of Annual Development Programme from Punjab government. Along with this new construction, four pumps installation, OHR rehabilitation and outlet pipe installation were completed. Pilot activities utilize these facilities and established the proper distribution management system. From tank operation simulation, pilot area was decided to limit to only Block X in Madina Town, and it was estimated that 24-hour water supply can be established.

(2) Ensuring of Proper Water Pressure

Height of Madina Town OHR is not enough and even if it is full, only 21.6 m of water level is secured same as Fawara Chowk OHR. However, hydraulic analysis was calculated when hydraulic separation in pilot area were achieved, and it was confirmed that more than 18 m of water pressures will be secured in pilot area (for hydraulic analysis result in Madina Town Pilot Area, see **Appendix AF3.6**).

(3) Ensuring of Safety Drinking Water

When regular water supply and proper water pressure is ensured and pump suction is eliminated, risk of wastewater contamination will drop significantly. Therefore, safe drinking water can be provided by extension of water supply time and ensuring of proper pressure.

However, in Madina Town, the issue of water quality accidents is very common and customer's trust towards WASA-F is remarkably low. Many customers were not using appropriate materials for connecting WASA-F service pipe to household to ensure safe water supply avoiding sewer water mixing. When installing meter, it is necessary to show WASA-F's positive attitude to customers by changing these bad materials to appropriate ones.

(4) Establishment of Water Distribution Management System

In Sarfraz Colony Pilot Area, it was difficult to achieve hydraulic separation because of inaccurate GIS and duplicated pipeline. Thus, for promoting more efficient and reliable hydraulic separation of the water distribution area, JMT decided to install new HDPE pipe of 100 mm that goes around the periphery of the pilot area, disconnect all pipelines connecting to outside of the Madina Town Pilot Area (Block X) and reconnect all distribution mains within the same block.

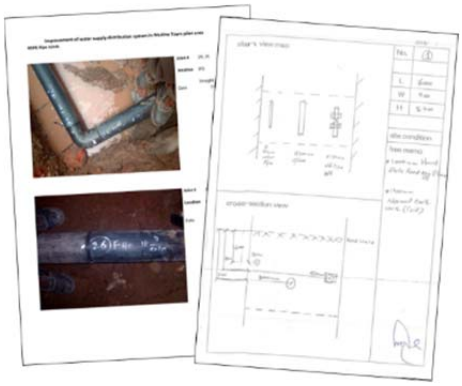
Figure 3.2.3. DMA Creation in Madina Town Pilot Area

A tender for this new DMA creation work was held in February 2018, and a contract was signed with local contractor, and construction work was started.

Japanese style of safety management system was instructed to contractor in the field and contractor had to submit construction photos, plan view and cross-section view of excavation, joint check sheet, etc. every Monday for quality control.

Appropriate Safety Management

Quality Control for Joints



Thorough Control of Japanese-Style Construction Management

In July 2018, all DMA creation work was completed. Construction procedure of DMA creation work were followings.

- The roads all over at all intersections were excavated.
- All test pits at intersections were excavated more than 2.0 m (in fact, some old duplicated pipes were found at depth of 2.05 m)
- When duplicated pipelines are found, only one pipeline was selected, and all others were disconnected.
- Any pipelines connected to the outside of pilot area were disconnected.
- Construction management was instructed to the contractor in the field and the contractor had to submit drawings and records of the works such as construction photographs, plan view and cross-section view of excavation, all joint check sheet for quality control.

The activities up to the new services in the Madina Town Pilot Area are as shown in **Table 3.2.1**.

Table 3.2.1 Activities up to New Services in Madina Town Pilot Area

Date	Action	Pressure	Outflow from OHR	Evaluation
2017/8/22	Meeting			It was decided to outsource construction for DMA creation.
2017/8/24	Field Survey	2-3m (average)		Field survey was implemented to design the pipe installation.
2018/2/8	Contract with contractor			
2018/2/27	Start of construction works			
2018/5/14	Pressure Test			The decrease in water pressure of the new pipe was within the allowable range.
2018/7/16	Completion of construction works			
2018/9/5	Trial Operation for 12-hour Supply	7-10m (average)	$90m^3/h$	Consideration of pressure rising, 1-hour operation was tried. No serious leakage or pipe burst was observed.
2018/9/13	Zero Pressure Test and Step-test			One water escaping was detected, and valve was closed. Hydraulic separation was achieved.
2018/9/16	Leakage Repair	12-15m (average)		Two leakages were repaired, and pressure was improved.
2018/9/22	Trial Operation for 12-hour Supply			12-hour water supply was achieved.
2018/10/1	Official New Services			

The outline of construction for DMA creation in the Madina Town Pilot Area is as shown in **Table 3.2.2**. (For detail construction completion books, see **Appendix AF3.7**).

Table 3.2.2 Outline of Construction for DMA Creation in Madina Town Pilot Area

Construction Cost	136,640USD (almost 15 mil JPY)
Installation Pipe Length	1,740 meters (HDPE DN100mm)
Number of Test Pit	59 points
Depth of Test Pit	Maximum 2.50 meters
Depth of old pipeline	Maximum 2.05 meters
Number of Disconnected Pipeline	49 points
Number of Connected Pipeline	23 points
One Day Work for Pipe Installation	10 meters/day (5 persons, depth: 0.5~0.8m)
One Day Work for Excavation	1 point/day (3 persons, W=2, L=1, H=1.5)

During the new pipeline installation activities, on the WASA-F side, the construction of Ground Storage Tank (GST), inlet pipe to GST and a new pump station and the rehabilitation of OHR were implemented and all the construction works were completed by the end of June 2018.

Same as in the Sarfraz Colony Pilot Area, “Madina Town OHR Log book” for pump operator was prepared, and pump operator OJT for 12-hour operation was implemented (for Madina Town OHR log book, see **Appendix AF3.8**). Trial operation from Madina Town OHR started in September 2018. Considering the risk of water leakage or pipe burst in the pilot area due to the water pressure rising, starting from operation for 1 hour and a half on the first day, patrolling within the pilot area, and gradually the operation time was extended. Through customer survey in all streets, overflow from customers' roof-top tanks, leakages, and illegal connections were detected. At the beginning of the trial operation, very low water pressure was confirmed but after repairing the leakages, water pressure dramatically increased. Water pressure of roughly 10 meters was secured. In September 2018, 12-hour water supply was achieved. After that, many surface water leakage were detected and repaired. Finally, 18 m of pressure was ensured.

(5) Starting of New Services

In the Madina Town Pilot Area, based on the experience in the Sarfraz Colony Pilot Area, complete hydraulic separation was established with new methods and achieved 18 hours water supply. It is also possible to secure 24-hour water supply by calculation from the outflow of the OHR tank. It has been observed that with prolonged water supply, the sewerage system lacked capacity to handle the quantity of water being supplied and overflowing of sewers occurred. So, by enhancing the sewerage and drainage capacity, it is expected to maintain 24-hour water supply in the future. 24 hours water supply is desirable for safe water.

In addition, water pressure of more than 18 m was secured. Initially, water leaks frequently occurred due to poor construction and use of poor quality materials at joints of water distribution pipes and water supply branches, etc., and water pressure was only about 10 m. However, water pressure of 18 m or more was secured by instructing and repairing the water leakage. A ceremony was held in January 2019 and the launch of a new service in Madina Town Pilot Area was declared. It was also declared to supply water for 24 hours in the future. The water supply and distribution management system implemented by JICA at Madina Town Pilot Area has had a great positive effect. With the construction of a complete DMA, 18 hours of water supply was achieved and a water pressure of 18 m was secured. A special water supply area has been achieved in Faisalabad.

Ceremony for new services

Newsletter about new services

3.2.3 Meter Installation and Establishment of Meter Reading System

(1) Meter Installation

In Madina Town Pilot Area, WASA-F installed meters in 2017. These meters were installed outside of premises using mild steel cage. However, there are many cases where the meter cover did not have enough space to be opened and check reading, installation in the vertical direction, using many unnecessary bend pipes, etc. Therefore, they should be re-installed with new meter installation standard.

The original plan, as of April 2018, was to install customer meters in Madina Town Pilot Area within two months from July 2018. However, meter installation in Sarfraz Colony Pilot Area was greatly delayed, so installation began in September, 2018.

A number of issues have been identified in the installation of water meters in the Sarfraz Colony Pilot Area. There is a lack of practical experience in the contractor for meter installation, a lack of ability to supervise by the WASA-F staff who manage the progress of the meter installation, and a shortage of manpower for the project project. The contractors understood that the installation of meters was an important task for water supply operators (WASA-F) at Faisalabad. In theory, it is possible to install 30 units a day, so in Madina Town Pilot Area, the installation period for approximately 400 customers was set as one month, and as a result of installation including verification, it takes approximately one month. Installation of the meter has been completed. From this, it could be demonstrated that it is possible to install 20 to 30 meters a day.

Madina Town Pilot Area has experienced dramatic changes in water supply services, resulting in a large number of new interested customer.

(2) Establishment of Meter Reading

Same as Sarfraz Colony Pilot Area, meter reading zones were decided by SMART WASA in Madina Pilot Area as shown in **Figure 3.1.2**. Meter reading books for each zone were prepared.

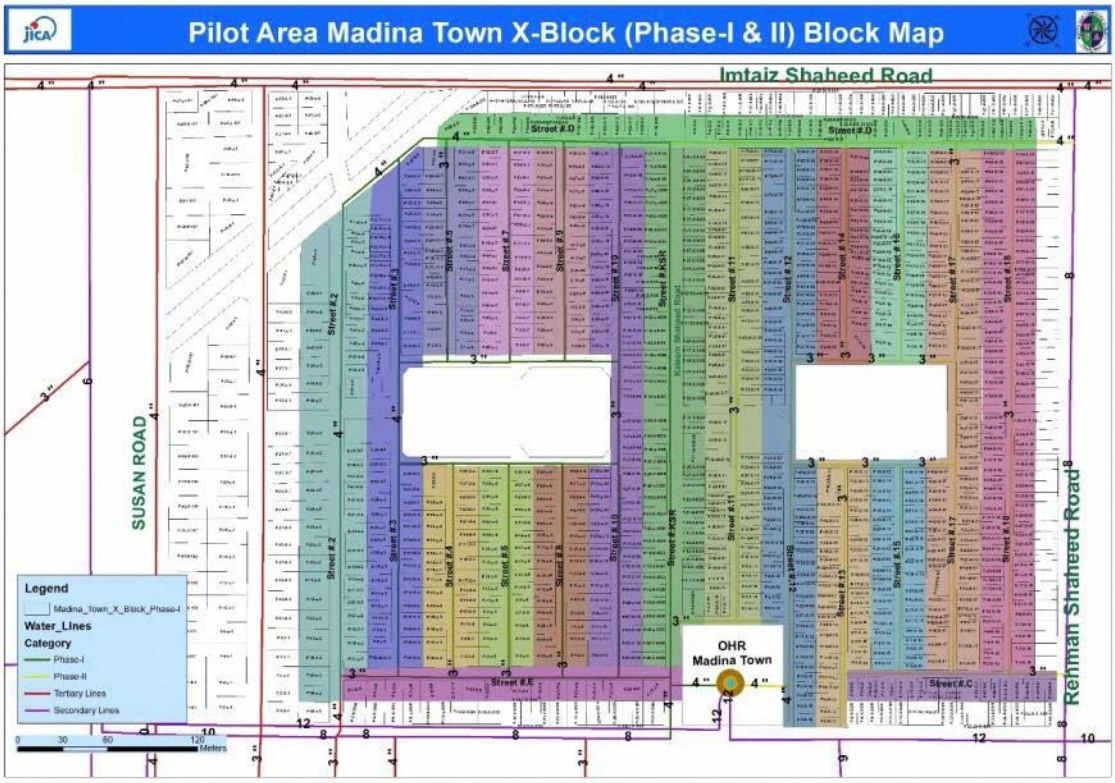


Figure 3.2.4 Meter Reading Zone in Madina Town Pilot Area

3.2.4 Billing Collection and Customer Satisfaction

Bill collection ratio and customer satisfaction was very low in Madina Town. In September, 2018, complete hydraulic separation of the Madina Town Pilot Area (Block X) was confirmed. Also, since the schedule of the installation of the water meter was planned, it was decided to shift the metering system beginning in January of 2019.

The guidance period for new water supply services to customers is not enough. A new service campaign was conducted with WASA-F staff to provide effective guidance. Many field staff also participated in the activities, and carried out OJT activities for WASA-F staff. The WASA-F staff also gave a positive attitude and more than 10 staff explained their water supply service levels to the customers one by one. The R&R, CLC, and WDM sections functioned together for the first time. It was recommended to carry out this activity in other areas and prepare for meter tariff system charges, instead of making it a one success case.

By holding a commemorative ceremony of the special supply service, the media featured the improvement of the water supply service in Madina Town on a big scale. In the area, campaigns had been implemented individually, such as door-to-door visits and banner postings, but the ceremony was the most effective. Immediately after the ceremony there was an increase in received applications for new connection.

Customers who had meters installed since December 2018 were planned to shift to meter rates. Compared to the Sarfraz Colony Pilot Area, which has already been shifted to meter rates, the Madina Town Pilot Area has high service levels in terms of water supply time, water pressure and water quality, so there are less obstacles to the transition to meter rates. In response to this, meter rates were started from the January 2019 invoice.

In order to improve customer satisfaction, a special team was formed in three divisions, SMART-WASA, CLC, R & R, and WDM, and brochures were delivered to all customers one by one to guide new services. Due to the high level of service, customers who had a bad impression of WASA-F services were able to gain trust gradually. On the other hand, many customers still do not trust WASA-F because of past failures. The Madina Town Pilot Area has 350 customers out of 1,040 households, that means with contract rate of 35%, many are still non-contracted. Public relations activities are needed to be continued so that all residents become customers of WASA-F.

3.2.5 Changes in Situation by Pilot Activities in Madina Town Pilot Area

The changes in situation of water supply service at the beginning of the pilot activities (November 2016) and the after activities (May 2019) in Madina Town Pilot Area are shown below.

Table 3.2.3 Changes in Situation by Pilot Activities in Madina Town Pilot Area

[Madina Town Pilot Area]

	As of Nov. 2016	As of Mar. 2019	
Water Tariff System	Flat-rate	**Metered-rate**	
Billed Amount	Average: 144Rs Total: 46,599Rs	Average: **263Rs** Total: **91,788Rs**	**+82.6%** **+97.0%, +45,189Rs**
Water Supply Time	6 hours	**18 hours**	
Water Pressure	2-3m	**18m**	**Water can reach 3rd Floor**
Water Quality	Contamination was observed	**Contamination was not reported**	
Bill Collection	48.1%	**60.6%**	
Nos. of Conn.	322 conn.	**350 conn.**	**+9%, +28 conn.**

In Madina Town, customer numbers had not increased in these years. However, it was confirmed that a certain proportion of new customers registered after the improvement of the water supply service resulting from the pilot activity. Since the increase in the number of customers directly lead to the increase in income, WASA-F should continue to improve and promote their services for customer satisfactions.

3.2.6 NRW Reduction

In Madina Town Pilot Area, 29 valves were installed during DMA creation works. As every pipeline was separated hydraulically, it was possible to identify each the lines for leakages through step-test conveniently.

As a reference, leakage ratio of WASA-F was calculated to be 27% by the French Project and leakage ratio in Sarfraz Colony Pilot Area was also calculated roughly to be 26.8% by JMT. In Madina Town Pilot Area, assuming outflow from OHR (almost 90 m^3/h), number of households (360 households) and water consumption of customer (140 L/c/d), leakage ratio is estimated to be 25%. This rough estimation in Madina Town Pilot Area is a reasonable compared with other results.

After trial water supply from OHR from September 2018, water pressure in Madina Town Pilot Area has been increased to 10-18 m and a lot of surface leakages were observed. WASA-F already excavated and repaired two leakages.

From November 2018, leakage survey and repair work are scheduled, and leakage ratio is planned to be decreased to 20% or less.

As well as Sarfraz Colony, variety of surveys were carried out experimentally in Madina Town, and it could be said that several methods such as step test, road surface survey, leak identification survey and illegal connection survey are effective to control NRW from the evaluation shown in **Table 3.2.4**.

Table 3.2.4 Evaluation of Surveys in Madina Town Pilot Area

Survey method	Equipment	Effectiveness				
		Good	Fair	Less	Poor	In process
Flow measurement	Flow meter	○				
Step test	Flow meter	○				
Door to door survey	Acoustic rod			○		
Road surface survey	Leak detector	○				
Correlation survey	Correlator			○		
Leak identification survey	Leak detector	○				
	Hammer drill				○	
Manhole survey				○		
Meter accuracy check	Test meter		○			
Illegal connection survey	Leak detector	○				
Leak repair work				○		
Pipe detection	Pipe locator			○		

In Madina Town, night time flow measurements and step tests were first conducted; next, leakage survey was carried out from the high priority pipeline. Initially, the survey was planned in the daytime; however, due to the heavy traffic and other circumstances, the noise around the survey area was very high that would reduce the work efficiency. Therefore, the leakage survey was conducted at night time.

Figure 3.2.5 Locations of Leakage and Repair in Madina Town

Compared to Sarfraz Colony, a road surface survey using a leak detector was much efficient in Madina Town. Because the water pressure was high and the activity was carried out at night, water leakage noise

could be clearly detected. Furthermore, it was a significant result that WASA-F staff identified many illegal connections and unregistered customers through this road surface survey.

A total cost for the leakage surveys and pipe repairs in Madina Town Pilot Area was 32,426 PKR as shown in **Table 3.2.5**.

Table 3.2.5 Costs for Leakage Survey and Pipe Repair in Madina Town Pilot Area

Survey Cost	Repair Cost
10,333 PKR	22,093 PKR

There are many leakages found from pipe joints, service branches, and fittings in Madina Town Pilot Area. It is required to improve skills of plumbers and to use better quality of pipe joint and fitting materials.

Table 3.2.6, **3.2.7** and **3.2.8** present water balance (i.e. revenue water and NRW) estimations at pilot area of Madina Town. The data was obtained in December 2018 and in May 2019, that are before and after the activities in the pilot area.

Table 3.2.6 Bases of Revenue Water and NRW Estimations in Madina Town Pilot Area

System input volume ＝ Input volume from OHR	Revenue water = Consumer consumption	Billed metered consumption (Metered rate)	Depend on Meter reading volume
		Billed unmetered consumption (Flat rate)	Average of meter reading volume x unmetered consumer
	NRW ＝System input volume - Revenue Water	Unbilled metered consumption (Mosque) 30% off	2 mosque in Madina Town Pilot Area pilot area
		Unbilled unmetered consumption	Not applied in Madina Town Pilot Area pilot area
		Customer meter inaccuracies	Depend on meter accuracy test
		Unauthorize consumption (Illegal connection, unregister customer) and Leakage*	Amount of water left from all water volume

*Unregistered customers may remain. It could not separate the illegal connections from the leakage volume.

Table 3.2.7 Water Balance in Madina Town Pilot Area before Pilot Activity (December 2018)

System input volume 21,454 m^3, 100 %	Revenue water, 11,441 m^3, 53.3 %	Billed metered consumption (Metered rate), 10,841 m^3	50.5 %
		Billed unmetered consumption (Flat rate), 600 m^3	2.8 %
	NRW, 10,013 m^3, 46.7 %	Unbilled metered consumption (Mosque) 30% off, 21 m^3	0.1 %
		Unbilled unmetered consumption, 0 m^3	0.0 %
		Customer meter inaccuracies, 214 m^3	1.0 %
		Unauthorized consumption (Illegal connection, unregister customer) and Leakage, 9,778 m^3	45.6 %

Table 3.2.8 Water Balance in Madina Town Pilot Area after Pilot Activity (May 2019)

System input volume 15,807 m^3, 100 %	Revenue water 8,612 m^3, 54.5 %	Billed metered consumption (Metered rate), 6,884 m^3	43.6%
		Billed unmetered consumption (Flat rate), 1,728m^3	10.9 %
	NRW 7,195 m^3, 45.5 %	Unbilled metered consumption (Mosque) 30% off, 16 m^3	0.1 %
		Unbilled unmetered consumption, 0 m^3	0.0 %
		Customer meter inaccuracies, 158 m^3	1.0 %
		Unauthorized consumption (Illegal connection, unregister customer) and Leakage, 7,021 m^3	44.4%

The amount of NRW was reduced only 1.2 % after the pilot activities. The amount of leakage water was certainly reduced by the leakage survey. However, NRW is still high. The following reasons are considered for this situation:

(1) Re-occurrence of leakage due to poor quality of repair work and materials,
(2) Leakage from aged pipelines, which are multiple and could not be found during DMA creation,
(3) Large amount of water use by unregistered customers and illegal connections,
(4) Increase in water leakage amount resulting from increase in water pressure.

Among the pilot activities in Madina Town Pilot Area, a construction for DMA creation remarkably contributed to improve the stable water supply (18 hours/day continuous supply) with sufficient water pressure inside of the area. This was the first challenge for improvement of water supply service in the pilot area; and the next challenge is that WASA itself should reveal the dominant reasons for NRW in the area, and finding countermeasures against for NRW would be very effective and usable in improving efficiency of water-use in the whole city.

3.3 Sitara Sapna City Pilot Area

Sitara Sapna City was newly developed residential area by private developer in 2010s, richest households in Faisalabad are living.

This high-income area is located 3.2 km downstream from TR and water is coming from TR for 6 hours (intermittent water supply of 3 times). However, there is neither GST nor OHR and water is supplied from arterial main (transmission pipe) directly. During water supply time, water is supplied with pressure of pumps at TR and about 7 m of pressure is secured, however water cannot reach to their roof-top tanks. Furthermore, outside of water supply time, water is coming to distribution pipelines with pressure of intake pumps at Chiniot well-fields, however, water is just filled into distribution pipelines and pressure is almost zero and customer cannot get water from WASA-F system.

Because there is no water storage facility (neither GST nor OHR) in this area, it is not possible to verify the method of water supply service improvement utilizing existing OHR like Sarfraz Colony Pilot Area and Madina Town Pilot Area.

Fortunately, hydraulic separation is already achieved because of newly developed area. Although distribution pipe material is ACP, less than 10 years has passed since the installation.

Despite the favorable conditions that it is close to TR and the hydraulic separation is achieved, the cause of low water pressure lies in the branching method from the arterial main. Sitara Sapna City was expanded by connecting to an existing branch pipe from arterial main for supplying water to Siddhu Pura. As a result, sufficient water pressure could not be secured in Sitara Sapna City, on the other hand, the water pressure in Siddhu Pura dropped. Such unplanned expansion had been carried out in various places in Faisalabad city.

To improve the water supply services in Sitara Sapna City, it has been studied to extend water supply time and ensure proper water pressure by construction of GST and booster-pumps. Since these constructions require considerable cost and time, JMT and WASA-F discussed its feasibility and finally agreed on construction of only booster-pumps.

3.3.1 Water Supply Services Improvement

Sitara Sapna City is a newly developed residential area by private developer and hydraulic separation is already achieved. However, water supply is two hours for three times in a day, a total of six hours. Even during water supply time, water pressure is too low to supply water to rooftop tanks of customers. Unlike the two eastern pilot areas, Sarfraz Colony Pilot Area and Madina Town Pilot Area, there is neither a GST nor an OHR in Sitara Sapna City. Although improving water supply services and shifting to metering system are the final goals, services cannot be improved utilizing existing OHR. As a difference approach to improve services, JMT considered three plans.

(1) Plan 1: Water supply services improvement by construction of new GST and pump station

It was planned in inception report in December 2016 to construct new GST and booster pump station and supply water directly by pump boosting, shift to metering system and verify the customers' water saving behavior in Sitara Sapna City.

To extend the water supply time, it is necessary to construct GST (capacity: 57,000 gallons) at a position lower than arterial main and to establish a system capable of constantly receiving water from that arterial main. To ensure the proper pressure, it is necessary to install booster-pumps. In the future, community has a plan to construct OHR in Sitara Sapna City. Pilot activities considered GST construction and booster-pump installation so as to be consistent with this plan (for hydraulic analysis result in Sitara Sapna City Pilot Area, see **Appendix AF3.9**).

However, compared with other colonies, the water supply service level in Sitara Sapna City is relatively high although it is not enough, and these constructions require considerable cost and time. From these reasons, WASA-F was cautious about big investment for new facility constructions. Therefore, JMT and WASA-F discussed its feasibility carefully.

(2) Plan 2: Water supply services improvement throughout the western area by the WB Project

WB has a plan to improve western areas including Sitara Sapna City. In the WB plan, WB will install control valves in arterial main, and WASA-F closes these valves out of time of current operating and only supply to west side areas from TR. By this procedure, WASA-F will achieve 12-hour water supply in west side of Faisalabad. Phase 1 achieved water supply for 12 hours to the areas closed by Valve 1 and Valve 2 below. After that, a project by Performance Based Contract (hereinafter PBC) will implement for NRW reduction in the Phase 1 area and distribute the secured water volume to the Phase 2 area closed with Valve 2 and Valve 3.Sitara Sapna City will be covered by the WB project Phase 1.

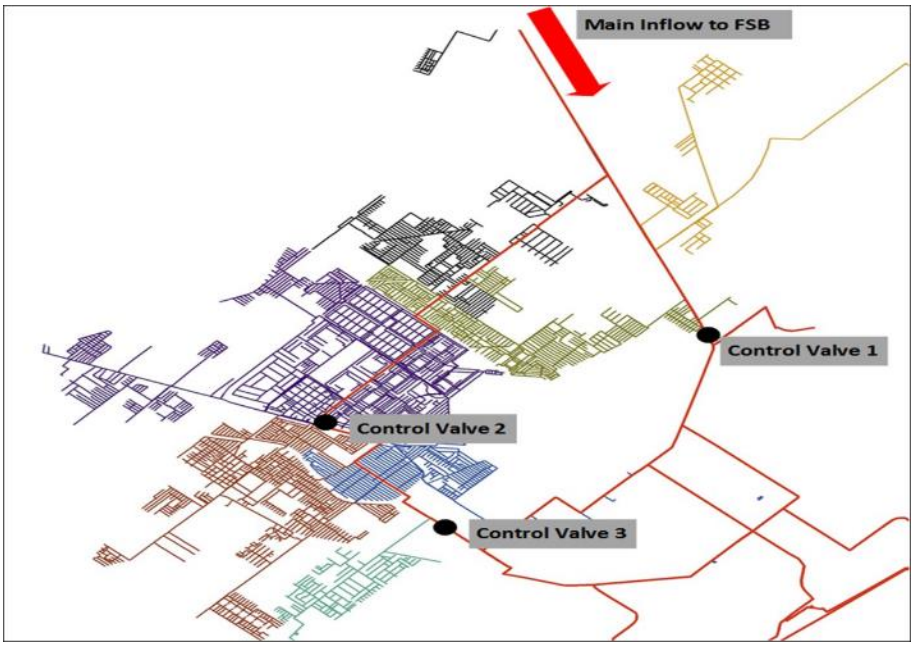


Figure 3.3.1 Image of Water Services Improvement by World Bank

Although NRW reduction by PBC is effective or not, WB approach is reasonable and water supply time extension will be feasible in these areas by this approach of WB project in the future. Once WB increases the water supply time in the western side of Faisalabad city, pressure condition will improve to some extent by customer's changed water using behavior. As customers do not always use water concurrently and simultaneously as before, head losses in pipeline will be decreased due to the decrease in instantaneous flow rate, and water pressure will be improved slightly. Hydraulic separation is already achieved in Sitara Sapna City, so distribution management is not so difficult at that time.

However, at the moment the specific implementation time of the WB project has not been decided, and the project implementation itself is unclear.

(3) Plan 3: Temporary water supply service improvement by construction of manhole with booster pump

The meter rates transition was achieved in the Sarfraz Colony Pilot Area in December 2018, and in the Madina Town Pilot Area in January 2019. The contents that were originally intended to be demonstrated in the Sitara Sapna area have already become verifiable in the other two areas. In addition, although the time is unclear, measures to improve water supply services throughout the western area are also being considered. Also, despite being inadequate, the service level of Sitara Sapna area is relatively high compared to other areas; customer satisfaction is also relatively high.

Considering the improvement by future WB project or similar approach, at the moment, it is better for WASA-F to keep the minimum investment in Sitara Sapna City.

With considering this situation, WASA-F decided to improve the temporary water supply service by installing a manhole and a booster (pressurized) pump rather than investing in the Sitara Sapna area to improve the water supply service. There was a suggestion of similar small-scale pump station exists in the Yokohama City Waterworks Bureau, and provided these know-how. In the future, implementing Plan 3 would be advance.

3.3.2 Meter Installation

In the Sitara Sapna area, meters will be installed for all households in the area on the assumption that a new service of 12 hours water supply and appropriate water pressure will be started. About 70 meters of Kent (UK) and Diehl (France) have already been installed in Sitara Sapna area, but the installation standard is not followed with the current SOP and the meters are not operating properly. The number of meters to be installed is around 300 so it is expected to be completed in 2 months duration.

It is necessary to keep this in mind that customer's water consumption will increase with water supply service improvement. So, without any water supply improvement, it is not possible to shift to metering system and there is no meaning to install meter under these situations. First of all, study of water supply service improvement is needed and it is desirable to start installing meters at the stage when the target of the shift to metering system is established.

3.3.3 Billing Collection and Customer Satisfaction

Since Sitara Sapna City is one of the elite class residential colony, it is expected that water consumption by customers is very high. Pilot activities initially planned to shift to metering system from flat-rate system, to compare the revenue income and to verify the water saving behavior of customer accompanying shifting to metering system.

However, through pilot activities, it was confirmed that customers consume water more than expected in Sarfraz Colony Pilot Area and Madina Town Pilot Area. The smaller the property, the less payment for flat-rate system. Therefore, by shifting to metering system, in these pilot areas, the expected revenue per property area will be also increased compared with flat-rate system.

In Sitara Sapna City, because of high income area, on the other hand, customer has a large property. When comparing the flat-rate and the metering system, it may not be possible to expect more revenue as much as the water consumption increasing. Sitara Sapna City needs to be carefully analyzed for its water consumption and revenue through metering system.

In Sitara Sapna City, utilizing existing 36 meters, meter reading was done, and water consumption was analyzed. Monthly water consumption per household is estimated to be 47.4 m^3, so average bill amount is about 500 PKR in metered-rate. Since average property area is about 10-20 marla (about 252.9-505.9 m^2), so average bill amount is 322 PKR in flat-rate. Therefore, although revenue increase can be expected, it depends on the amount of water consumption when shifting to metering system.

Confirming the details, while some parts of customers consume huge amounts of water, on the other hand, many customers do not use water at all and individual variations are huge. In addition, there are also many houses where in-house piping is connected to their individual groundwater and is not connected to the WASA-F system. After installing meters, WASA-F should continue to analyze water consumption and revenues.

WASA-F divides the city into two areas, East and West, and manages them respectively. Therefore, unlike the East part like Sarfraz Colony and Madina Town, meter reading system have not yet been organized in West part. Therefore, it is necessary to implement OJT and develop the capacity of meter readers.

In addition, staff of Revenue and Recovery West also has not experienced a series of work flow of meter reading, settlement, billing and collection in metering system. Making staff of R&R West participate in SMART WASA activities and implementing the OJT of billing management in Madina Town Pilot Area, WASA-F establishes an organization that allows promptly shifting to metering system in Sitara Sapna City after meter installation.

In Sitara Sapna City, The number of households is 280, of which the contract for water supply is as high as 270. Also, revenue rate is as high as about 70%, customers' reliability to WASA-F is not too low. Regarding shifting to metering system, this area is the high-income residential area, the set-up tariff of flat-rate system is originally high, and the payment increase after shifting is not so large. Sitara Sapna City is an area where there is relatively little resistance to the transition to meter rates. However, it is assumed that income will not increase dramatically as it has in the previous districts, even if it shifts to meter rates for that minute, as it is expected to get good results than other pilot areas.

3.3.4 NRW reduction

When water inflow to Sitara Sapna City was measured for 3 days continuously in September 2018, water flow was 603.7 m^3/day. Based on the meter reading result of existing 36 meters, water consumption volume was 47.4 m^3/month/household. There are 298 households and NRW ratio in Sitara Sapna City was estimated to be 22.0%.

Considering that the average NRW ratio in WASA-F is about 50% to 55%, 22% of NRW ratio is very low because of less than 10 years of pipe age, and the priority to invest in NRW reduction activities is also low. According to WASA-F, this figure is an acceptable value in Punjab provincial government.

On the other hand, in Sitara Sapna City, hydraulic separation was achieved, and it can be said that it is an ideal area for conducting the NRW amount measurement and water distribution analysis.

In addition, WASA-F divides Faisalabad city into two areas, East and West and manages each area. Technological transfer of NRW reduction has already implemented in Water Distribution and Maintenance East in two pilot areas. On the other hand, it is not implemented yet in Water Distribution and Maintenance in West.

Considering these points, JMT will instruct the methods of NRW reduction activities only for the purpose of technical transfer for the staff of WDM West. As a large investment to NRW reduction is not necessary in Sitara Sapna City, JMT will not aim for substantial reduction, and will give appropriate advice to the voluntary activities of WASA-F.

CHAPTER 4 OUTCOMES AND FUTURE CHALLENGES

4.1 Outcomes

This chapter presents the specific activities and outcomes of the pilot activities in detail. The outline of situations of water supply services at the beginning of the pilot activities (November 2016) and the current situation (March 2019) are summarized below.

Table 4.1.1 Changes in Situation Before and After Pilot Activities

[Sarfraz Colony Pilot Area]

As of Nov. 2016	
Water Tariff System	Flat-rate
Billed Amount	Average:200Rs, Total: 97,304Rs
Water Supply Time	3.5 hours (1-1.5 hours x 3 times)
Water Pressure	2-3 m
Water Quality	Contamination was observed.
Bill Collection	48.2%
Nos. of Connection	487 Conn.

As of Mar. 2019	
Water Tariff System	Metered-rate
Billed Amount	Average: 271 Rs, Total: 160,522Rs
Water Supply Time	12 hours
Water Pressure	7-10 m Water can reach 2nd floor
Water Quality	Contamination was not reported.
Bill Collection	56.9%
Nos. of Connection	592 Conn. +105 Conn. +21.6%

[Madina Town Pilot Area]

As of Nov. 2016	
Water Tariff System	Flat-rate
Billed Amount	Average: 144Rs, Total: 46,599Rs
Water Supply Time	6 hours (2 hours x 3 times)
Water Pressure	2-3 m
Water Quality	Contamination was observed.
Bill Collection	48.1%
Nos. of Connection	322 Conn.

As of Mar. 2019	
Water Tariff System	Metered-rate
Billed Amount	Average: 263Rs, Total: 91,788Rs
Water Supply Time	More than 18 hours
Water Pressure	18 m Water can reach 3rd floor
Water Quality	Contamination was not reported.
Bill Collection	60.6%
Nos. of Connection	350 Conn. +28 Conn. +9%

4.1.1 Establishment of Taskforce Team "SMART WASA"

In the pilot activities, a cross-organizational and cross-hierarchical taskforce team (SMART WASA) was established in WASA-F to promote information exchange within the organization. By bringing together members from revenue section, water distribution section, planning section and GIS section, it was possible to jointly implement action plans for improvement of water supply services, customer satisfaction and billing collection. From the director to field staff, goals and details of independent activities became integrated and project objectives were implemented together.

The achievements of this team were evaluated, and now all members are allowed to participate in the management meeting. Not only field staff but also non-regular employees can directly report their activities to managing director and executives. It is a major change from the hierarchical structures often seen in Pakistan.

In addition, by carrying out work that is usually not in their job descriptions, the staff understood the relationship between the work of their own department and the work of other departments and how they affect each other. Through such development of relationships and exchange of various ideas, effective OJT was achieved. This is one of the positive results of forming this taskforce team.

4.1.2 Increasing Revenue

In the pilot activities, various activities were promoted through SMART WASA in order to transform the business operation of WASA-F into a virtuous circle.

Improving water supply service and customer satisfaction resulted in new customer acquisition and profitability improvement in the pilot areas. The shift from flat rate system to meter system rate, and the increase in the unit price of the customer, led to an increase in revenues for WASA-F.

In addition, registration of unregistered customers and payment promotion campaigns were carried out throughout the city. As shown in **Table 4.1.2**, the billing collecting action plan started in pilot activities clearly resulted in increase of revenue.

Table 4.1.2 Revenue Collection Results, Month-wise Recovery Comparison (July 2011 - February 2018)

million PKR

	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
Jul.	27.00	25.58	46.09	47.03	54.61	49.10	68.31
Aug.	53.96	26.54	49.09	53.43	57.98	66.50	**84.94**
Sep.	25.45	45.89	60.11	55.15	49.19	48.96	**71.17**
Oct.	50.30	50.14	48.01	54.08	57.83	57.16	**88.60**
Nov.	24.66	51.26	53.60	49.00	51.19	62.59	**73.82**
Dec.	52.10	49.32	59.70	52.82	49.15	61.93	**74.09**
Jan.	31.40	49.99	59.40	58.15	66.11	66.05	**87.60**
Feb.	63.57	55.25	57.10	48.79	70.00	68.54	**88.15**
Mar.	22.65	53.45	60.30	54.28	64.29	67.58	**83.77**
Apr.	42.49	56.72	60.01	64.45	62.00	65.11	**84.48**
May	35.31	49.30	60.50	51.74	63.42	67.64	**88.40**
Jun.	55.42	57.83	59.37	60.74	54.74	64.47	**78.31**
Ave.	**40.36**	**47.61**	**56.11**	**54.14**	**58.38**	**62.14**	**80.97**

Specifically, the significant financial improvement since August 2017 is due to detection of unregistered customers. Proposal of a city-wide customer survey by JMT and its implementation by R&R Section were successful. As a result, total revenue increased from 68.31 million PKR at the end of FY 2016 to 78.31 million PKR at that of FY 2017.

Water utilities must always make investments that lead to increased revenues. In the pilot activities, members of the pilot team have discussed and worked on all measures that lead to sales growth, such as; acquisition of new customers, increase in registered customers, and discovery of unregistered customers due to the improvement of water supply services. As a result, sales and revenue were increased.

The pilot activities were able to demonstrate a virtuous cycle of establishing a water distribution management system, improving customer satisfaction that lead to increased total revenue, and improved financial conditions.

As a result, WASA-F has made it possible to newly investment in further improvement of water supply services in the future.

4.1.3 Establishment of Data Management System (Mapping)

Proper data management is essential for all activities. Faisalabad has many unregistered residents and WASA-F had not identified them correctly, leading to unregistered WASA-F customers. Accurate information regarding number of customers, address, and meter numbers are needed to implement metered system.

On the other hand, pilot activities faced many difficulties such as inaccurate mappings and unknown multiple piping.

In many developing countries, GIS specialists are employed, and GIS construction is carried out. However, field information is often held by the field staff and not communicated effectively to the GIS specialists. In this project, all management, technical and GIS staffs were responsible for mapping creation. Establishing a GIS system was carried out by cooperation of all members.

Thus, a customer survey was carried out for all households in the pilot area, and information on pipelines, customers, water supply conditions, etc. was obtained. All data was linked to GIS and printed on a sheet of paper.

As a result, accurate mapping that can be utilized in day-to-day operations was created. Every day, field staff worked on the field using map, added new information, and left records. In addition, through making mapping, it became easier to organize customer information, identify the cause of water supply failure, and detect illegal connection. Understanding of the necessity of mapping is increasing. Data management is the basis of all tasks. Once these platforms are established, it can be effectively used in many other activities.

By printing on a sheet of paper, field workers have easy access and can use it for daily operation management tasks.

In the future, it will be necessary to establish an organizational structure that allows the GIS cell to periodically update this mapping. Also, expansion into other areas should be discussed.

4.1.4 Establishment of Water Distribution Management

In the Sarfraz Colony Pilot Area, proper water distribution management was established. From September 2017, 12-hour water supply has been achieved consistently, except when the RBC is closed for canal maintenance. Although the targeted 12 m water pressure could not be achieved consistently, it has improved to an average of 10 m in the pilot area. In addition, contamination from wastewater has not been observed since the improvements.

In fact, new customers are gradually increasing. Customers attitudes in the pilot area have undergone substantial transformation and are now cooperative in activities of WASA-F. WASA-F received appreciation from customers, and the motivation of the SMART WASA has greatly improved. It can be said that the foundation of water supply (to deliver drinking water to customers properly) has been realized for the first time in this area.

4.1.5 Door-to-Door Confirmation Survey of Water Supply Situation

It is the mission of any water utility to establish water supply services which provide access to safe drinking water anytime with appropriate pressure. For this, it is necessary to understand the situation at the water taps and improve it. In this project, together with the members of SMART WASA, JMT visited customers one by one and made mappings. While checking the status of the water supply connection, many activities were continued to improve the water supply service. At the same time, each customer was visited and the new services were explained carefully. Such straightforward activities in the field are linked to the positive results.

4.1.6 Establishment of Hydraulic Separation (DMA)

In the Sarfraz Colony Pilot Area, there were many challenges in achieving hydraulic separation, such as inaccurate mappings, unknown multiple piping. In the end, complete hydraulic separation was not achieved. However, 12 hours water supply and 7-10 m water pressure were achieved, and contamination by wastewater was eliminated. A much improved water distribution management system was established. The Sarfraz Colony Pilot Area declared the launch of the new service from September 2017 and shifted to meter rates in December 2018.

Taking advantage of the difficult lessons learned in Sarfraz Colony, a different approach to hydraulic separation was taken in Madina Town Pilot Area. A new distribution pipeline was installed around the perimeter of the pilot area, cutting of all cross pipes and unnecessary pipes, and plugging unnecessary pipes. As a result, hydraulic separation was established and 18 hours water supply was achieved.

However, due to the extension of the water supply time, overflows from sewerage manholes were observed. If the problem of the sewer capacity is solved, water supply time can be extended to 24-hours. In addition, water pressure of 18 m was secured and direct water supply to in he third floor became possible. Naturally, contamination of supply water by infiltration of domestic wastewater was eliminated. The water supply in Madina Town Pilot Area has improved dramatically, demonstrating that the hydraulic separation method is effective and essential for water supply improvement. In many developing countries where undeveloped drawings and multiple piping have been reported, and the same method may be effective.

4.1.7 Introduction of Japanese Style of Construction Management

In order to achieve complete hydraulic separation in Madina Town Pilot Area, the technology of companies with construction experience in Yokohama city was adopted. Japanese-style construction photographs management, construction record keeping methods, and joint check sheets were modified for local use, and used for construction management (see **Appendix AF3.4**). By keeping records of all construction processes, instances of water escaping from the DMA were eliminated, and reliable hydraulic separation was achieved.

4.2 Future Challenges

4.2.1 Water Meter Selection

Before the start of the pilot activities, WASA-F had procured 20,000 waters meters from a previous project. These meters were rotary piston type with Class C accuracy, able to measure micro flow rates. However, after meter installation, many “stuck” meters were reported by meter reading staff in the pilot areas. In the Sarfraz Colony Pilot Area, 12 meters were reported as “stuck” and those meters have been replaced. This means almost 2% of the rotary piston meters became “stuck” in less than 6 months. As a comparison, about 1.6 million meters have been installed in Yokohama city and the stuck meter ratio is nearly 0%, even though eight years passed since installation. Therefore, the 2% “stuck” rate is judged to be not acceptable for effective management of water supply system.

WASA-F has few washouts in its distribution system and often operates the distribution system without cleaning the pipeline after construction or repair works. Particles of dust and sand that introduced under these conditions severely impact rotary piston type meter due to its complex and high accuracy mechanism.

The large amount of non-revenue water attributable to faulty meters has a significant negative impact on WASA-F finances. From the financial view point, it is not acceptable to continue implementation of metered tariffs with meters such high probability of malfunction in these conditions. WASA-F must improve this situation as soon as possible.

It is recommended that WASA-F reconsider the meter specifications. Also, it is not necessary to rely on a single manufacturer or a product. Diversification and comparison of products from different manufacturers and selection of optimal products through day-to-day demonstration in the field is recommended.

Considering the limitations of the existing water distribution system, JMT recommends simpler, more robust propeller type meters for WASA-F. Although accuracy is reduced at micro flow rates, failures are less common. Accuracy is high at typical flow rates. In addition, and perhaps most importantly, it is easy to maintain and manage for WASA-F.

As a part of the pilot activities, Japanese-made meters were installed in the three pilot areas. Aichi Tokei Denki Co., Ltd. (Vietnam Factory), Azbil Kimmon (made in Japan) and STS (made in Japan) made meters were introduced. WASA-F will demonstrate the durability and accuracy of the meters in the future.

The meters of the three companies differ in their standards and materials, and do not conform to the specifications of the Punjab Government, but all are impeller-type, and based on the installation results in Japan, WASA-F decided to introduce Japanese-made water meters. 20 waters meters of each company were equally distributed to 3 areas. At present, the same type of meters are installed in Japan and the customers are being charged based on the reading result of the meters. Therefore, it can be expected that these meters can be installed and used in Faisalabad.

Removed stuck meter

Bypassing due to meter stuck

4.1.2 Establishment of Meter Inspection Laboratory

In the case of metered rate system, water bills are calculated based on volumetric water consumption. A 1% difference in meter accuracy will change the revenues by 1%. After shifting to metering system, it is assumed that customer who is billed high water consumption might complain about meter accuracy. To cope with this, a facility that allows WASA-F itself to check the accuracy of the meter is necessary.

In this project, JMT recognized that issues of great interest are: meter accuracy, appropriate meter selection, and adequate meter installation. Also, Construction of simple meter inspection laboratory was proposed by JMT in August 2017, it was designed in April 2018 and constructed in August 2018.

In this simple meter inspection laboratory, seven meters can be installed in series, and the water volume can be measured with water from the OHR. The meter accuracy can be analyzed by comparing the water amount of drum/bucket with the reading of the meter.

It is a simple facility, so in the future a higher accuracy laboratory may be required.


Meter Inspection Laboratory


Meter Inspection Laboratory

4.1.3 Implementation of Sustainable NRW Reduction Activities

Regarding NRW reduction activities, pilot activities have been promoting DMA creation in Sarfraz Colony and Madina Town Pilot Area Pilot Areas, but due to duplicated pipelines and incorrect GIS, it has been found that it is very difficult to create DMA and a large amount of construction expenses are required. NRW reduction by DMA method is based on the DMA creation. Therefore, unless DMA is created, details of NRW situation cannot be analyzed. WASA-F needs to further examine the optimum method of NRW reduction suitable for WASA-F in pilot areas.

As the pilot activities proceeded, many unregistered customers in the pilot area were identified, and JMT recommended conducting the city-wide survey. As a result, 16,332 unregistered households for water supply, and 49,621 unregistered households for sewerage were identified. Registration of these households had a great influence on turning non-revenue water into profitable water.

Water leakage accounts for a large portion of NRW. JMT estimated annual costs required for leakage surveys and repairs in the whole city based on the records of pilot activities in Madina Town. Assuming 13 teams (3 workers each team) to be established in WASA-F for leakage surveys and repairs throughout the city, the estimation is presented in **Table 4.2.1** below.

Table 4.2.1 Annual Costs for Leakage Surveys and Repairs for the Whole City

Survey costs of the whole city		
Working costs/team/day (with reference to pilot activity in Madina Town)	2,067	PKR/day
Annual work days	200	days
Number of teams required for surveys in the whole city	13	teams
Annual survey costs of the whole city	5,374,200	PKR/year
Repair costs of the whole city		
Repair costs (with reference to pilot activity in Madina Town)	22,093	PKR
Number of repairs (with reference to pilot activity in Madina Town)	25	places
Average of repair costs	884	PKR/place
Number of leakages/km (with reference to pilot activity in Madina Town)	5	places
Total pipe length of the whole city (75mm-300mm)	1,309	km
Estimated number of leakages in the whole city (annual number of repair)	6,545	places
Annual repair costs of the whole city (average cost × number of leak)	5,785,780	PKR/year
Equipment costs of the whole city		
Acoustic rod (1 rod/team)	18,000	PKR/team
Leak detector (1 detector/team)	465,000	PKR/team
Total costs of equipment (13 teams)	6,322,470	PKR
Annual Costs of leakage surveys and repairs in the whole city activities		
Total Annual Cost (1st year, i.e. Survey, Repair and Equipment costs)	**17,482,450**	**PKR**/year
Total Annual Cost (From 2nd year, i.e. Survey and Repair costs)	**11,159,980**	**PKR**/year

It should be noted that because the water pressure is low and the pipeline information is inaccurate, leakage investigations are very difficult and investment in these activities is difficult to justify at the moment. JMT considers that leakage control should be performed in a series of advancing steps. In the current stage of Faisalabad, simple patrol of surface leakages and repairs is the most suitable for WASA-F. Control of underground leakage should commence when the distribution management system is in place and water pressure is consistently available. Although the construction of the water distribution management area in this pilot activity was effective as a means of water service improvement, how to contribute to financial improvement as a means of NRW reduction will continue to be discussed from the viewpoint of financial cost and benefit. The non-revenue water reduction by DMA method is not sustainable unless WASA-F can operate as a business entity where hydraulic mappings and hydraulic separation are achieved, and construction costs can be extracted.

If WASA-F does not upgrade to such an entity, then at least the leakage reduction activities will not produce a major financial improvement to the investment.

4.1.4 Converting to Billing Based on Consumption Volume

In 2015, the Punjab provincial government set the tariff for minimum water consumption for metering system in an extra-ordinance (Preparing for meter failure, etc.) (For extra-ordinary: water supply Faisalabad regulations, see **Appendix AF4.1**). In this extra-ordinance, WASA-F can bill for minimum water consumption to customers with stuck meter, removed/stolen meter, etc. According to the meter reading result in Sarfraz Colony Pilot Area, water consumption volume per household is increasing and WASA-F revenue will increase after shifting to metering system. On the other hand, many zero consumption consumers were also observed. This is assumed to be because of one of two cases: groundwater dependent type consumers or faulty water meters.

If customers rely on their own groundwater and truly do not use piped water at all, when WASA-F bills the tariff for minimum water consumption, WASA-F will face the conflict against such kind of customers.

From now on, by effectively utilizing the meter laboratory, WASA-F can check the meter accuracy and differentiate between faulty meters and true no-volume customers. For customers with a small water consumption, it is necessary to collect the data that can grasp the proper water consumption and promote shifting from groundwater to tap water.

4.1.5 Expansion of Pilot Activities

Based on the results in Sarfraz Colony Pilot Area and Madina Town Pilot Area, WASA-F independently started examining the candidate site for shifting to metering system. It is one of the great achievements of pilot activities that such a movement was voluntarily born out of WASA-F. However, although WASA-F is considering implementation at a relatively newly-developing residential area where water consumption is relatively high, there is lack of discussion on how to improve water supply service.

It is necessary to shift to a metering system that is underpinned by improving water supply services. Planning section, water distribution section, revenue section, etc. need to discuss together how to establish proper water distribution management system.

Private developers are handling the development of new colonies like Sitara Sapna City. It is easy to achieve hydraulic separation in these areas. In colonies close to water sources such as TR and New JK WTP, it is also easy to improve water supply services. On the other hand, as in Sarfraz Colony and Madina Town, old colonies have duplicated pipelines and hydraulic separation is difficult. The new hydraulic separation method demonstrated in Madina Town Pilot Area will be effective in such area where GIS data is lacking and there are unknown duplicated pipeline.

CHAPTER 5 CONCLUSIONS AND WAY FORWARD

5.1 Conclusions

WASA-F water supply services faced many issues including water supply (supply time), pressure, and quality. This led to distrust among customers resulting in non-payment of bills and cancellation of contracts. In the pilot activities, water supply services were improved though the establishment of an appropriate water distribution management system. To establish it, JMT and WASA-F implemented various activities described in previous chapters such as surveying customer situation, creating DMAs, shifting to metering system, etc. As a result of these activities, WASA-F could achieve the improved water supply services and increase revenue.

5.1.1 Customer Response to Improved Water Supply Services

The improved water supply services led to greater customer satisfaction. Many customers were able to save money on their expensive electricity bills since the need to pump ground water was significantly reduced. Additionally, with respect to water quality, improved water supply services contributed to the safety of the water by keeping positive pressure in the water distribution pipes. Thanks to these improvements, WASA-F could achieve new customer acquisition and improved bill payment rate. On the other hand, with the closure of the canal that is the water source for Sarfraz Colony in July 2018, water supply services were degraded. As a result, customer satisfaction and bill collection ratio decreased. This experience clearly showed the close link between water supply service and customer satisfaction. This is shown in **Figure 3.1.6**. In order to secure income of WASA-F, it is necessary to maintain sufficient water supply services and customer satisfaction at a high level. In the pilot activities, WASA-F shifted from the flat-rate system to the metering system in Sarfraz Colony and Madina Town Pilot Areas. Although the metering system could increase billed amounts of many customers, bill payment rate has not declined in Sarfraz Colony since the transition in December 2018. As shown in **Table 3.1.3** regarding bill collection, the figures have increased from 48.2% to 56.9% between November 2016 and March 2019. This proves that WASA-F can maintain and increase customer satisfaction and bill collection rate by continuing the sufficient water supply service.

5.1.2 Cost and Benefit of Pilot Activities

(1) Sarfraz Colony Pilot Area

Table 5.1.1 shows the cost, benefit and predicted cost recovery period of pilot activity in Sarfraz Colony. In the Sarfraz Colony Pilot Area, a DMA was created by cutting pipes at the boundaries, installing valves, and establishing hydraulic separation. A DMA meter was installed to measure incoming water and establish an accurate water balance.

Table 5.1.1 Cost and Benefit of Pilot Activity in Sarfraz Colony Pilot Area

Cost		
Item	**Description**	**Amount (PKR)**
Valve Installation	DN200:1, DN150:2, DN75:4	300,000
Pipe Cutting	13 points	100,000
Connection Shifting	12 places	100,000
DMA Meter Installation	DN200	300,000
Leakage Repair	28 points	150,000
Pump Repair		100,000
Valve Repair		50,000
Pipe Repair		100,000
Work cost (DMA Creation)	Supervisor × 1 × 2 Month (each half day 4 month)	80,000
Work cost (Meter Installation)	Supervisor × 1 × 2.5 Month (each half day 5 month)	100,000
Total cost		1,380,000

Benefit		
Item	**Description**	**Amount (PKR / Month)**
Revenue of November 2016	Invoiced	97,304
Revenue of March 2019	Invoiced	160,522
Increase		+63,218

Cost Recovery Period		
Item	**Description**	**Months**
Cost Recovery Period	Cost 1,380,000PKR/Benefit 63,218≒ 22 months	Approximately 22

The cost shown in **Table 5.1.1** was borne by WASA-F budget. Water supply and distribution systems were designed and optimal investment in equipment was made accordingly, resulting in significant improvement in water supply services. In addition to technical investment, WASA-F took many steps to improve customer satisfaction through coordinated awareness campaigns regarding the new services. Comparing with the previous service, it is easy to see the bill demand has greatly increased. Improved bill payment rate, acquisition of new customers, and switch to metering system has resulted in a 65% increase in billing revenue on a monthly basis as shown in **Table 5.1.1**. Considering the amount of bill demand increase from November 2016 to March 2019 (63,218 PKR/month), it is possible to recover the costs of the Pilot Activities by revenue increase in about two years even if the water tariff is not revised. However, it should be noted that it is difficult to specify how much revenues came from water supply alone, since sewerage bills and payment of arears are all included in WASA-F bills.

As a part of pilot activity in Sarfraz Colony, the campaign targeting payment of arrears was implemented, resulting in the improvement of bill collection ratio. In addition, many households in this area are depending largely on groundwater pumping to meet their water demand. Improved water supply service and increased customer's trust would lead these customers to abandon pumping and rely on WASA-F water supply. Furthermore, there are still many unregistered households in the area. It is reasonable to expect further customer acquisition and revenue growth as services are improved and more households become registered customers. If WASA-F can achieve this, cost recovery period will be shorten less than two years.

(2) Madina Town Pilot Area

Table 5.1.2 shows the cost, benefit and predicted cost recovery period of pilot activity in Madina Town Pilot Area. A 100 mm pipe was installed around the perimeter of the pilot area to achieve complete hydraulic separation. Existing pipes leading out of the pilot area were connected to a new pipe.

Table 5.1.2 Cost and Benefit of Pilot Activity in Madina Town Pilot Area

Cost		
Item	**Description**	**Amount (PKR)**
Installation Pipe Length	1,740 meters (HDPE DN100mm)	14,320,000
Number of Test Pit	59 points	
Depth of Test Pit	Maximum 2.50 meters	
Depth of old pipeline	Maximum 2.05 meters	
Number of Disconnected Pipeline	49 points	
Number of Connected Pipeline	23 points	
One Day Work for Pipe Installation	10 meters/day (5 persons, depth: 0.5~0.8m)	
One Day Work for Excavation	1 point/day (3 persons, W=2, L=1, H=1.5)	
Work cost (DMA Creation)	Supervisor ×1 ×2 Month (each half day 4 month)	80,000
Work cost (Meter Installation)	Supervisor ×1 ×1.5 Month (each half day 3 month)	60,000
Total cost		14,460,000

Benefit		
Item	**Description**	**Amount (PKR / Month)**
Revenue of November 2016	Invoiced	58,500
Revenue of March 2019	Invoiced	*92,000
Revenue of 2021 (after 2 years)	Invoiced	**450,000
Increase	2021 - 2016	＋391,500

Cost Recovery Period		
Item	**Description**	**Months**
Cost Recovery Period	Cost 14,460,000PKR/Benefit 391,500≒ 37 months	Approximately 37

*Estimated figure as of March 2019 (263 PKR x 350 connections)

**Probable figure in 2021 (600 PKR x 750 connections)

Most of the funds for the Madina Town Pilot Area construction works shown in **Table 5.1.2** were provided by JICA. The targets for water supply improvement for water quality (potable), water pressure (high pressure), water supply time (18 hours) were achieved. However, unlike in the Sarfraz Pilot Area, the metered-rate system was introduced immediately after the start of improved services, without time for appropriate public relations and information campaigns to customers. Due to this, revenues has not been improved until now. Nevertheless, according to the hearing data of May 2019 from WASA revenue staff, household water bills increase to 550 - 600 PKR/month on average, compared with the 263 PKR/month under the metered-rate system. To put it simply, more than double increase in billing has been achieved. However, like Sarfraz Colony, it is difficult to specify how much revenues came from water supply alone, since sewerage bills and payment of arears are all included in WASA-F bills. In addition, the number of registered customers is growing roughly 10% per month, from the original 350 households. It is predicted that 75% of the households in the area (750 households) will be registered in the next two years and monthly bill demand will be around 450,000 PKR in 2021. Considering the amount of bill demand increase from November 2016 to 2021 (391,500 PKR/month), it is possible to recover the costs of the Pilot Activities by revenue increase in about three years.

5.1.3 Feasibility and Validation of Pilot Activities

Through the pilot activities, it was proved that improving water supply services lead to increasing revenue, which is proposed in Master Plan. By continuing the activities to improve water supply services like the pilot activities, WASA-F will be able to transform the vicious business management cycle into a virtuous one in the future.

In pilot activities, SMART WASA, which is the Taskforce Team of pilot activities performed a variety of activities and played very important role. To expand the success model of water supply services improvement such as Sarfraz colony and Madina Town Pilot Area, it is necessary to utilize the experience of SMART WASA.

5.2 Way Forward to improve Water Supply Services

In order to improve water supply services, WASA-F is recommended to make effort described below in terms of policies, measures, funding, and performance indicators.

5.2.1 Policies

Based on the results of the pilot activities, it is recommended that future water supply development projects and WASA-F operations be conducted adhering to the following policies:

i) Create DMAs and improve water supply services; Divide the distribution network into blocks (create DMAs) and execute service development (improve services) for each block unit.
ii) Increase customer satisfaction and bill payment rates; Along with improvement of water supply services, execute publication and awareness campaigns to increase customer satisfaction and bill payment rates.
iii) Block by block expansion to cover the whole city; Expand the improvements from block to block, and gradually expand improvements to the whole city.

5.2.2 Measures

In order to accomplish the policies outlined above, the following measures are specified.

(1) Create DMAs and improve water supply services

- To separate (isolate) each water supply block (DMA) hydraulically
- To set improvement target:
  - Water pressure of 12 meters or more
  - Water supply time of 12 hours or more per day
  - Water quality to meet national standards
- To establish appropriate water distribution management system and maintenance management system
- To secure water source and establish backup system to ensure sustainable and uninterrupted water supply service

(2) Increase customer satisfaction and bill payment rates

- To implement initiate public relations campaigns in order to ensure that customers recognize the start of new services
- To conduct campaigns urging the importance of bill payment including for late or unpaid bills once customer satisfaction is improved
- To invest in new customer acquisition for further revenues increase
- To build accurate customer data base using GIS
- To install water meters according to the SOP and shift from flat-rate to metered-rate.
- To review the water rate system regularly and set rates with low income groups in mind. Use subsidies or discounted rates if necessary.

(3) Block by block expansion to cover the whole city

- To determine the priority of each area and select the next block and maintenance area
- To save records and data for each block and apply to the development of the next block
- To improve OHRs, GRs, pumps, and distribution pipes of each block
- To transfer knowledge and skills to each block through training-of-trainers (ToT) methods

5.2.3 Funding

Pilot activities were conducted in different methods in Sarfraz Colony and Madina Town, and WASA-F was able to gain experience from both situations. The revenues of WASA-F increased dramatically by providing new water supply services in the Pilot Areas. Switching to the metered-rate also improved revenues.

Based on the experiences gained in the pilot activities, WASA-F will secure funding from the revenues gained from the improved areas and carry out projects similar to the pilot activities in the new areas by themselves. WASA-F selects about 20 areas like G.M. Abad, Lasani Town as candidate areas.

It is necessary for WASA-F to secure funding to expand improved services area by themselves in the future. However, considering the current financial situation of WASA-F, it seems to be difficult to secure all budget by themselves initially. As funding sources, not only the revenues improved in WASA-F, but also the Government of Punjab, JICA, AfD, WB and others should be considered to implement projects for improving water supply services and shifting to the metering system.

With the support of the Government of Punjab, foreign donors, and WASA-F's own funds, water supply services improved area can be expanded, and financial condition of WASA-F can be strengthened.

5.2.4 Performance Indicators

Performance indicators are divided into financial indicators and water supply service indicators. Indicators should be evaluated for each block (DMA) to clearly show the effects.

Table 5.2.1 Performance Indicators for Each Block

Category	Item	Indicator
Financial indicators	Billing system	Flat-rate or metered-rate
	Billed amount	PKR
	Payment rate	%
	Number of customers	Households
Water supply service indicators	Water supply time per day	hours
	Water pressure	m
	Water quality	E. coli or coliform bacteria must not be detectable.

Evaluation of water supply indicators should be performed at customer tap, not at water source or treatment plant. 24-hour water supply has not been achieved, and numerical indicators for water supply time per day cannot be set. However, water supply time is an important indicator for contamination prevention under intermittent water supply, so that the efforts to prolong water supply time per day should be made.

APPENDIX FOR CHAPTER 1 OUTLINE OF PILOT ACTIVITIES

AF1.1 Pilot Activities Plan

PILOT ACTIVITIES PLAN

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Chapter 1 Outline of Pilot Activities

1.1 Purpose of Pilot Activities

The billing collection rate of WASA-F is low and it is 27.6% in FY 2014 (based on Performance Indicator of WASA-F), on the other hand, NRW rate of WASA-F is high and it is estimated officially 32.9% in FY 2014 (based on Performance Indicator of WASA-F), and the study carried out in French Project estimated 55%.

In these pilot activities, three pilot areas are selected from Faisalabad city and the billing collection rate and NRW rate should be improved, and ultimately, revenue situation of WASA-F should be improved.

To achieve these goals, it is essential to provide good water service to customers and it is necessary to eliminate the current intermittent water supply and extend water supply time, and to supply water with proper pressure.

Therefore, considering the current facility and water operation of WASA-F, this pilot project aims at improving the billing collection rate and the reducing the NRW rate through WASA-F's activities to establish the appropriate water distribution management system in three pilot areas; it means that WASA-F supplies safe drinking water with sufficient amount and appropriate water pressure.

In addition, through these pilot activities, this project also aims at improving the ability of WASA-F to implement the master plan.

Since the conditions of facility placement, water management and customer characteristics are different in the three pilot areas; different targets should be verified, compared and examined according to each area.

1.2 Workflow of Pilot Activities

This pilot activity will proceed with the following workflow.

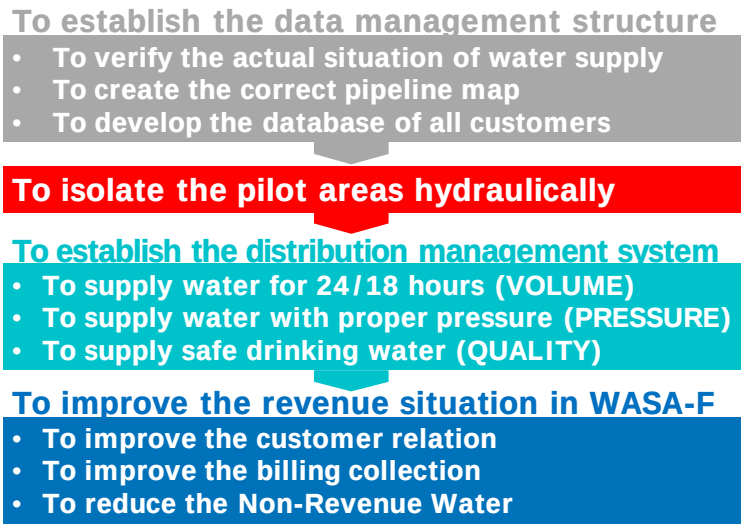


Figure 1.2.1 Workflow of pilot activities

To ultimately improve the financial situation of WASA-F, WASA-F should build a good relationship with customers, improve the billing collection rate and reduce the NRW amount; that is, by legal customerization from illegal and supplying water saved by water leakage repair to other areas.

To achieve these goals, however, it is necessary to collect accurate information and to develop a data management system such as creating a customer database, actual grasping a water supply situation and developing pipeline maps. After that, it is necessary to establish the water distribution management system within the limited area by hydraulically isolation of the pilot areas; that is to proper management of water volume, water pressure and water quality.

Chapter 2 Pilot Area

2.1 Outline of Pilot Area Selection

The current WASA-F has an intermittent water supply system. However, five sites were selected from Faisalabad city as candidate sites as areas where water supply time can be extended and proper water pressure can be secured; such as Sitara Sapna City, Sarfraz Colony, Madina Town, Gulberg Colony and G. M. Abad. And three of these were selected as pilot areas based on the selection criteria described in 2.2.

2.2 Selection Criteria of Pilot Area

As shown in Appendix 1, five candidate sites were evaluated in three stages from the viewpoints of water source facilities, water storage facilities, water distribution facilities, sewage and drainage facilities, customer information, and three areas; Sitara Sapna, Sarfraz Colony and Madina Town, were selected finally as pilot areas.

2.3 Features of three pilot areas

Features of the three pilot areas are as follows. Details of each item will be described in the relevant chapter.

Chart 2.3.1 Features of Pilot Areas

		Sarfraz Colony	Sitara Sapna	Madina Town
Nos. of Customer		478	265	1,774
Costomer Income		Middle	Rich	Middle & Poor
Billing Collection		48.2%	64.7%	55.1%
Water Source		TR, New JK	TR	RBC
Facilities		GR: 100,000 gallons OHR: 50,000 gallong	-	GR: 400,000 gallons OHR: 100,000 gallons
Water Supply Time		3.5h	7h	7h
Water Pressure		Very low Pump sucking	Low	Low Pump sucking
Water Quality	Chlorine	High	High	Low
	E.Coli	-	-	detected
Meter Installation		121 (2015, FR)	46 (2015, FR) 78 (2012, UK)	145 (2015, FR)
DMZ, DMA		DMZ11, DMA10	DMZ13, DMA1	DMZ10, DMA3
Groundwater		Brackish	Brackish	Brackish
Power Suply		18h	18h	18h

The low concentration of residual chlorine in Madina Town is because Rakh Branch Canal (hereinafter RBC), its water source is a clean groundwater and chlorine is not injected. In addition, the number of customers and the billing collection rate in Chart 2.3.1 are strictly data on the administrative district. Since the boundary of the water distribution system does not necessarily correspond to the administrative district, it is needed to extract these data only for the pilot areas.

2.4 Activities in each pilot area

This section outlines the activities of each pilot area and the details of activities related to water distribution management will be described in Chapter 3 and also the details of activities related to NRW reduction will be described in Chapter 6.

2.4.1 Outline of Activities in Sitara Sapna City

Water source of Sitara Sapna City is Terminal Reservoir (hereinafter TR) and there is no Ground Reservoir (hereinafter GR) and Over-Head Reservoir (hereinafter OHR) for this area, but water is supplied to this area from

arterial main directly. WASA-F supplies water three times a day and total water supply time is almost seven hours. Although water comes from TR with the pressure of TR pumps during the operation time, water cannot reach to the water storage tank installed on the roof of each customer because of insufficient water pressure. Outside the water supply time, water has arrived at the distribution pipe network from Chiniot well-field with the pressure of intake pumps, however, customers cannot use water because the proper water pressure cannot be secured.

Based on this situation, regarding water distribution management, a GR will be constructed in this pilot area and a booster pump will be installed, thereby WASA-F can extend the water supply time and secure the proper water pressure.

Sitara Sapna City is relatively advanced in installing meters and customers in this area are supported to consume a lot of water because of high-class residential area. For this reason, the project shifts from the flat-rate system to the metering system, compares the water tariff income and verifies the customer's water saving behavior accompanying shifting to the metering system.

Currently, most customers in Sitara Sapna City use WASA-F's water service only as a sprinkle because of intermittent water and low water pressure and their living water depends on their own groundwater, their drinking water depends on the bottled water. For this reason, almost in-home piping does not connect to WASA-F system. Therefore, after realizing 24/18-hour water supply at proper water pressure, this project has to consider the in-home plumbing work of each customer.

Regarding the NRW reduction, since this area has already been isolated hydraulically, the project installs valves to divide the area into three areas and carries out the step test and identifies the water leakage for each route.

In this area, illegal connection survey has already been carried out and legal customerization from illegal is progressing. Therefore, a large-scale investigation is not necessary.

Because Sitara Sapna City is considering shifting to a metering system, the project proceeds with installing meters for all households. Also, based on the shifting to the metering system, it is necessary to check the accuracy of existing water meters using the test meter.

2.4.2 Outline of Activities in Sarfraz Colony

Sarfraz Colony has two water sources, one is TR and the other is New Jhal Kanuana Water Treatment Plant (hereinafter New JK), and water comes through Fawara Chowk OHR.

In this area, terminal water pressure is significantly low and a lot of customer has installed the small pump, connected it to service pipe illegally and sucking the water directly from distribution pipeline to store the water into their own water storage tank installed on the roof of their house. Due to this, the pressure of the WASA-F water distribution pipe becomes negative and there is a high risk of contamination. It is very dangerous situation. In addition, existing pump water sucking decreases the further water pressure of the water supply system, which is the cause of further pump water sucking.

Based on this situation, to eliminate these pump water sucking, this pilot activities will be implemented with a focus on ensuring proper water pressure in this pilot area. WASA-F improves the water supply time at appropriate water pressure, increases the customer satisfaction, and removes their small pumps, after that improves the billing collection rate.

Regarding the NRW reduction, since this area has already been isolated hydraulically, the project installs valves to divide the area into four areas and carries out the step test and identifies the water leakage for each route along with replacement of inefficient/faulty valves.

In this area, illegal connection survey has already been carried out and legal customerization from illegal is under progress. Therefore, a large-scale investigation is not necessary.

In this area, WASA-F partially installed French made meters in 2015. However, there is a possibility that pump water sucking may adversely affect the meter, so it is necessary to check the accuracy of the meters. And at the present stage where pump water sucking cannot be eliminated, even if the meters are installed, it causes faulty meters, therefore, the project do not positively install meters in this area.

Fawara Chowk OHR also distribute water to neighboring Peoples Colony and others, but it is difficult to extend water supply time and to ensure the proper water pressure when distributing to both areas, so Peoples Colony is separated from the Fawara Chowk OHR distributed area in this project.

2.4.3 Outline of Activities in Madina Town

Water source of Madina Town is RBC. Water is directly supplied from groundwater along with the canal with the

water pressure of intake pumps.

In Madina Town, GR and lifting pump to existing OHR are being constructed by ADB fund. The project is waiting for the completion of this GR and lifting pump, establishes the water distribution management system utilizing the existing OHR.

Madina Town is very complicated in piping situation; therefore, the project divides the area into about 500 households, gradually expands the water distribution area, isolates the area hydraulically, extends water supply time, and secures proper water pressure. As a result, the billing collection rate is raised after improving customer satisfaction.

However, Madina Town has problems with water quality. Customer's trust in tap water is very low. Although improving the relationship of trust is very difficult, this project improves water pressure and this prevents contamination in the distribution pipeline. At the same time, the project conducts a campaign to replace the existing low quality plastic service pipe with PE, and improve the image for water quality; project aims to re-build the relationship of trust with customers.

In addition, Madina Town has the problem of the duplication pipeline. Because of health problem, WASA-F carried out the old pipe replacement by Gastro Project of Annual Development Program of Punjab. However, WASA-F has not sufficient pipeline and customer information and WASA-F could not remove the old pipeline and some customers are still connecting to old pipeline and take water from it. This project disconnects the old pipes from the distribution system and solves the duplicated pipeline problem and re-connects all customers to newer pipeline.

Regarding the NRW reduction, as the project gradually expands the water distribution area, and gradually identifies the water leakage in these activities.

Since illegal connection survey has not yet been carried out in this area, illegal connections will be revealed one by one in door-to-door leakage survey.

WASA-F partially installed French made meters in Madina Town in 2015. At the moment, WASA-F cannot shift to the metering system immediately because of small water consumption.

This project will not install meters actively, however, after considering the timing of shifting to metering system, installs meters if necessary.

In Faisalabad, power outages occur frequently, and power is not supplied stably. To cope with the situation, the solar power generation can be a viable option. For this purpose, it is possible to secure a large space at the top of Madina Town GR and utilize it for the installation of solar power generation system.

Chapter 3 Establishment of Distribution Management System

3.1 Current Situation of Distribution Management in WASA-F

For water supply business, the water distribution management is to control water volume, water pressure and water quality and it means to supply the enough safe drinking water to the customers with the proper water pressure.

At present, WASA-F supply water three times a day, in the morning, the afternoon and evening, and total water supply time is seven hours a day. The main cause of this intermittent water supply is not water shortage but the limitation of the pump operation due to expensive electric power cost. As WASA-F adopts the flat-rate system, increasing water distribution does not directly affect their income. Therefore, WASA-F selects to supply the minimum necessary water for civic life at the necessary time. However, customers are largely dissatisfied with intermittent water supply, which is considered to contribute to the high rate of non-payment.

In addition to planed intermittent water supply to reduce electricity costs, as observed in G. M. Abad, depending on the area, WASA-F has been supplying water for only 1 or 2 hours a day because the pump cannot be operated due to unstable power supply. This is also considered to contribute to the high rate of non-payment.

For the water pressure, on the west side of Faisalabad City close to TR, in many areas, adequate water pressure is secured with TR pumps, and WASA-F can supply water directly to the two-storied building. On the other hand, in areas where there is a distance from TR, especially on the east side, WASA-F has problems such as no water or low water pressure.

As observed in Sarfraz Colony and Madina Town selected as pilot areas, the illegal act that the customer connects the personal small pump directly to the water service pipe and sucks water from the water distribution pipe is very common. This pump water sucking causes the negative pressure inside the pipe and it has a risk of contamination.

In order to prevent contamination inside the pipe, WASA-F operates the water intake pumps in Chiniot well-field for 18 hours. By continuing to supply water to their water system, approximately 90,000 m^3/day, it is intended that water is always filled in the water distribution pipe but pipe becomes empty in some areas like Peoples Colony. So at the present time it has not necessarily achieved satisfactory results. To resolve the low water pressure is urgent for WASA-F.

For the water quality, the project briefly investigated the residual chlorine concentration at the tap in three sites; Shahbaz Nagar, Sarfraz Colony and Clock Tower Market, and confirmed that there was sufficient concentration of residual chlorine (More than 2.0mg/L at three sites).

In addition, from interviews with customers in these areas, tap water of WASA-F is used for drinking for some customers and the project confirmed that customers are recognized as "water of WASA-F can be drunk."

WASA Laboratory is in charge of water quality control, conducts water quality inspection at 4,000 sample points per year, especially 2,000 sample point for residual chlorine, and they commented that they do not have any particular big problem with water quality especially about chlorine. Therefore, in most areas, it is judged that there is no big problem regarding water quality. However, from customer hearing in Madina Town, information such as "sewage mixed smell" and "dust contamination into tap water" were received, and the residents are skeptical about the water quality of WASA-F. In addition, JMT conducted the water quality survey with four taps of water in Madina Town, E Coli. was detected at two sites. In some areas, WASA-F has water quality problems in the distribution piping network.

3.2 Actual Condition of Customer Water Use in WASA-F

In the process of pilot area selection, the actual condition of water use in WASA-F was surveyed. The customer water use style in WASA-F is two in the following Figure 3.2.1 or a combination of both.

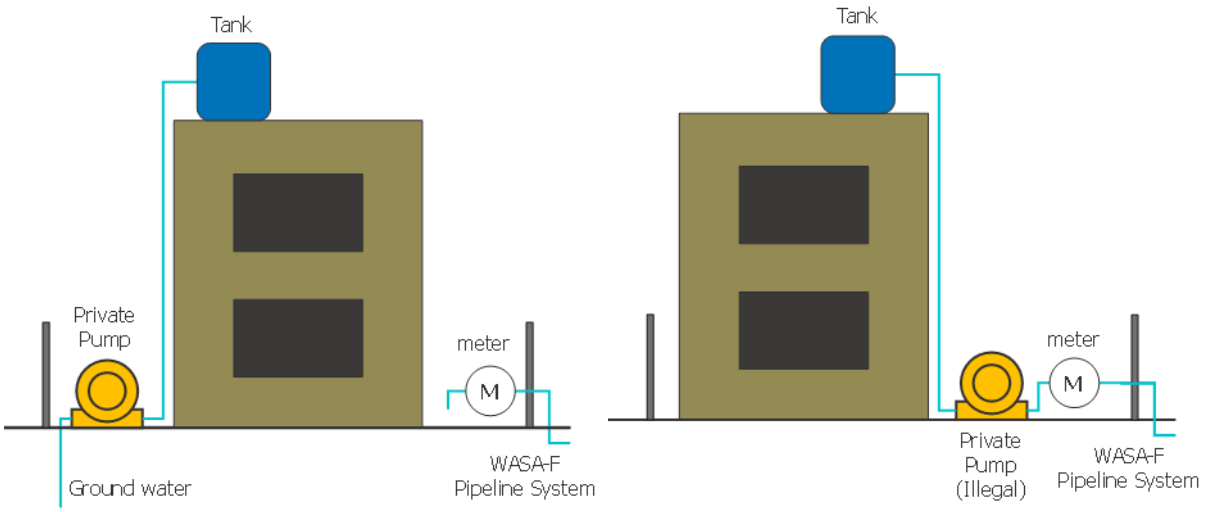


Figure 3.2.1 Groundwater dependent type (left) and pump water sucking type (right)

Due to intermittent water supply, a lot of customers have to rely on their own groundwater (groundwater dependent type). Customers pay electricity bills of 800 to 1200 Rs per month to FESCO, electric company, pump up the groundwater to their own rooftop tanks and use water.

However, in Faisalabad, most groundwater is brackish water (Average of TDS is almost 2,000 ppm in Faisalabad City), so it is not suitable for drinking. Therefore, most of groundwater use is for life water. For drinking uses, customers purchase the bottled water or they use the tap water of WASA-F.

Also, since brackish water is not suitable for garden. The tap water of WASA-F is also used for sprinkling water.

In any case, the in-home piping is not connected with the tap water of WASA-F, and the water of WASA-F is only drinking and sprinkling water, and it is rarely used for life water. At this stage, even if shifting to metering system, WASA-F cannot expect increasing income over the flat-rate system.

In Shahbaz Nagar and Sitara Sapna City, for example, most customers take this groundwater dependent type of water use.

On the other hand, in areas where the water pressure is remarkable low, pump water sucking type is normal water use.

Customer connects his own pump to water service pipe directly, sucks water from WASA-F water distribution pipe to the rooftop tank and uses it. This pump connection is obviously illegal and should be enforced to remove. However, WASA-F cannot supply enough water to the customers at the moment; it is forced to tolerate this.

The electricity bill is the same 800 to 1200 Rs as in the case of groundwater dependent type. However, there is a high risk of contamination due to the negative pressure inside the water distribution pipe. Actually, in Sarfraz Colony and Madina Town, "sewage mixed smell" and "dust contamination into tap water" were reported.

In addition, pump water sucking causes a reduction in water pressure in the water distribution system of WASA-F, which leads to further customer pump installation and results in a vicious circle.

In some areas, French made meters has already been installed, and some meters are already out of order, due to the sudden rise in water pressure by pump operation, mixing of air or pump vibration.

In Sarfraz Colony, most customers are using this water use style, and it considered a normal practice. Also, part of Madina Town is same as Sarfraz Colony.

Some customers have adopted a combined water use of groundwater dependent type and pump water sucking type. The tap water of WASA-F and the groundwater are mixed in the rooftop tanks and they use it.

In any case, these types of water use are caused by the intermittent water supply and low water pressure. Customers cannot be satisfied with the tap water of WASA-F at this service level and sufficient billing collection cannot be expected without improvement of these situations. Based on this, in this pilot project, it is necessary to promote the establishment of the appropriate water distribution management system such as extension of water supply time and improvement of water pressure.

3.3 Current Operation in the Water Transmission/Distribution System in WASA-F

In the establishment of appropriate water distribution management system, it is important to grasp the current water operation system of WASA-F.

It is necessary to establish the water distribution management system by utilizing the existing system in this project.

At present, WASA-F has seven water sources. The two lines of water from Chiniot Well-field and JBC Well-field are collected in TR and are distributed throughout the city using a transmission pumps in TR. Approximately 70% of the water demand in WASA-F supply area is from TR.

Although WASA-F operates the transmission pumps only three times a day for the total of seven hours, WASA-F can supply water with reasonable water pressure which ensures to directly supply to two storied building in the most west side of the city. However, as the distance from TR increases, the water pressure decrease and water supply failure occurs in various places, especially in the east side of the city.

To avoid the risk of contamination of pipe inside outside of the operation time, WASA-F operates a part of the water intake pumps (18 of 29 units) in the Chiniot well-field. This water does not go through the TR but is distributed to the city area by bypass. The amount of the distributed water outside of operation time is about 90,000 m^3/day.

WASA-F considers that contamination can be prevented because water is always filled in the pipeline network outside of operation time by this operation, although water pressure is almost zero. In fact, high concentration of residual chlorine and clear water can be confirmed at taps of various places just after TR pumps are started to operate. Therefore, this water operation has achieved certain results.

However, it was confirmed in the field investigation at Peoples Colony that water is arrived 20 minutes after operating TR pumps, and it is assumed that the inside of the water distribution pipe is empty in some areas. It is not necessarily the water operation as expected by WASA-F.

In addition, although 16 DMZs and 91 DMAs are developed in French project from 2012 to 2015, due to this water operation, it is necessary to keep all boundary valves open. This operation is an obstacle to construct the constant hydraulic separation of DMZ and DMA.

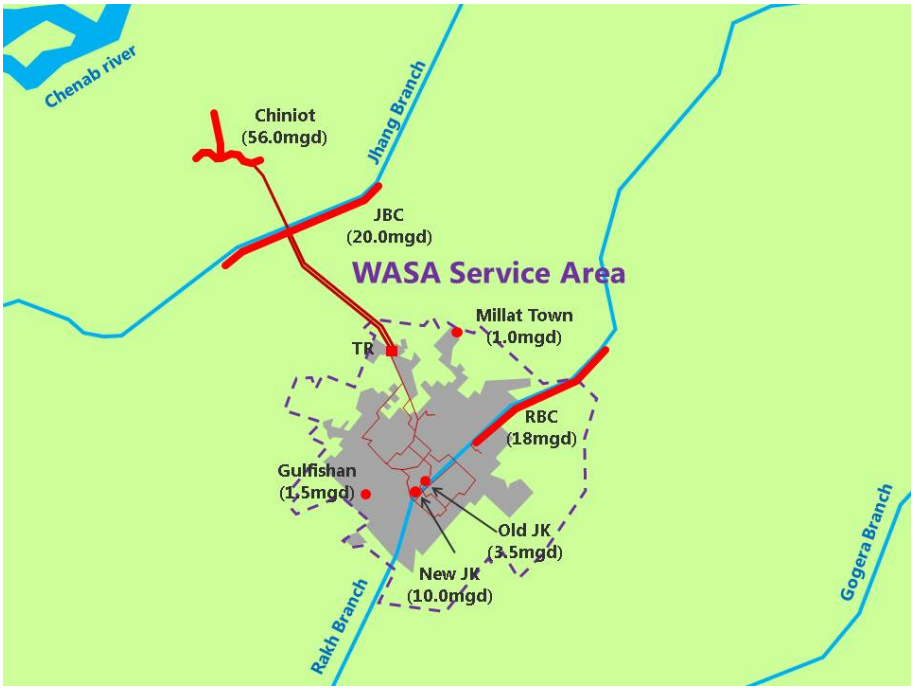


Figure 3.3.1 Current Water supply system in WASA-F

Chart 3.3.1 Current Water Source in WASA-F

Facility	Water Source Type	Capacity		Remarks
		Mgd	m^3/day	
Chiniot Well-field	Groundwater	56.0	254,600	There are 29 Tube wells and Facilities occupancy rate is about 55%.
Jhang Branch Canal Well-field (JBC)	Groundwater	20.0	90,900	There are 25 Tube wells and facilities occupancy rate is about 70%.
Cube-wells along Rakh Branch	Groundwater	18.0	81,800	There are 38 Tube Wells, there is no flow

Canal (RBC)				meter.
New Jhal Kanuana Water Works (New JK)	Surface water	10.0	45,500	It is constructed by French PJ in 2015 and is coagulation sedimentation, rapid sand filtration system.
Jhal Kanuana Water Works (JK)	Surface water	3.5	15,900	It is slow sand filtration system.
Gulfishan Water Works	Surface water	1.5	6,800	It is slow sand filtration system.
Millat Town Water Works	Surface water	1.0	4,500	It is slow sand filtration system.
Total		110.0	500,000	

WASA-F has constructed GRs and OHRs in various places. Water comes from TR to GR and is lifted to OHR with small lifting pumps and is distributed to customers. However, the capacity of most OHR is 50,000 gallons, which is not enough. For example, when opening the valve of outlet pipe of Fawara Chowk OHR, OHR will be empty in less than 30 minutes.

Also, even if the lifting pumps to OHR fail, a lot of cases are not found repaired in areas where a certain water pressure is secured during the water supply time, especially west side of the city. In these areas, WASA-F supplies water to customers directly from TR. In these areas, intermittent water supply is forced. In order to improve these situations, it is necessary to construct a hydraulically separated water distribution area centered on the OHR.

Based on the above situation, it is necessary to realize the water distribution management system in the pilot area by using existing facilities in this project.

3.4 Achievement of Water Distribution Management System in Pilot Areas

Locations of three pilot areas are as shown in Figure 3.4.1.

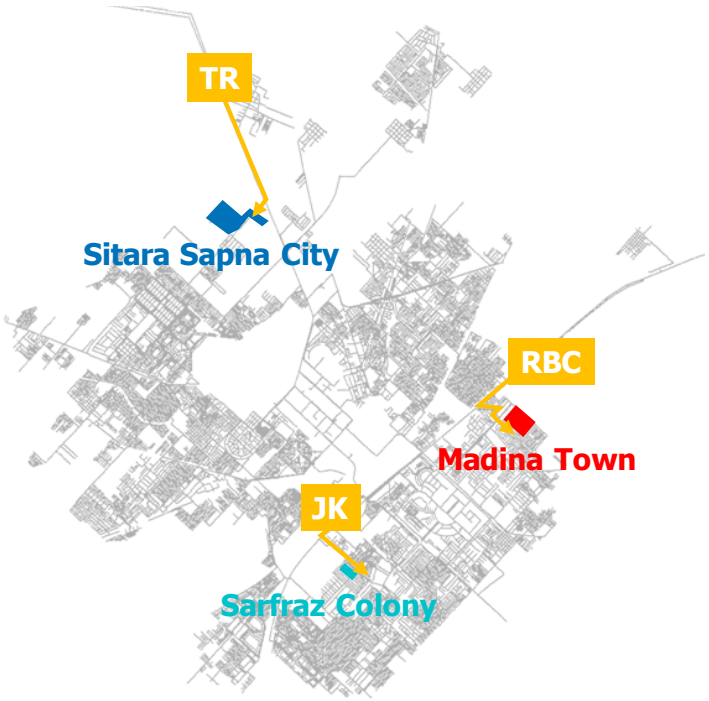


Figure 3.4.1 Location of three pilot areas

3.4.1 Sitara Sapna City

Sitara Sapna City is located 3.2km downstream from TR as shown in Figure 3.4.1. GR and OHR are not installed and WASA-F distributes water to customers directly from TR.

During the water supply time, although about 17m of water pressure is secured at the inlet point of Sitara Sapna City with TR pumps, water does not reach the rooftop water storage tanks of the customers. And Outside of operation time, water pressure from Chiniot well-field is short of water pressure, customers cannot get water from

their taps.

In this area, fortunately, there is water in the arterial main even though it is outside of operation time. Therefore, in order to expand the water supply time, it is necessary to construct a GR (Capacity: 57,000 gallons) at a lower position than the arterial main and to establish a system that can receive water from the arterial main at all times. Also, to ensure proper water pressure, it is necessary to install small pumps.

As there is a plan to construct OHR in this area, this project constructs GR and small pumps taking the consistency with this plan and in consideration of the future expansion of this area.

Sitara Sapna City is a luxury residential area developed by private developer. For this reason, hydraulic separation has already been done. The project establishes a water distribution management system in this limited area.

Figure 3.4.2 Image of establishment of water distribution management system

3.4.2 Sarfraz Colony

In Sarfraz Colony, water comes from Fawara Chowk OHR. Fawara Chowk has two water sources, one is TR and the other is New JK. Water is stored in GR and is pumped up to OHR, and is distributed to customers. Fawara Chowk OHR has two outlet pipes and supplies water to not only Sarfraz Colony but Peoples Colony, etc.

Although the height of OHR is almost 20m and operational water level is 15-18m, WASA-F cannot secure the proper water pressure for these two areas. For this reason, WASA-F opens and closes valves of two outlets from Fawara Chowk and distributes water to two areas alternately. Therefore, the water supply time to each area is substantially three and a half hours. Nevertheless, sufficient water pressure has not been secured.

In Sarfraz Colony, water pressure is extremely low and a lot of pump water sucking are observed. Therefore, it is urgent to secure proper water pressure. After that, it is necessary to remove the illegal pumps sequentially and improve the water pressure of the water distribution system.

Based on this situation, this project focuses on pilot area only for Sarfraz Colony, and Peoples Colony is excluded from the distributed area from Fawara Chowk OHR.

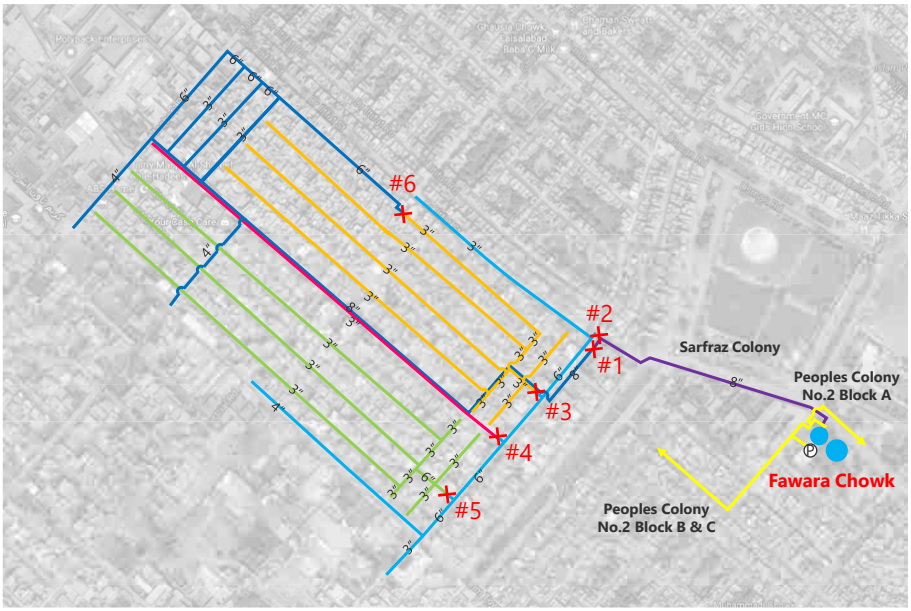


Figure 3.4.3 Image of establishment of water distribution management system

During the water supply time, Fawara Chowk GR can receive water from TR and New JK. However, outside of operation time, water does not reach Fawara Chowk GR. In order to extend the water supply time in Sarfraz Colony, it is necessary to extend the operation time of New JK which is the nearest water source of Sarfraz Colony.

In Sarfraz Colony, the water pressure is remarkably low. Therefore, this project carried out the hydraulic analysis and simulated the water pressure that water is distributed to the Sarfraz Colony from the Fawara Chowk OHR. Thus, it was confirmed that proper water pressure was secured in the simulation. The results of hydraulic analysis are shown in Appendix 2.

However, unlike the simulation results, the water pressure is very low at the actual site and water has not reached the rooftop tanks. For this reason, most customers have to use water by pump water sucking.

On 27th October, 2016, water pressure survey was conducted based on the drawing made in the French Project. As a result of operating several valves, it turned out that there was a large gap between the actual site and the drawing of the distribution pipes. Moreover, the differences from the initially assumed water distributed area were also found out. In addition, it was also found that only 1.7m of water pressure was secured at the customer's tap in Sarfraz Colony, although 15m of water pressure was secured at the outlet from Fawara Chowk OHR.

The project requested the maintenance section staff of WASA-F to recreate the drawing based on the existing records and their knowledge, after that, carried out the water pressure survey again on 10th November, 2016 based on the new drawing.

The zero-pressure test were conducted and it is confirmed that Sarfraz Colony and Peoples Colony are hydraulically separated, respectively. However, despite securing the proper water pressure in hydraulic analysis, the water pressure remained low even when water was supplied only to Sarfraz Colony. At the tap of about 500m from the OHR, water pressure was only 1.9m, and at the end, water pressure was 0m and no water.

One of the causes of this low water pressure is thought to be illegal pump sucking by customers. However, it alone cannot be explained. It is still possible that the drawing is inaccurate and water flows out of the assumed distributed area although hydraulic separation is realized. The project needs to identify the cause of this low water pressure.

In this project, valves are installed to divide the area into four. During this construction work, hydraulic separation should be confirmed gradually and the water pressure should be checked. Through this process, it is necessary to specify the causes of low water pressure in detail.

3.4.3 Madina Town

In Madina Town, GR and lifting pump station are being constructed by ADB fund. The capacity of it is 400,000 gallons and it is planned to complete by April, 2017.There is the existing OHR and its capacity is 100,000 gallons. After completion of GR construction, WASA-F plan to lift water to existing OHR form new GR and distribute

water to customer.

In this area, water comes from RBC and WASA-F has to distribute water to a lot of area. Therefore, this project separates the distribution areas to create dedicated route from 10 RBC pumps that were developed by French Project to Madina Town GR for Madina Town pilot area, and the other area will be supplied water from other existing 18 pumps.

On November, 2016, the project visited 4 customers and two customers pointed out the water quality problems in Madina Town such as “smell of sewerage” or “contamination of dust” of tap water. As the result of the water quality survey conducted by JMT, E. coli was detected at 2 taps in Madina Town. Customers trust in tap water of WASA-F is relatively low in Madina Town, and improving the good relationship is very difficult.

The distribution pipes of Madina Town were installed in 2007 and are relatively new. However, some service pipe uses a vinyl pipe which is used for a hose and this material has a high risk of sewage contamination. By ensuring proper water pressure all the time within the pilot area, this project eliminates the contamination of sewage in the water distribution pipe. At the same time, if necessary, the project replaces the customers’ water service pipes to an appropriate pipe material like PE or HDPE. Through these activities, the project eliminates the negative image of the WASA-F water system of customers and reconstructs the relationship of trust with customers.

In addition, Madina Town has the problem of duplicated pipeline. This is also the reason of low pressure and contamination. This project disconnects the old pipeline from the distribution system and re-connect all customers to newer pipeline.

Since the piping of Madina Town includes a large size and it is very complicated, the project develops the water distribution areas gradually expanding. Although OHR has 100,000 gallons of the capacity and it can distribute water to almost 3,200 households, this project achieves the water distribution management system in the limited areas of Phase 1 and Phase 2 and development after phase 3 is left to WASA-F. In the future, it is necessary to plan to expand to a suitable scale with 3,200 households as a distribution area. Based on the results of the verification in this project, the project will consider and propose future expansion plans.

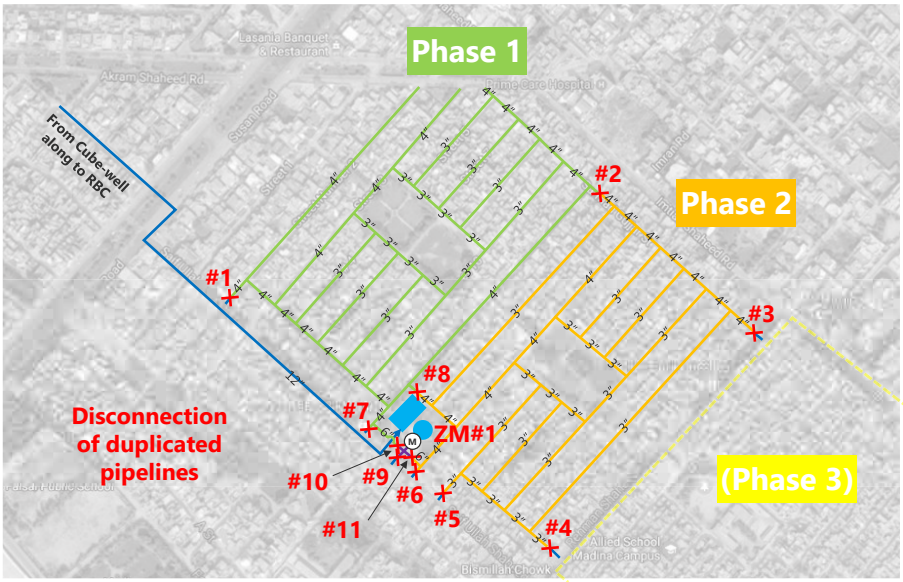


Figure 3.4.5 Image of establishment of water distribution management system

3.4.4 Study of Its Own Power (Additional)

Unlike Japan, the power outage is daily and the power supply is not stable in Faisalabad.
To continue supplying water for 24/18-hours even at the time of power outage, it is important to shift to the gravity flow water supply system from OHR, not direct water supply system by TR pumps.

Commercial contracts are signed at major water facilities such as TR and New JK, and 18-hour water supply from the FESCO is secured. However, the electric cost of the pumps is very pressing business, and it is forced to operate for seven hours.

On the other hand, the small facilities such as RBC pumps and lifting pumps from GR to OHR are affected by power outage as well as ordinary households. For example, In G.M.Abad, electricity does not come sufficiently, it is impossible to operate a lifting pump to OHR, and it is inevitable to supply water for less than 1 hour a day.

In addition, since the capacity of a lot of OHRs is 50,000 gallons and the capacity is not enough, even a short power outage critically affects OHR. Once the pump is stopped, the OHR will be empty immediately.

In this way, the unstable power supply situation is a major obstacle to 24-hour water supply.

It is also important that WASA-F develops the system that can independently secure electricity without depending on FESCO, such as installing solar power generation facilities at each facility.

Fortunately, it is possible to secure a large space at the top of Madina Town GR. In this project, if possible, the solar power generation equipment should be installed and it should be verified.

Chapter 4 Improvement of Billing Collection

4.1 Method of tariff collection and plan

Observed on the present situation, it is not so easy to improve the billing collection rate in WASA-F. Although WASA-F emphasizes the revenue situation as a policy, any donor does not support this point and there is no progress related to it. However, when introducing a self-supporting accounting system in future, the tariff revenue is the important and only one income. WASA-F could not change this situation for a long time, and some staff given up halfway.

In this master plan, tariff revision will be discussed. Therefore, it is time to discuss the fundamental improvement of billing collection.

4.1.1 Current water tariff system

For domestic, the latest tariff revision was approved by Punjab government in 2004 and the metering rate was included, however, all customers have subscribed on a flat-rate at present. The billing collection rate is very low and is 27.6%. Strictly, there are a lot of un-registered customers in WASA-F and bill is not distributed to all customers in WASA-F water area. Therefore, it is estimated that the actual billing collection rate is lower.

Chart 4.1.1 Tariff Table for Flat-rate of Domestic Use

Plot size (area)						Tariff
marla			m2			Rs/mon.
-		2.5	-		63.2	83
2.5	-	3.5	63.2	-	88.5	124
3.5	-	5	88.5	-	126.5	145
5	-	10	126.5	-	252.9	242
10	-	20	252.9	-	505.9	322
20	-	40	505.9	-	1,011.7	644
40	-		1,011.7	-		966

a. The above-mentioned water supply rates are the connections of 1/4” ferrule size. The domestic connection of 1/2” ferrule size will be charged double of above rates.
b. The above-mentioned water supply rates on area basis will be charged up-to three stories. On above. 33.33% of the rate will be charged to each story.

On the other hand, for commercial and industry, the latest tariff revision was approved by Punjab government in October, 2016. And Only 93 consumers adopt the metering system, but others are frat-rate consumers.

Chart 4.1.2 Tariff Table for Flat-rate of Commercial and Industrial Use

Plot size (area)						Tariff
marla			m2			Rs/mon.
-		3	-		75.9	483
3	-	6	75.9	-	151.8	725
6	-	10	151.8	-	252.9	1,208
10	-	20	252.9	-	505.9	1,932
20	-	40	505.9	-	1,011.7	3,623
40	-		1,011.7	-		4,830

a. The above-mentioned water supply rates are the connections of 1/4" ferrule size.

Chart 4.1.3 Tariff Table for Meter-rate of Commercial and Industrial Use

Tariff	
Rs/1,000gallons.	Rs/m3
80.0	17.6

4.1.2 Shifting from frat-rate system to metering system

The billing collection rate of domestic and commercial consumers is almost 27.7%.

Chart 4.1.4 Current Situation of domestic and commercial use

Area (Subdivision)	Category	Consumers	Payee	%
G.M.Abad	Domestic	29,585	9,041	30.6
	Commercial	2,618	1,031	39.4
Millat Town	Domestic	21,889	5,305	24.2
	Commercial	2,965	1,041	35.1
Civil Lines	Domestic	35,907	10,215	28.4
	Commercial	1,952	879	45.0
Gulberg	Domestic	43,950	13,086	29.8
	Commercial	4.678	1,719	36.7
Madina Town	Domestic	33,291	8,284	24.9
	Commercial	2,265	866	38.2
Peoples Colony	Domestic	40,087	9,147	22.8
	Commercial	2,805	1,193	42.5
Allama Iqbal	Domestic	21,593	5,234	24.2
	Commercial	1,781	662	37.2
Salman Abad	Domestic	25,743	6,667	25.9
	Commercial	3,575	1,166	32.6
Total	Domestic	252,049	66,979	26.6
	Commercial	22,639	8,557	37.8
	Dom.+Com.+Ind.	276,204	76,472	27.7

On the other hand, the billing collection rate of industrial consumers is not so high but better than domestic.

Chart 4.1.5 Current Situation of Billing Collection Rate in Industrial

	Category	Consumers	Payee	%
A99	IND: Sewer APTMA	64	48	75.0
AQF	Aquifer Charges	495	347	70.1
I95	IND: NON Sewer APTMA	863	464	53.8
IWS	Bulk water with meter	94	77	81.9
Total		1,516	936	61.7

Reference: WASA-F (August, 2016)
*APTMA: All Pakistan Texitle Mills Association

At present, customers of WASA-F are almost flat-rate customer and average of billing collection rate in whole city is almost 28%. First, WASA-F should improve this billing collection rate to nearly 100%, it is necessary to shift to metering system from flat-rate system. However, metering system is different from the present way of flat-rate system and the water tariff is decided from water consumption by metering. So it is not realistic to improve the billing collection rate and to shift to metering at the same time.

In Sitara Sapna City, the billing collection rate is higher than other areas and is 64.7%. Some of the reasons are that the residents in Sitara Sapna City are relatively richer than other areas and that their educational standard is higher and they have the higher consciousness to pay.
WASA-F has installed a meter preferentially in this area and meter installation rate is also high. WASA-F already installed 78 meters of British-made in 2012 and also 146 meters of French-made in 2015. This project will install the meters to all households in this area. Based on the results of the customer survey by JMT in November, in three pilot areas, a lot of customers use three kinds of water, tap water from WASA-F, groundwater and can units/bottled water. It has been found that living standards of these customers are high and they consume large amounts of water. In Sitara Sapna City, remarkable results were obtained regarding the water consumption. Therefore, in Sitara Sapna City, it can be evaluate that it is possible to change the tariff to metering system from the present flat-rate system and compare the tariff income of metering system with flat-rate system. In addition, the water saving behavior of customers and customer satisfaction when changing to metering system can be evaluated. If possible, the project will change the tariff system to metering system from flat-rate system in Sitara Sapna City.
The assumed problems when changing the tariff to metering system from flat-rate system should be evaluated in this project. The customer satisfaction survey should be carry out periodically and these results in Sitara Sapna City should be utilized for planning of tariff revision.

The billing collection rate in WASA-F is extremely low at present. In addition, water consumption of customers and NRW rate cannot be calculated as the correct numerical value. In pilot areas, the information of every household should be registered. The invoices of water tariff should be sent to all customers and the true billing collection rate should be confirmed. Anyway, the improvements of water supply services including water distribution management are needed.

4.1.3 Current Operation of Billing Collection Improvement in WASA-F

In WASA-F, before, period of billing collection was once two months, however it was changed to monthly to reduce the billing collection cycle and reduce the unpaid customer. In 2015, WASA-F started to introduce the tariff invoice distribution by private company. In recent years, WASA-F has actively introduced the measures to improve the billing collection rate.

4.1.4 Draft plan of revenue recover action

Pilot activities establishes the water distribution management system, this is, extent the water supply time, improve the water pressure at tap, improve the water quality at tap in three pilot areas. Once improving the water supply services, the customer satisfaction will be improved and the billing collection rate will be also improved.
WASA-F intensely publicizes three big merits for customers many times. Promotional activities for payment will be understood to customers through activities to improve service levels. WASA-F also communicates new policies and dramatic improvements to the mosque and the local community.
In the organization, all members of taskforce team “SMART-WASA” aim to achieve the same goals, share the information of service improvements and appeal them to customers. Team clarifies the purpose, confirms its progress as appropriate and takes its actions quickly.
It is necessary to utilize the media such as cable networks and newspaper as much as possible to inform the citizens of the information implemented in the pilot areas. However, once it was announced it, WASA-F cannot fail. It is necessary to pay close attention to announce only that it can be executed by grasping the correct progress of activities in pilot areas.

Chapter 5 Public Relations

5.1 Improvement of Customer Satisfaction

The customer satisfaction plays an important role for the improvement of the billing collection rate. To change the consciousness of payment of customers, it is necessary to improve the three basic service levels of water quantity, water pressure and water quality.

It isn't easy to change this customer's impression and draw out a change in feeling to water tariff payment. I'd like to do improvement of water service and the public relations put together and achieve degree of satisfaction improvement at this implementation pilot area.

The very low collection rate of water tariff is evidence that customers are unsatisfied with the water supply services, such as the intermittent water supply, low water pressure and low water quality. It is not easy to change these impressions of customers and feelings for payment of water tariff. Improvement of customer satisfaction should be achieved by linking the improvement of service level and public relations in three pilot areas.

5.1.1 Needs of customers and Provision of information

Although the situation is different in each pilot area, improvement of water quantity, water pressure, water quality is basically required in these areas. Certainly WASA-F established Customer Relation Center (CRC) and "complaints" have been received and processed. However, WASA-F could not grasp the "requests" of customers accurately and had not been able to reflect them in the improvement. WASA-F simply takes these complaints received at CRC as needs of customers. However, securing water quantity, water pressure and water quality is a duty of water utilities. WASA-F has not worked on these improvements of three needs so far. Words of appreciation for the good activities of WASA-F staff should also be evaluated. The sale of bottled water and the holding of citizen participation event like town meeting promoted a certain understanding of WASA-F's policy. However, it is not sufficient for information provision to customers. Regarding the above three low services, WASA-F should grasp the actual situation and improve them. In this project, WASA-F should thoroughly provide the information to the customers on what, how and when to improve. In addition, the various needs obtained from the customer survey conducted in this project. WASA-F should also improve the other needs as well, and provide information on them as appropriate.

5.1.2 Customer Relations and Willing to Pay

Chart 5.1.1 Willing to Pay

	Nos. of respondents
Up to +500 Rs.	177
Up to +750 Rs.	66
Up to +1,000 Rs.	88
Up to +1,500 Rs.	65

Customer survey in three pilot areas in 2016

Improving the service level simply does not connect to the water tariff payment. Investing in facilities for improvement of service levels is meaningless unless it gains effect. In order to restore WASA-F's trust that has not responded to the true needs of customers over a long period, a special team was set up in this project. It is important for staff to act with the aim of a common goal by sharing information across organizations, and reform of awareness of staff is a top priority.

Japanese water supply utilities provide customers with various information. Similarly, pilot activities provide customers with various information. It is necessary to construct a database for provision. In addition, the water supply utilities in Japan has a lot of education program about water supply for elementary school students and junior high school students. Pilot activities explore the effective ways while utilizing these experiences.

Chapter 6 Reduction of Non-Revenue Water

6.1 DMA Creation

6.1.1 Sitara Sapna City

Sitara Sapna City was developed by the private developer and hydraulic separation has been achieved already. After constructing the GR, DMA is constructed in this area by installing the zonal meter at outlet point from GR.

Total pipe length in this pilot area is 8.4 km and the project divides DMA into three segmented areas so that it will be approximately 3 km by installing valves.

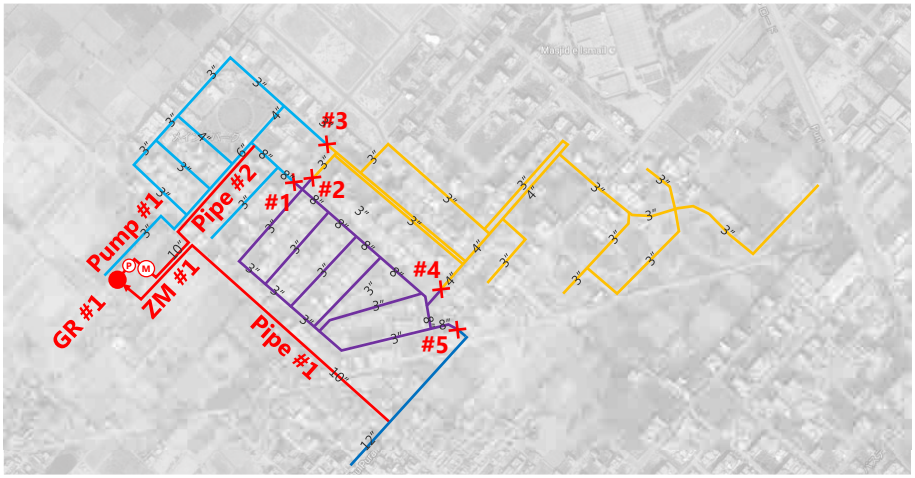


Figure 6.1.1 DMA image in Sitara Sapna

6.1.2 Sarfraz Colony

Sarfraz Colony is distributed water from Fawara Chowk OHR. As a result of zero pressure test, hydraulic separation was confirmed. DMA is constructed by installing the zonal meter at the outlet point from OHR.

However, as a result of the operation of the valves in the field, it is found that there was a large gap between actual site and the drawing of the distribution pipes. In addition, the proper water pressure was not secured at the tap of customers in two pressure tests in the field. Although hydraulic separation has been achieved, there is also the possibility that water may flow out of the assumed area.

The total pipe length in this pilot area is about 9 km and the project divides DMA into four segmented areas so that it will be approximately 3 km by installing valves.

It is necessary to confirm the actual distributed area while repeating to check the pressure during these construction works, and to verify the cause of the low water pressure in this area.

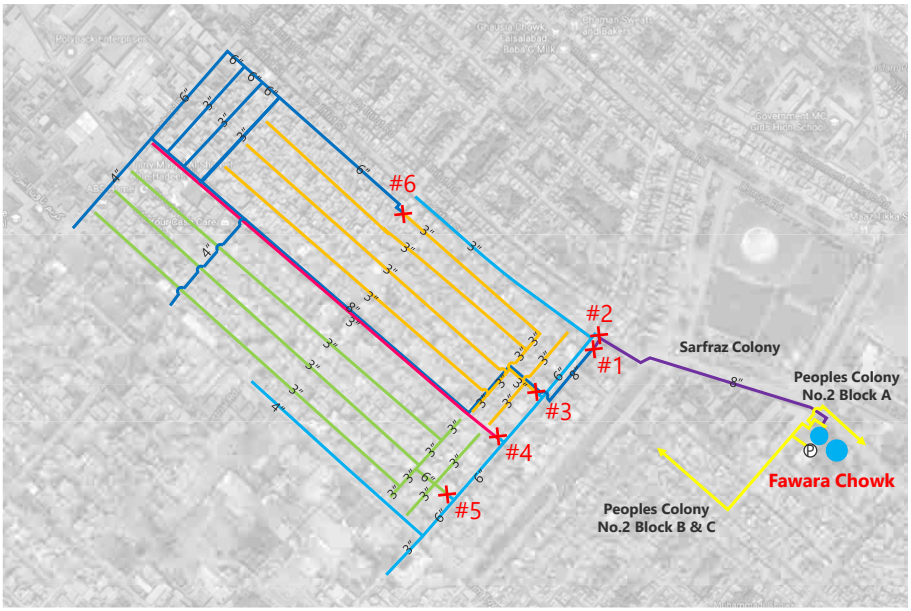


Figure 6.2.2. DMA image of Sarfraz Colony

6.1.3 Madina Town

The piping of Madina Town is very complicated and contains a lot of large size. If the project cover the all area of Madina Town, a large amount of construction cost are needed to create DMA. Therefore, in this project, the pilot area is limited to some areas shown in Figure 6.2.3. The project gradually expands the water distribution area.

The total pipe length in this pilot area is about 6 km and the project divides DMA into Phase 1 and Phase 2 so that it will be approximately 3 km by installing valves, and water distribution management system is established in order.

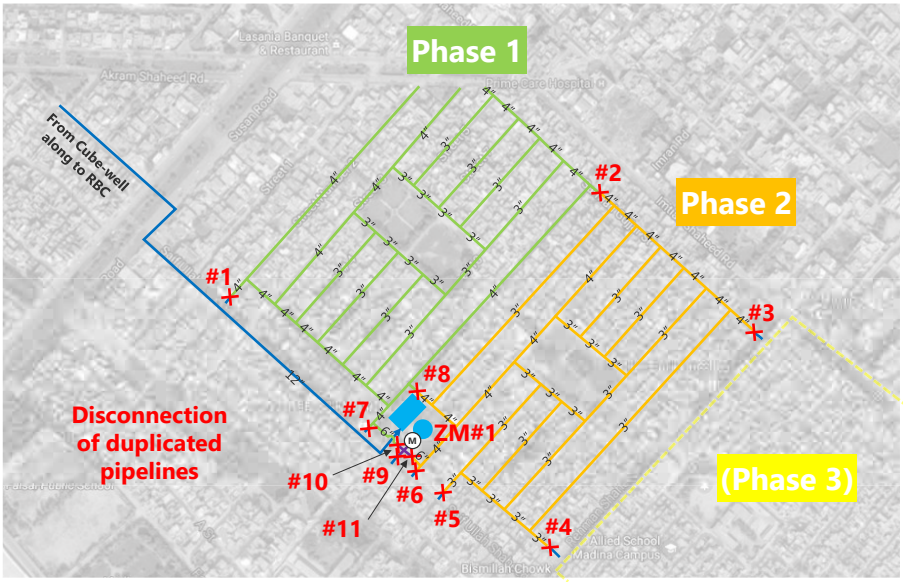


Figure 6.2.3 DMA image in Madina Town

6.2 Water Balance Analysis

NRW consists of various elements. The IWA defines the water balance table as Table 6.2.1. This project classifies each element of the NRW based on IWA water balance table. As a result, the cause of the NRW can be analyzed.

Each component will be described later in 6.3 and 6.4.

Chart 6.2.1 Water balance table in IWA

System Input Volume	Revenue Water	Billed metered consumption (**metered**)	%
		Billed unmetered consumption (**flat-rate, estimated**)	%
	Non Revenue Water	Unbilled metered consumption (**settlement discount**)	%
		Unbilled unmetered consumption (**used by utility, excess use of flat-rate, authorized unbilled**)	%
		Unauthorized consumption (**illegal connection**)	%
		Customer meter inaccuracies (**faulty meter**)	%
		Leakage / Overflows	%

A baseline survey should be conducted in advance and calculate the NRW rate in three pilot areas. After that, countermeasures should be implemented such as customizing illegal connected customers, replace the faulty meters (if necessary), leak repairing, etc., and the water balance analysis should be conducted again.

Finally, the NRW rate should be compared before and after countermeasures and cost effectiveness of NRW reduction activities should be evaluated.

6.3 Revenue Water

From the result of interviews in three pilot areas, it is found that the customers use water by three difference ways. The first is the tube well installed by customers and rely on their own groundwater for life water. Unfortunately, it is not suitable for drinking or sprinkling for the garden because groundwater is brackish. The second is the tap water from WASA-F. However, customers cannot use it sufficiently because of the intermittent water supply. In addition, because of the low water pressure, in some area, customers need to store the water in rooftop storage tank by illegal pump water sucking. For these reasons, a lot of customers only use WASA-F water for drinking and sprinkling. The third is bottled water that water seller provides almost 20 liters of water. A lot of citizens who doubt the quality of tap water of WASA-F use this bottle water as drinking water. But the quality of bottled water depends on the price and not necessarily all suppliers provide safe water.

The amount of revenue water is limited to the “tap water of WASA-F” of the three ways. To improve the revenue situation of WASA-F, it is important not only to reduce the amount of NRW but also how to shift from using groundwater or bottled water to using tap water and to increase the amount of revenue water.

From the result of interview in three pilot areas, although the water consumption of tap water of WASA-F is very low at present, it is assumed that the total amount of water consumption of three ways becomes a considerable amount of water. Detailed investigation is necessary. One of the reasons for this may be the lifestyle of Faisalabad citizens that they wash off the flooring with water for cleaning purpose. Therefore, by establishing the water distribution management system, promoting the use of tap water, shifting from the flat-rate system to the metering system, it is expected to result in a significant increase in the amount of water revenue for WASA-F.

6.3.1 Billed Metered Consumption

Billed metered consumption is the amount of water consumption of customers measured by meter reading.

In Sitara Sapna City, the project installs meters for all households and shift to the metering system. Meter should be read monthly in principle, and billed metered consumption should be obtained.

Since it is not possible to grasp the amount of water consumption of customers under the flat-rate system, it is important to shift to the metering system. However, the current situation of WASA-F is intermittent water supply, and a lot of customers have to rely on their own groundwater pumps. Thus, the water consumption of tap water of WASA-F is very small. It is difficult to immediately change the whole city area to the metering system, but in order to grasp the amount of water consumption of customers, it is important to immediately start to read the meters once the meter is installed regardless of the tariff system.

6.3.2 Billed Unmetered Consumption

In Sarfraz Colony and Madina Town, all customers charged on the flat-rate system.

French Project carried out the water consumption survey by installing the temporary flow meters to 1,000 house connection. This project utilizes this result and estimates the billed unmetered consumption by multiplying the number of customers by the water consumption unit estimated.

French Project calculated the water consumption units per DMZ, and based on their survey, water consumption unit can be assumed 486 L/household/day in DMZ #11 including Sarfraz Colony. Similarly, water consumption unit can be assumed 833 L/household/day in DMZ #10 including Madina Town.

However, in water consumption unit, a big difference depending on the DMZ was observed from French project result. Water consumption varies greatly depending on site area and household size. From these viewpoints, it is necessary to measure the amount of water consumption by customers by meter reading of existing meters and installing temporary meters to flat-rate customers, if necessary, and project compares them with the results of French Project, and verifies the water consumption unit according to each pilot area.

As reference, in the design criteria of the Punjab state, water consumption is supposed to be 40 gallons/person/day, that is 182 L/person/day. If the average number of people in household is assumed to be seven, the designed water consumption will be 280 gallons/household/day, this is 1,273 L/household/day. At the present, it can be said that considerable part is supplemented by groundwater and bottled water.

6.4 Non-Water Revenue

6.4.1 Unbilled Metered Consumption

In Japan, there are several systems to exempt customer payment, even if water utilities supply water and the amount of water is measured through water meter. For example, when water not suitable for drinking such as turbid water and rusty water has been supplied, customers will be exempted from payment. Alternatively, some water utilities exempt the amount of in-house leakage. These water amounts are considered as the unbilled metered consumption in Japan.

On the other hand, since WASA-F has not adopted the metering system at the present, there is no item corresponding to the unbilled metered consumption.

6.4.2 Unbilled Unmetered Consumption

(1) Used by Water Utilities

This corresponds to pipe washing at the time of pipeline construction. When pipeline construction occurs during pilot activities, they are counted, but in principle, this project assumes that this amount is not present.

(2) Authorized Unbilled Consumption

The staff of WASA-F can use water for free, it is authorized unbilled consumption and GIS section has entered the location of the staff house of WASA-F into the GIS, this information should be collected in the pilot area.

In addition, some mosques and special schools for the handicapped are offered 30% discount. This 30% is also NRW and these amounts are organized as authorized unbilled consumption.

Chart 6.4.1 Numbers of Authorized Unbilled Customers

	Sitara Sapna	Sarfraz Colony	Madina Town
Total Customer	294	799	2,150
Water Connection	288	489	656
Mosque	0	1	2
Exempt (WASA-F staff)	0	3	2

Reference: WASA-F

In addition, WASA-F has a lot of Free Water Station. Water comes directly from OHR and supplied to citizens for free. In this pilot project, there is no Free Water Station in pilot areas. However a lot of customers visit and take water from Free Water Station. This is one of the NRW. Therefore, this project measure the water consumption of Free Water Station in order to grasp the volume.

(3) Excess Use of Flat-rate

By comparing the flat-rate system with the metering system, the assumed water consumption of flat-rate system can be calculated.

For example, in the tariff table of the flat-rate for domestic customers, water tariff for 1/4 inches of ferrule size and plot size of 5-10 marla, this is 126.5-252.9 m^2 and three stories is 242 Rs/month. On the other hand, for same customer in the metering system, water tariff is 40 Rs/1,000 gallons for water usage upto 10,000 gallons.

Comparing these two tariff, the assumed amount of water consumption of this flat-rate customer is 6,050 gallons/month, because 242 divided by 40 multiplied by 1,000 is equal to 6,050, this is 27.5 m^3/month.

Therefore, when customer uses water more than 27.5 m^3/month, if WASA-F shift to the metering system, they will be able to billed more water. On the other hand, when it is less than 27.5 m^3/month, shifting to the metering system leads to reduction of revenue of WASA-F.

Even in this pilot area, by comparing the assumed water consumption of flat-rate customer with the meter reading result, the amount of the excess use of flat-rate should be calculated.

Sitara Sapna City is a high-class residential area and it is expected that residents use a considerable amount of water. On the other hand, in other two areas, the tap water of WASA-F is only for drinking and sprinkling and most of the life water depends on their own groundwater. In addition, in WASA-F, to prevent the flat-rate customers from using a large amount of water, the water supply pipe is branched from the water distribution pipe at 1/4 inch, and then a 1/2-inch water supply pipe is installed, so customers cannot use a lot of water. For these reasons, it is expected that the amount of excess use of flat-rate will be small.

However, at Shahbaz Nagar, which is close to TR and proper water pressure is constantly secured and 24-hour water supply has been achieved, but some house open the tap at all times and water continues to flow out like a river. It is necessary to confirm whether or not there is a similar area in the city, but if there are a lot of cases like this, it is counted as the excess use of flat-rate and it becomes a major factor of NRW.

6.4.3 Unauthorized Consumption (Illegal Connection or Unregistered Customer)

In developing countries, illegal connections are a major element of NRW. Currently, the exact number of households in Faisalabad city is not grasped, but it is estimated to be approximately 488,000 households by Urban Unit survey. On the other hand, the number of contracted households of water supply of WASA-F is approximately 120,000 households, which has a large gap from the total number of households in Faisalabad city.

One of the reasons of this gap is the fact that customers can easily get water from their own groundwater, but in the WASA-F survey, it is estimated that 60,000 to 70,000 unregistered customers connected to the water system of WASA-F and use water. These customers have illegal connections.

An illegal connection detecting campaign was conducted in 2015 in WASA-F, and a list of illegal connection customers was created. Through this campaign, in Sitara Sapna City and Sarfraz Colony, the list of illegal connection customers has already created and promoted to change to legal customers. Therefore, it is considered that the large-scale illegal connection survey is not necessary in these two areas in this project. However, in Madina Town, illegal connection survey has not been implemented, the project need to survey the illegal connection in this area.

In this project, for leakage detection works, the door-to-door acoustic survey will be conducted at all households in the pilot area. Through this activity, water connection situation should be grasped and illegal connection should be identified comparing with the customer list.

6.4.4 Customer Meter Inaccuracies (Faulty Meter)

The customer meter inaccuracy is an error between the amount of water passed through the meter and the amount of water measured. For example, if $10m^3$ of water passes through the meter and the meter measures only $9.8m^3$, then $0.2m^3$ is the customer meter inaccuracy or meter error and it is NRW.

In Faisalabad city, although there is a tariff table for metering system, it has not shifted to the metering system, and the actual situation is 100% flat-rate system. For this reason, there is no meter error for water balance analysis. However, 20,000 meters are brought from France and 14,087 meters have been installed as of 2015. So WASA-F has a lot meters already.

In Sitara Sapna City, 78 British-made meters were installed in 2012. Then, 46 French-made meters were installed in 2015. In Sarfraz Colony, 121 French-made meters were installed and in Madina Town, 145 French-made meters were installed in 2015. But meter reading has not been carried out in any of three areas and water consumption is not measured.

In Faisalabad, a large number of customers connect pumps directly to the service pipe and suck the water from the water distribution system. Most meters are installed before and after the pump. Vibration of pump, fluctuation of large water pressure, mixing of air adversely affect meter. In Sarfraz Colony, it was observed that several meters have already failed, even though these meters were installed in 2015,

This project will install meters to all customers in Sitara Sapna City and if possible, will shift to the metering system from the flat-rate system. At that time, the meter error becomes the target of the NRW, and accuracy of existing meter becomes important. The project will bring the test meter and meter accuracy check should be conducted.

Although it is not counted for NRW, it is necessary to check the accuracy of the meter for other areas as well. Impact of pump water sucking on meters and differences between meter brands should be evaluated.

6.4.5 Leakage

(1) Minimum Flow Measurement

In the pilot areas, after hydraulic separation and 18-hour water supply will be achieved, a minimum flow measurement will be tried.

Normally, no one uses water at night time. In theory, if there is no water leakage and there is no water use, there is no water inflow into the water distribution area. Thus, the flowmeter at the inlet point should count zero. On the other hand, if it is assumed that there is no water use but the flowmeter is counting, it can be said that there is leakage in this water distribution area.

As described above, it is possible to calculate the leakage amount by measuring the minimum flow during the night time when no one use water.

Strictly, the measured minimum flow includes some components such as small water use by customers, storage water to rooftop tanks, in-house leakage, and illegal connection and so on. However, in this project, the minimum flow is regarded as the water leakage.

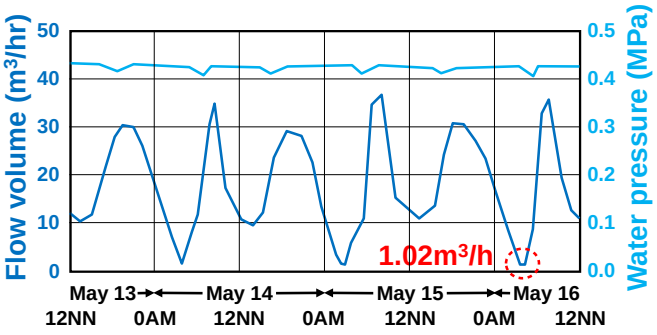


Figure 6.4.1 the image of Minimum Flow Measurement

(2) Step-test

Although it is possible to grasp the amount of water leakage throughout the water distribution area by minimum flow measurement, it is necessary to specify the leakage point in more detail. As shown in 6.1, this project installs valves in the pilot areas to divide the distribution areas into several areas.

By operating these valves and comparing the flow before and after that, it is possible to grasp the amount of inflow into the segmented area, that is, the amount of leakage. This is step-test.

For example, as shown in Figure 6.4.2, by installing a flowmeter at the inlet point of the water distribution area, measuring the flow at night and operating the four valves, after that, it is possible to specify which area among the four areas leakage is high. As a result, the priority is given to leakage survey, and leakage survey can be efficiently progressed.

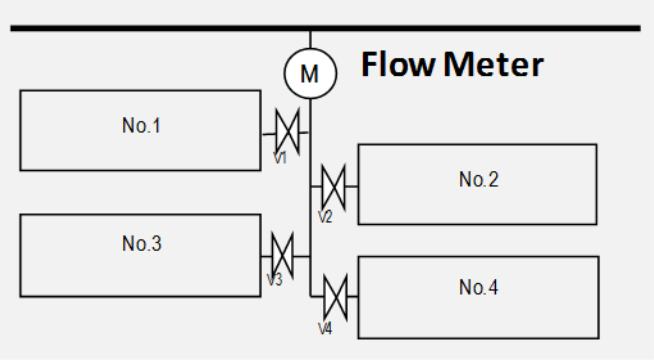


Figure 6.4.2 the image of Step-test

(3) Leakage Survey

In this Project, JMT will inspect leakage survey method and formulate standard of investigation plan. Following is the explanation of the leakage survey activity.

(i) Inspection of Leakage survey

Leakage survey will be carried out Door to door of all houses and Correlative detection of all pipe line in each pilot area. By these investigations, rough leakage points and pipe line can be identified.

(ii) Leakage Survey Steps

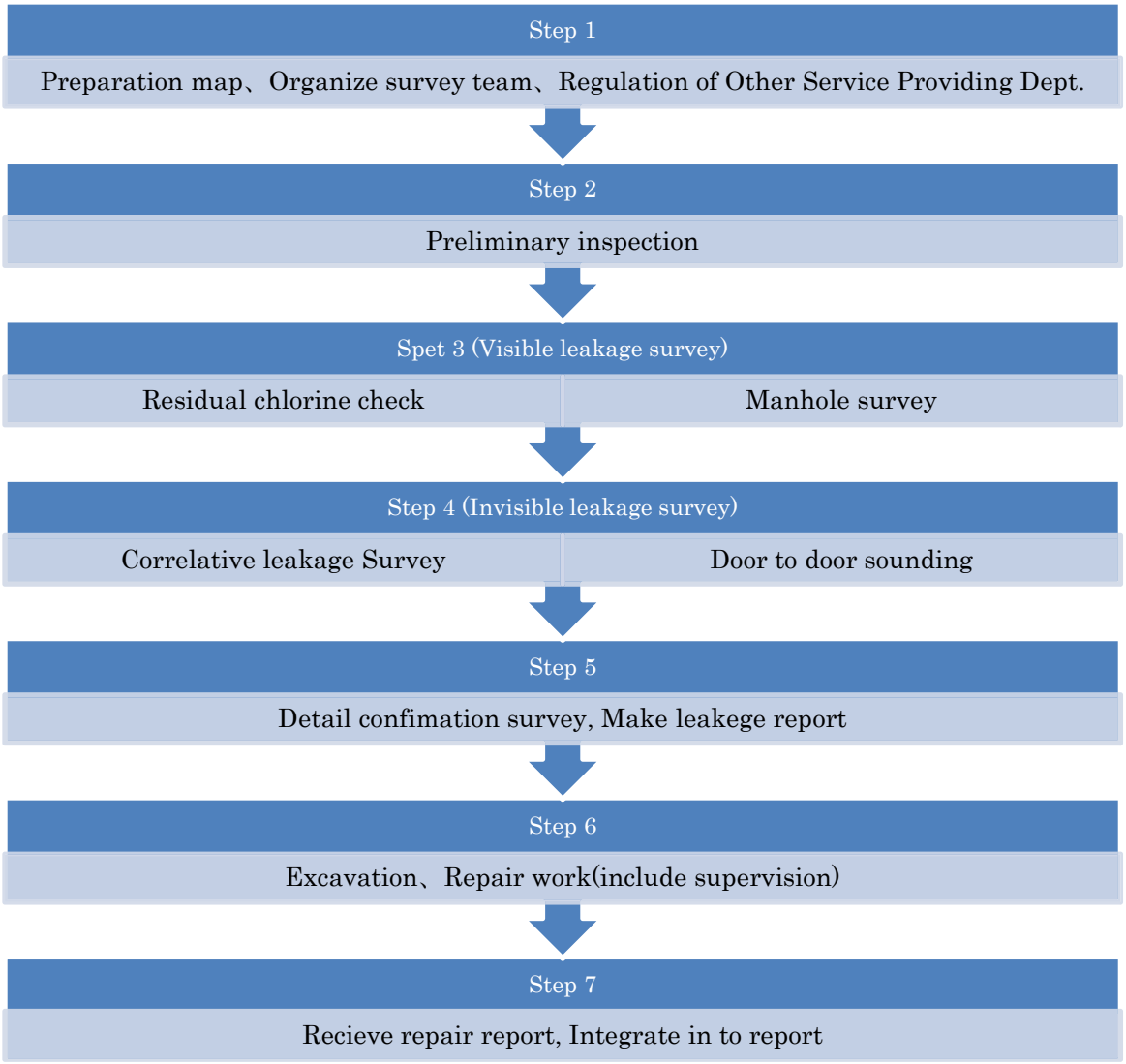


Figure 6.4.3 Leakage survey・Repair work flow chart

(iii) Consideration of survey method in this pilot.

(a) Visible leakage (Surface leakage)
- Manhole survey
In this survey, it is estimated whether or not the drainage to sewage and side grooves has water leakage. Chlorine reagent is used for leakage presence.

- Residual chlorine check
In this survey, residual chlorine reagent is used to find whether the ground water leak is WASA water.

(b) Invisible leakage (Underground leakage)
- Door to door survey
In this survey, a sound bar will be used for connection pipes of each house to distinguish the sound for leakage.
- Correlative leakage survey
This survey is a method to catch leakage noise transmitted through pipe line by leakage correlator. Then, by automatic analysis of the equipment, the possibility of water leakage and the position of water leakage are detected.

- Detail confirmation survey
In this survey, confirm the pinpoint of leakage found other surveys. The following is the procedure and image of

the survey.

- Making hole(boring) on the road by hummer drill and boring bar
- Acoustic rod insert into near pipe
- With the intensity of the audible leak noise, it approaches the water leakage point
- Repeat steps 1 to 4 to find water leakage

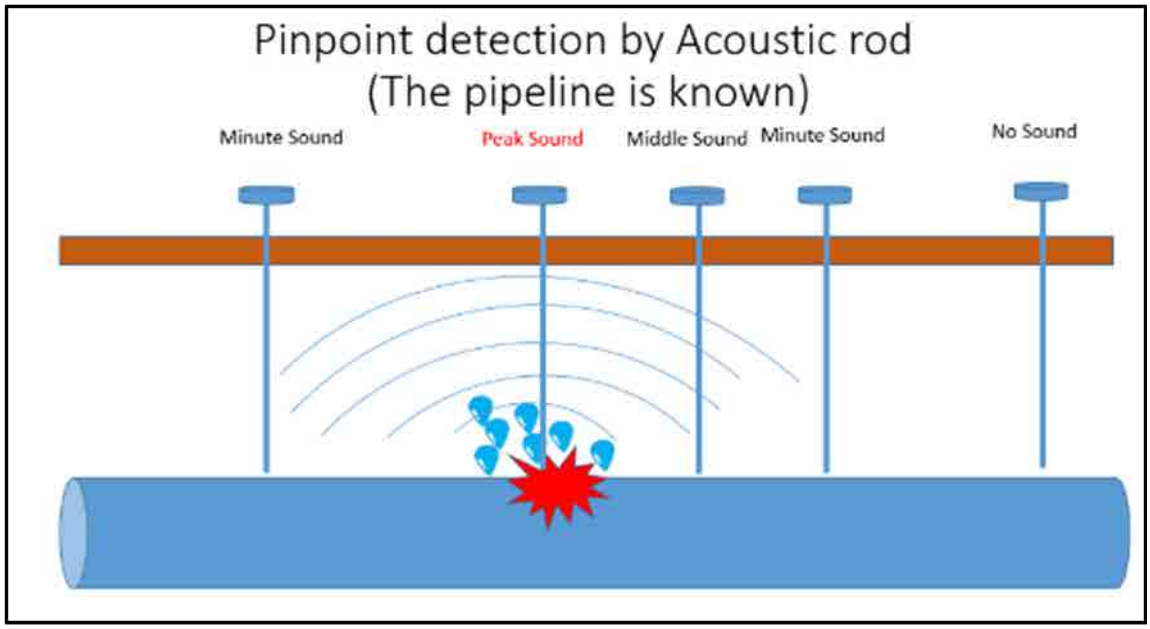


Figure 6.3.4 Image of detail confirmation survey

(d) Creation of standard for survey plan

Accumulation and man-hours are necessary to plan and implement the leakage survey. We will create a standard for WASA-F to conduct by result of pilot activity.

(e) Equipment

Chart 6.3.1 List of leakage survey equipment

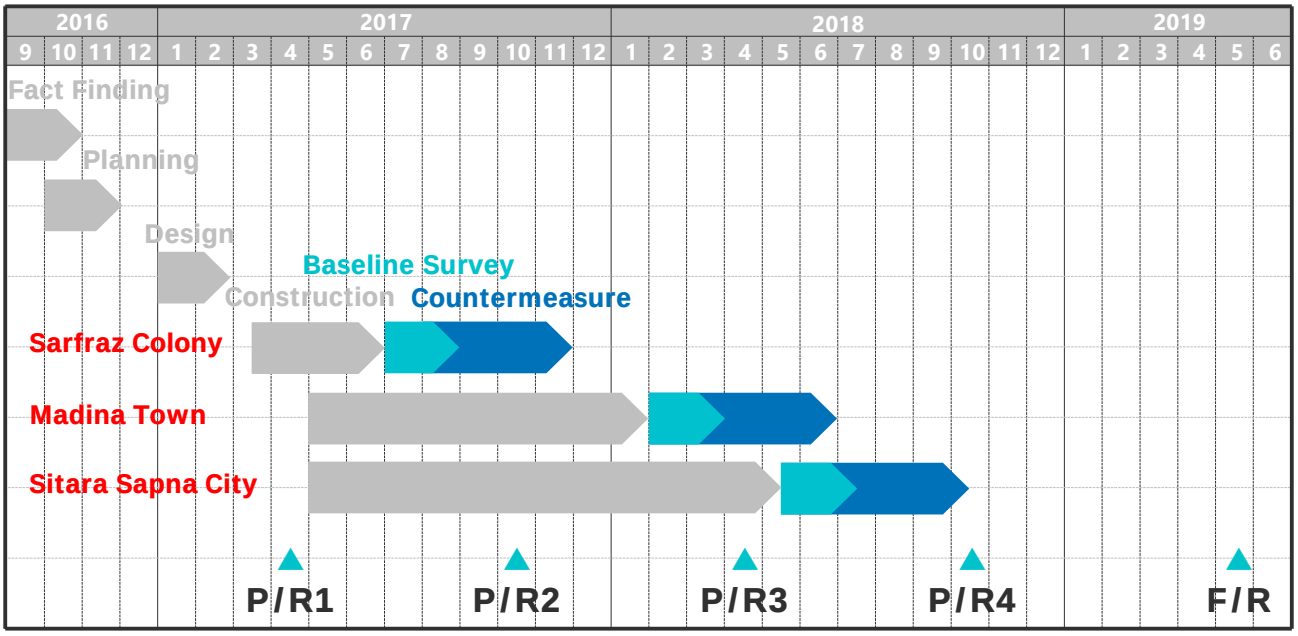
Name of equipment	Intended purpose
Ultrasonic Flow Meter	Flow Measurement
Water pressure logger	Water pressure test
Acoustic rod	Door to door sounding Detail confirmation survey
Leak detector	Detail confirmation survey
Leak noise correlator	Correlative leakage Survey
Leak noise correlator (Multiple type)	Correlative leakage Survey
Non-metal pipe detector	Non-Pipe locating
Metal pipe locator	Metal-Pipe locating
Test meter for customer meter	Meter accuracy check
Residual chorine kit	Visible leakage survey
Boring bar	Detail confirmation survey
Road measure	Correlative leakage Survey
Drill bid	Detail confirmation survey
Generator	Detail confirmation survey
Hummer drill	Detail confirmation survey

(iv) Leak repair work

The goal is to establish a proper repair system. Particularly improvement in construction method, construction procedure, repair parts, material and attitude is desired.

Chapter 7 Schedule of Pilot Activities

The schedule of pilot activities is as follows. More detailed schedule is described in Appendix 4.



Chapter 8 Establishment of Taskforce Team, “SMART WASA”

In this project, in order to establish the data management structure and the distribution management system, finally improve the financial situation, JMT proposed to establish the taskforce team in WASA-F and it was approved. Taskforce team was named “SMART WASA (Supply Management And Revenue Team WASA Faisalabad)”.

This team was intended to be a cross-organizational team of clerical staff (billing collection) and technical staff (water distribution management), and a cross-hierarchical team by mixing head quarter staff and field staff.

The pilot activities verify the actual situation of water supply in WASA-F, create the correct pipeline map, develop the database of all customers, establish the distribution management system, improve the customer relations, improve the billing collection and reduce the NRW. To solve these problems, the corporation of clerical staff and technical staff is necessary. By establishing this team, it is expected to enhance the information sharing beyond the boundaries of the job.

In addition, there is a huge gap between the head quarter staff and field staff in WASA-F. In the pilot activities, it is also expected to implement the practical activities involving field staff without restricting to paper activities by head quarter staff.

The proposal and the member list of SMART WASA are described in Appendix 3.

Pilot Area Selection criteria

The selection of pilot area is based on flowing key features:

Water Source:

The quality of ground water in Faisalabad city is poor so multiple water sources are developed to provide water to the city. All the water sources are connected to water supply network. Due to intermittent water supply timing system, the extension of water supply time in specific area requires some modifications for conveyance of water during off time in this area. Priority is given to the area where least modifications in the existing system are required for conveyance of water. The comparison of candidate sites for this facility is as below

Parameters	Sitara Sapna	G M Abad	Sarftaz Colony	Madina Town	Gulberg
Water Source	TR	TR	JK WW + TR	RBC	TR
Connection	With Arterial Main	With Arterial Main	With Arterial Main	Dedicated Transmission main	With Arterial Main
Availability	Without special operation	Without special operation	With special operation	With special operation	With special operation
Ranking	A	A	B	A	B

Storage Facilities:

The storage capacity is the one the main feature for planning continuous water supply in pilot area. According to PHE criteria, 10% average day demand capacity of overhead storage and 25% average day demand capacity for ground storage is desired. The comparison of candidate sites for this facility is as below:

Parameters	Sitara Sapna	G M Abad	Sarftaz Colony	Madina Town	Gulberg
Storage Capacity	OHR=Nil GST=Nil	OHR=50,000 G GST=300,000 G	OHR=50,000 G GST=100,000 G	OHR=100,000 G GST=400,000 G	OHR=50,000 G GST=200,000 G
Current Status	N/A	Operational	Operational	OHR not operational & GST under construction	OHR not operational
Population serving capacity	N/A	12500 person	12500 person	25000 person	12500 person
Ranking	C	A	A	B	B

Distribution Network:

The water supply distribution network of pilot area has been analyzed for suitability of pilot activities. After the hydraulic isolation of pilot area, the network is hydraulically analyzed to ensure minimum terminal pressure of 12m as prescribed by PHE design criteria. The confirmation of hydraulic analysis result may be carried out later in the field. Due to hydraulic isolation of pilot areas, the effect of water supply services is determined for the adjoining areas and counter measures shall be adopted to restore the services in these area. The comparison of candidate sites for this parameter is as below:

Parameters	Sitara Sapna	G M Abad	Sarftaz Colony	Madina Town	Gulberg
Age of pipeline	<10 years	>10 years and <15 years	<10 years	<10 years	>10 years and <15 years
Hydraulic Isolation	Isolated	Modification desired	Isolated but not confirmed	Modification desired	Modification desired
Effect on Adjoining areas	No effect	Modification desired	No effect	No effect	Modification desired
Hydraulic Efficiency	Satisfactory with input of 20 m head	To be checked	Satisfactory with 25m head	To be checked	To be checked
Contamination complaints	No complaint	Mild	severe	severe	mild
Ranking	A	C	B	B	C

Sewerage & Drainage

The sanitation conditions of the area are also taken into account for selection of pilot area. Better sanitation conditions will encourage more consumers for payment of WASA tariff whereas poor sewerage services will result in poor payment of WASA tariff. The comparison of sewerage services in candidate areas is as below:

Parameters	Sitara Sapna	G M Abad	Sarftaz Colony	Madina Town	Gulberg
Age of pipeline	<10 years	>10 years and <15 years	>15 years some portion <5 year	<10 years	>15 years
Adequacy of system					
Storm water drainage	Available	Not available	Not available	Not available	Not available
Flooding / ponding points	NO	YES	NO	YES	YES
Ranking	A	B	B	C	C

Consumer Database:

The availability of all household data base is one of the key features for collection of water tariff and evaluation of NRW. Accurate database is necessarily required not only for efficient billing collection but also for designing of facilities. The current collection ratio and income level of consumers are also kept in mind for selection of pilot area. The comparison of parameters relating to consumers is as below:

Parameters	**Sitara Sapna**	**G M Abad**	**Sarftaz Colony**	**Madina Town**	**Gulberg**
Database	Yes	No	Yes	Yes	No
Collection Ratio	64.7%	38.9%	48.2%	55.1%	54.5%
Income level	Rich Class	Poor/Moderate	Moderate	Poor/Moderate	Poor/Moderate
Total household	272	2072	801	4686	1111
Ranking	A	C	B	B	C

Evaluation/Selection for M/P pilot area

Name of area: SITARA SADNA

DMZ

DMA

Total area

Land use

✓	Domestic		Industry		Commercial		
	Hybrid						

Estimated household Max = 634 Current =

1 Water Supply

1.1 Water Source

	Independent
✓	Direct connection to arterial main (without valve operation)
	Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type No Storage

	dedicated		Hybrid

Storage capacity

Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)

Estimated No. of refilling

Dedicated stroage: Is capacity sufficient for area (with extra supply hours)

Estimated No. of refilling

Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply

Estimated No. of refilling

Current condition of storage facility

Structure:

Any updataion

Piping :

Any updataion

Machinery:

Any updataion

1.3 Distribution Network:

Age of distribution network 5 yrs

Isolation of distribution network 4 cs

Capacity of distribution network (by hydraulic modeling/analysis):

Sufficient

Hydraulic efficiency of distribution network:

Good

Any updation required in distribution network

Isolation valves 2 No but confirm if already available

No. of inflow points: NIL

No. of outflow points: One

Intensity of valve operation during WASA supply to other area

1 valve

Current inflow to the area (actual or estimated)

Current pressure of distribution network < 2 bar

Percentage of pumps on WASA line 60%

2. Sewerage & Drainage

Age of sewerage system: 5 years

Sewerage type

✓	Pipe		Drains		Both pipe & drains

Condition of sanitation facilities: Good

Storm water drainage system	✓	Yes		No
Ponding / flooding areas		Yes	✓	No
No of ponding points			X	

3. Consumers

Availability of all household database: Yes

Reliability of household database: Reliable

Visibilty %age of water connection: 80 ~ 90 %

Estimated %age of illegal connections: < 10 %

Current physical collection ratio of area: 60%

Educational status of consumers in the area: Good / educated

Financial status of consumers in the area: Rich

Current water usage by household

	WASA		Ground	✓	~~Both~~ Bottle	✓	ALL

Concluding Remarks

Evaluation/Selection for M/P pilot area

Name of area: MADINA TOWN BLOCK X
DMZ
DMA
Total area
Land use [✓] Domestic [ ] Industry [✓] Commercial [ ] Hybrid
Estimated household

1. Water Supply

1.1 Water Source

- [✓] Independent
- [ ] Direct connection to arterial main (without valve operation)
- [ ] Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type
[ ] dedicated [✓] Hybrid Underconstruction
Storage capacity 50000 + 100000
Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)
Estimated No. of refilling
Dedicated stroage: Is capacity sufficient for area (with extra supply hours)
Estimated No. of refilling
Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply
Estimated No. of refilling

N/A as water source is independent

Current condition of storage facility
Structure: Good
Any updataion Minor Repairs
Piping : Satisfactny
Any updataion Moderate repairs
Machinery: Satisfactny
Any updataion

1.3 Distribution Network:

Age of distribution network >10 years
Isolation of distribution network Not isolated

Capacity of distribution network (by hydraulic modeling/analysis): To be evaluated
Hydraulic efficiency of distribution network: To be evaluated
Any updation required in distribution network To be evaluated
No. of inflow points: OHR + Direct supply
No. of outflow points: >5
Intensity of valve operation during WASA supply to other area Frequently
Current inflow to the area (actual or estimated)
Current pressure of distribution network
Percentage of pumps on WASA line >70%

2. Sewerage & Drainage

Age of sewerage system >15 years
Sewerage type
[✓] Pipe [ ] Drains [ ] Both pipe & drains
Condition of sanitation facilities Poor
Storm water drainage system [ ] Yes [✓] No
Ponding / flooding areas [✓] Yes [ ] No
No of ponding points Approx 2

3. Consumers

Availability of all household database

Not complete database

Reliability of household database

Visibilty %age of water connection

Less than 50%

Estimated %age of illegal connections

>25 %

Current physical collection ratio of area

Educational status of consumers in the area

Moderate

Financial status of consumers in the area

Poor ~ moderate / middle

Current water usage by household

[ ] WASA [ ] Ground [✓] Both

* Remarks

- Network isolation / Block creation can be difficult.
- Sanitation conditions shall be checked & improved.
- Storage facility need to be constructed

Evaluation/Selection for M/P pilot area

Name of area: GULBERG
DMZ
DMA
Total area
Land use [✓] Domestic [ ] Industry [ ] Commercial [ ] Hybrid

Estimated household

1 - Water Supply

1.1 Water Source

[ ] Independent
[ ] Direct connection to arterial main (without valve operation)
[✓] Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type
[ ] dedicated [✓] Hybrid
Storage capacity 50000 + 200000
Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)
Estimated No. of refilling 4~5
Dedicated stroage: Is capacity sufficient for area (with extra supply hours)
Estimated No. of refilling
Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply
Estimated No. of refilling
Current condition of storage facility Satisfactry but non operative
Structure:
Any updataion Repairs Required
Piping :
Any updataion Major Reparirs
Machinery:
Any updataion May have to be checked

1.3 Distribution Network:

Age of distribution network >10 yrs
Isolation of distribution network Not isolated

Capacity of distribution network (by hydraulic modeling/analysis):
To be checked
Hydraulic efficiency of distribution network:
To be checked
Any updation required in distribution network
To be checked
No. of inflow points: 1, To be determined
No. of outflow points: >4
Intensity of valve operation during WASA supply to other area
Freqwent
Current inflow to the area (actual or estimated)
Current pressure of distribution network
Percentage of pumps on WASA line >80 %

2. Sewerage & Drainage

Age of sewerage system >15 yrs
Sewerage type
[✓] Pipe [ ] Drains [ ] Both pipe & drains
Condition of sanitation facilities
Storm water drainage system [✓] Yes [ ] No
Ponding / flooding areas [✓] Yes [ ] No
No of ponding points >1

3. Consumers

Availability of all household database

Not Complete

Reliability of household database

Visibilty %age of water connection

Estimated %age of illegal connections

>25%

Current physical collection ratio of area

Educational status of consumers in the area

Middle

Financial status of consumers in the area

Poor ~ Middle

Current water usage by household

[ ] WASA [ ] Ground [✓] Both

Remarks

Evaluation/Selection for M/P pilot area

Name of area: SARFRAZ COLONY
DMZ
DMA
Total area
Land use [✓] Domestic [ ] Industry [ ] Commercial [ ] Hybrid
Estimated household

1. Water Supply

1.1 Water Source

[ ] Independent
[ ] Direct connection to arterial main (without valve operation)
[✓] Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type
[ ] dedicated [✓] Hybrid
Storage capacity
Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)
Estimated No. of refilling No. < 30 min OHR capacity
Dedicated stroage: Is capacity sufficient for area (with extra supply hours)
Estimated No. of refilling Yes for 12500 persons
Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply
Estimated No. of refilling Approx 20 times, 10~12 times during supply hours
Current condition of storage facility Good
Structure:
Any updataion Minor Repairs
Piping :
Any updataion Minor changes
Machinery:
Any updataion currently OK. But more efficient machinery is good Need electricity backup.

1.3 Distribution Network:

Age of distribution network < 10 years
Isolation of distribution network OK

Capacity of distribution network (by hydraulic modeling/analysis):
OK
Hydraulic efficiency of distribution network:
Ok
Any updation required in distribution network
Valve installation & meter caliberation
No. of inflow points: 1
No. of outflow points: Approx 2~3
Intensity of valve operation during WASA supply to other area
2~3 valves or make alternate arrangment
Current inflow to the area (actual or estimated)
Current pressure of distribution network < 0.2 bar
Percentage of pumps on WASA line more than 90%

2. Sewerage & Drainage

Age of sewerage system > 15 years
Sewerage type
[✓] Pipe [ ] Drains [ ] Both pipe & drains
Condition of sanitation facilities
Storm water drainage system [ ] Yes [✓] No
Ponding / flooding areas [✓] Yes [ ] No During rain
No of ponding points

3. Consumers

Availability of all household database

Fresh Survey for all houses

Reliability of household database

as above

Visibilty %age of water connection

Less than 50%

Estimated %age of illegal connections

20~30% estimated

Current physical collection ratio of area

Educational status of consumers in the area

Middle

Financial status of consumers in the area

Good

Current water usage by household

[ ] WASA [ ] Ground [ ] ~~Both~~ Bottle

✓ All of above

Remarks :-

* To confirm water pressure
* To make arrangments for alternate route/source of water for other areas connected to OHR.
* Sanitation services shall be confirmed from concerned O&M department.

Evaluation/Selection for M/P pilot area

Name of area: GM abad DA block
DMZ
DMA
Total area
Land use [ ] Domestic [ ] Industry [ ] Commercial
[✓] Hybrid
Estimated household

1. Water Supply

1.1 Water Source

[ ] Independent
[✓] Direct connection to arterial main (without valve operation)
[ ] Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type
[ ] dedicated [✓] Hybrid
Storage capacity 300,000 Gal
Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)
Estimated No. of refilling Yes 2 Times Filling
Dedicated stroage: Is capacity sufficient for area (with extra supply hours)
Estimated No. of refilling Not Required
Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply
Estimated No. of refilling Yes 2 times
Current condition of storage facility Repairs required
Structure:
Any updataion Minor Repair
Piping :
Any updataion Flow measurment not available.
Machinery: Pumps to be checked
Any updataion Alternate electricity

1.3 Distribution Network:

Age of distribution network more than 10 years
Isolation of distribution network To be checked

Capacity of distribution network (by hydraulic modeling/analysis):
To be checked in model
Hydraulic efficiency of distribution network:
To be checked
Any updation required in distribution network

No. of inflow points: 1
No. of outflow points: To be confirmed
Intensity of valve operation during WASA supply to other area
Check isolation of network
Current inflow to the area (actual or estimated)
Current pressure of distribution network
Percentage of pumps on WASA line Rarely

2. Sewerage & Drainage

Age of sewerage system
Sewerage type
[✓] Pipe [ ] Drains [ ] Both pipe & drains
Condition of sanitation facilities Poor
Storm water drainage system [ ] Yes [✓] No
Ponding / flooding areas [ ] Yes [ ] No } To be checked
No of ponding points

3. Consumers

Availability of all household database

Need Fresh Survey

Reliability of household database

Need Fresh survey

Visibilty %age of water connection

Approx 50 %

Estimated %age of illegal connections

More than 30 %

Current physical collection ratio of area

Educational status of consumers in the area

Financial status of consumers in the area

Poor

Current water usage by household

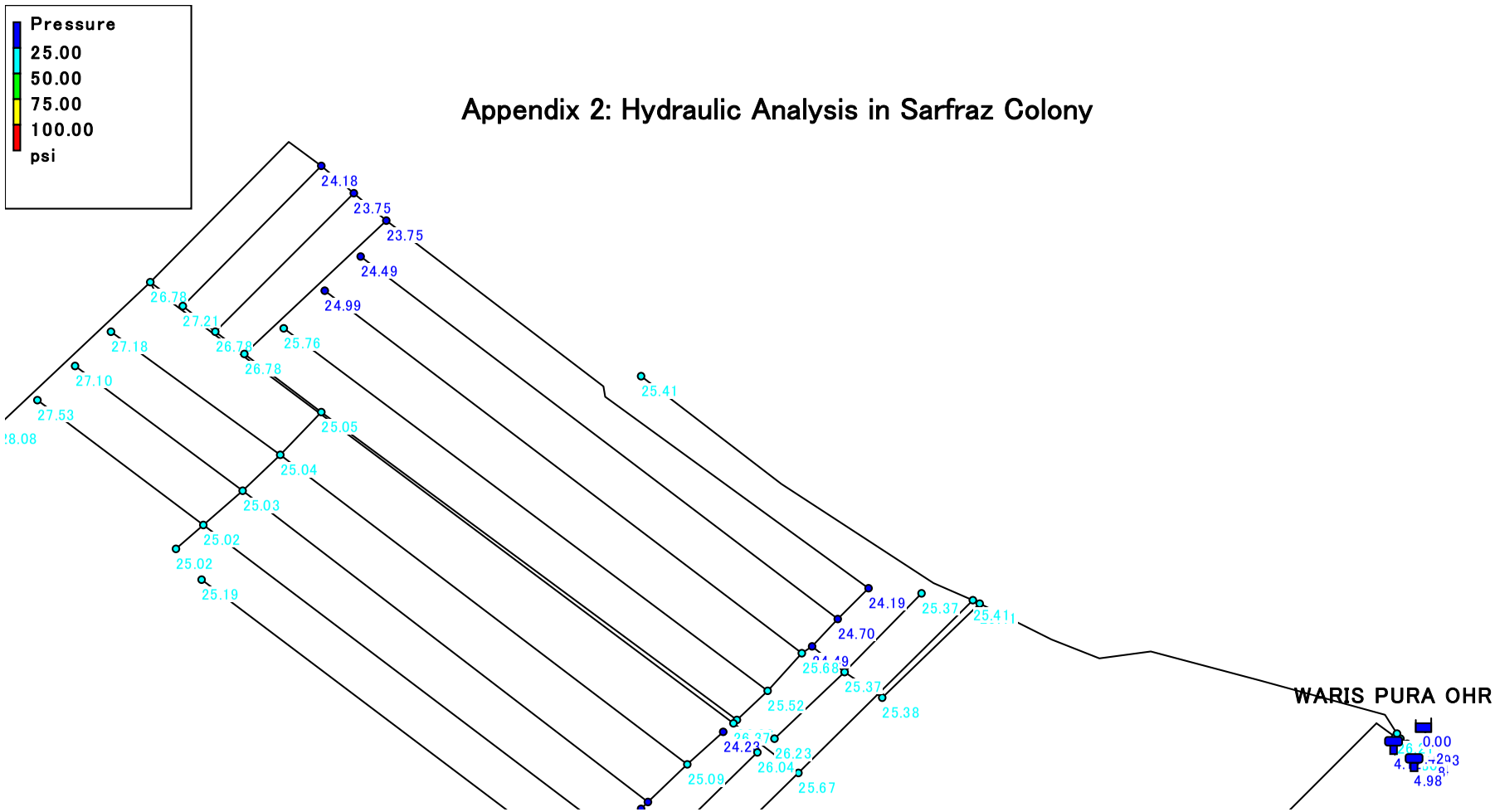
[ ] WASA [ ] Ground [✓] Both

Remarks :-

Already supplied water pressure is good but duration is 6 ~ 7 hours. but collection ratio is less

* May need improve sanitation services also. confirm from O&M WASA
* Need to educate ~~more~~ people more.

Appendix 2: Hydraulic Analysis in Sarfraz Colony



Network Table - Nodes

Node ID	Elevation ft	Base Demand GPM	Pressure psi
Junc J2	609	0	6.93
Junc J3	609	0	0.24
Junc J4	611	0	-0.68
Junc J5	611	0	25.80
Junc J6	610	0	26.21
Junc J7	610	0	17.42
Junc J8	610	0	26.21
Junc J9	610	0	26.21
Junc J10	611	0	25.41
Junc J11	611	16	25.78
Junc J12	611	0.1	25.41
Junc J13	611	0	25.38
Junc J14	610	1.2	25.67
Junc J15	610	1.6	25.63
Junc J16	610	1	25.63
Junc J17	611	1	25.19
Junc J18	611	1.167	25.37
Junc J19	611	0.3472	25.37
Junc J20	613	2.722	24.49
Junc J21	612	8.75	24.70
Junc J22	613	8.361	24.19
Junc J23	610	9.333	25.68
Junc J24	610	7.778	25.52
Junc J25	608	3.11	26.36
Junc J26	608	0	26.37
Junc J27	611	5.389	25.09
Junc J28	613	2.5	24.23
Junc J29	612	5.389	24.71
Junc J30	612	2	24.73
Junc J31	612	3.7	24.70
Junc J32	611	3.11	25.13
Junc J33	610	2.2	25.61
Junc J34	609	2.2	26.04

Node ID	Elevation ft	Base Demand GPM	Pressure psi
Junc J35	610	1	25.61
Junc J36	611	1	25.19
Junc J37	614	1.45	23.75
Junc J38	614	2.9	23.75
Junc J39	613	4	24.18
Junc J40	607	1	26.78
Junc J41	606	4.167	27.21
Junc J42	607	3	26.78
Junc J43	607	1.5	26.78
Junc J44	609	7	25.76
Junc J45	611	8.167	24.99
Junc J46	612	7.583	24.49
Junc J47	611	1	25.05
Junc J48	611	1	25.04
Junc J49	611	1	25.03
Junc J50	606	3.7	27.18
Junc J51	606	8.2	27.10
Junc J52	605	8.4	27.53
Junc J53	611	1	25.02
Junc J54	611	4.6	25.02
Junc J55	604	4	28.08
Junc J56	609	2.2	26.23
Junc J57	611	0	25.41
Resvr R1	625	#N/A	0.00
Tank T1	661	#N/A	4.12
Tank T2	598	#N/A	4.98

Proposal for forming a task team, "SMART WASA"

WASA-F should form a task team for water distribution management, named "SMART WASA", Supply Management and Revenue Team of WASA Faisalabad.

In pilot activities in 3 pilot areas, Sitara Sapna City, Sarfaz Colony and Madina Town, JICA Mission Team and WASA-F tries to supply safe drinking water for 24/18 hour with proper pressure, after that we can improve the billing collection and reduce NRW. In order to achieve this, it is required to grasp the actual situation in 3 pilot areas, such as water supply / pipeline condition, customer mind / behavior, power supply condition, etc., and therefore, we should involve the operation staff.

Member List of SMART WASA

Name	Designation	Responsibility
Mr. Shoaib Rasheed	Director (R&R)	Team Leader
Mr. M. Farhan Ali	DD I.T.	Sub-leader of revenue side in WASA-F
Mr. Mohsin	Revenue officer	Revenue Activities
Mr. Muhammad Ramzan	Revenue officer	Revenue Activities
Mr. Tassawar Hussain	AD GIS	Parcel Mapping
Mr. Farhan Akram	DD Water	Sub-leader of technical side in WASA-F
Mr. Asad Ali	AD F.F.P.	Hydraulic Separation, etc.
Mr. Muhammad Boota	AD Water	Area in charge regarding Water in Sarfraz Colony
Mr. Atiq-ur-Rehman	Sub Engineer	Overall Supervision in Sarfraz Colony
Mr. Ghulam Rasool	Water Supply Supervisor	Leakage control etc. in Sarfraz Colony
Mr. Riazul Haq Alvi	AD Water	Area incharge regarding Water in Sitara Sapna & Madina Town
Mr. Zulkarnan Haider	Sub Engineer	Overall Supervision in Sitara Sapna & Madina Town
Mr. Muhammad Afzal	Water Supply Supervisor	Leakage control etc. in Sitara Sapna & Madina Town

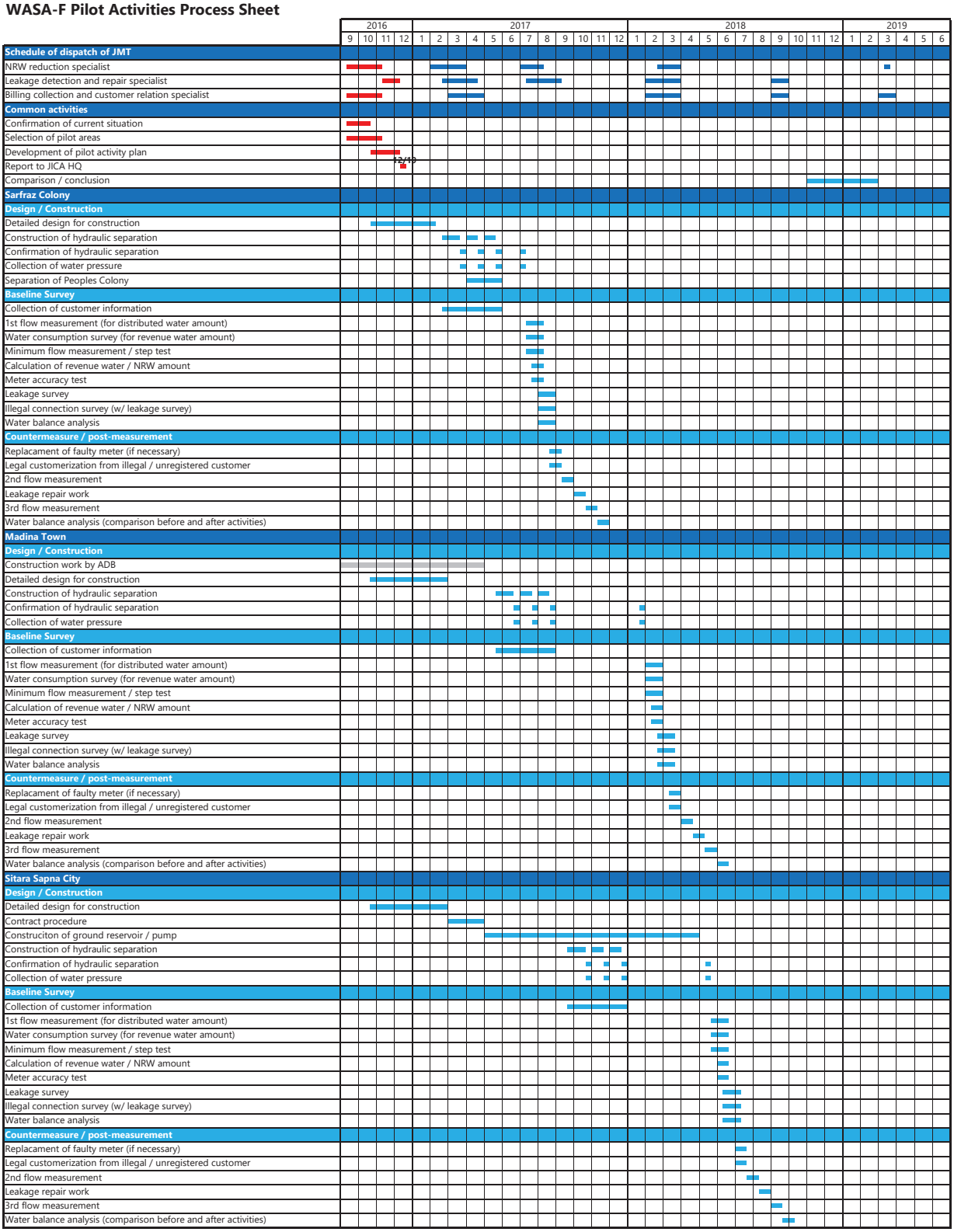
Member List of SMART JMT

Name	Designation	Responsibility
Mr. Hoshino	Team Leader	Team leader from JICA side
Mr. Pervaiz Iqbal	Coorinator	Coordinator and supervisor
Mr. Murakami	Billing collection and customer relation specialist	Billing collection and customer relation
Mr. Segawa	NRW reduction specialist	Distribution Management
Mr. Matsuoka	Leakage detection specialist	NRW reduction activities

Our targets;

- To develop the database of all customers in 3 pilot areas
- To verify the actual current situation of water supply in 3 pilot areas
- To create the correct pipeline map in 3 pilot areas
- To hydraulically isolate the 3 pilot areas
- To achieve the 18 hours water supply in 3 pilot areas
- To ensure the proper water pressure in 3 pilot areas
- To supply safety water (to guarantee the supply water quality)
- To achieve the water distribution management system in 3 pilot areas
- To improve the billing collection in 3 pilot areas
- To improve the customer relation in 3 pilot areas
- To reduce NRW in 3 pilot areas

WASA-F Pilot Activities Process Sheet



AF1.2 Pilot Area Selection

Pilot Area Selection criteria

The selection of pilot area is based on flowing key features:

Water Source:

The quality of ground water in Faisalabad city is poor so multiple water sources are developed to provide water to the city. All the water sources are connected to water supply network. Due to intermittent water supply timing system, the extension of water supply time in specific area requires some modifications for conveyance of water during off time in this area. Priority is given to the area where least modifications in the existing system are required for conveyance of water. The comparison of candidate sites for this facility is as below

Parameters	Sitara Sapna	G M Abad	Sarftaz Colony	Madina Town	Gulberg
Water Source	TR	TR	JK WW + TR	RBC	TR
Connection	With Arterial Main	With Arterial Main	With Arterial Main	Dedicated Transmission main	With Arterial Main
Availability	Without special operation	Without special operation	With special operation	With special operation	With special operation
Ranking	A	A	B	A	B

Storage Facilities:

The storage capacity is the one the main feature for planning continuous water supply in pilot area. According to PHE criteria, 10% average day demand capacity of overhead storage and 25% average day demand capacity for ground storage is desired. The comparison of candidate sites for this facility is as below:

Parameters	Sitara Sapna	G M Abad	Sarftaz Colony	Madina Town	Gulberg
Storage Capacity	OHR=Nil GST=Nil	OHR=50,000 G GST=300,000 G	OHR=50,000 G GST=100,000 G	OHR=100,000 G GST=400,000 G	OHR=50,000 G GST=200,000 G
Current Status	N/A	Operational	Operational	OHR not operational & GST under construction	OHR not operational
Population serving capacity	N/A	12500 person	12500 person	25000 person	12500 person
Ranking	C	A	A	B	B

Distribution Network:

The water supply distribution network of pilot area has been analyzed for suitability of pilot activities. After the hydraulic isolation of pilot area, the network is hydraulically analyzed to ensure minimum terminal pressure of 12m as prescribed by Punjab design criteria. The confirmation of hydraulic analysis result may be carried out later in the field. Due to hydraulic isolation of pilot areas, the effect of water supply services is determined for the adjoining areas and counter measures shall be adopted to restore the services in these area. The comparison of candidate sites for this parameter is as below:

Parameters	**Sitara Sapna**	**G M Abad**	**Sarftaz Colony**	**Madina Town**	**Gulberg**
Age of pipeline	<10 years	>10 years and <15 years	<10 years	<10 years	>10 years and <15 years
Hydraulic Isolation	Isolated	Modification desired	Isolated but not confirmed	Modification desired	Modification desired
Effect on Adjoining areas	No effect	Modification desired	No effect	No effect	Modification desired
Hydraulic Efficiency	Satisfactory with input of 20 m head	To be checked	Satisfactory with 25m head	To be checked	To be checked
Contamination complaints	No complaint	mild	severe	severe	mild
Ranking	A	C	B	B	C

Sewerage & Drainage

The sanitation conditions of the area are also taken into account for selection of pilot area. Better sanitation conditions will encourage more consumers for payment of WASA tariff whereas poor sewerage services will result in poor payment of WASA tariff. The comparison of sewerage services in candidate areas is as below:

Parameters	**Sitara Sapna**	**G M Abad**	**Sarftaz Colony**	**Madina Town**	**Gulberg**
Age of pipeline	<10 years	>10 years and <15 years	>15 years some portion <5 year	<10 years	>15 years
Adequacy of system					
Storm water drainage	Available	N/A	N/A	N/A	N/A
Flooding / ponding points	NO	YES	NO	YES	YES
Ranking	A	B	B	C	C

Consumer Database:

The availability of all household data base is one of the key features for collection of water tariff and evaluation of NRW. Accurate database is necessarily required not only for efficient billing collection but also for designing of facilities. The current collection ratio and income level of consumers are also kept in mind for selection of pilot area. The comparison of parameters relating to consumers is as below:

Parameters	**Sitara Sapna**	**G M Abad**	**Sarftaz Colony**	**Madina Town**	**Gulberg**
Database	Yes	No	Yes	Yes	No
Collection Ratio	64.7%	38.9%	48.2%	55.1%	54.5%
Income level	Rich Class	Poor/Moderate	Moderate	Poor/Moderate	Poor/Moderate
Total household	272	2072	801	4686	1111
Ranking	A	C	B	B	C

Evaluation/Selection for M/P pilot area

Name of area: SITARA SADAN

DMZ

DMA

Total area

Land use

✓	Domestic		Industry		Commercial		
	Hybrid						

Estimated household Max = 634 Current =

1 Water Supply

1.1 Water Source

	Independent
✓	Direct connection to arterial main (without valve operation)
	Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type No Storage

	dedicated		Hybrid

Storage capacity

Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)

Estimated No. of refilling

Dedicated stroage: Is capacity sufficient for area (with extra supply hours)

Estimated No. of refilling

Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply

Estimated No. of refilling

Current condition of storage facility

Structure:

Any updataion

Piping :

Any updataion

Machinery:

Any updataion

1.3 Distribution Network:

Age of distribution network 5 yrs

Isolation of distribution network Ycs

Capacity of distribution network (by hydraulic modeling/analysis):

Sufficient

Hydraulic efficiency of distribution network:

Good

Any updation required in distribution network

Isolation valves 2 No but confirm if already available

No. of inflow points: NIL

No. of outflow points: One

Intensity of valve operation during WASA supply to other area

1 valve

Current inflow to the area (actual or estimated)

Current pressure of distribution network < 2 bar

Percentage of pumps on WASA line 60%

2. Sewerage & Drainage

Age of sewerage system: 5 years

Sewerage type

✓	Pipe		Drains		Both pipe & drains

Condition of sanitation facilities: Good

Storm water drainage system	✓	Yes		No
Ponding / flooding areas		Yes	✓	No
No of ponding points			X	

3. Consumers

Availability of all household database: Yes

Reliability of household database: Reliable

Visibilty %age of water connection: 80 ~ 90 %

Estimated %age of illegal connections: < 10 %

Current physical collection ratio of area: 60%

Educational status of consumers in the area: Good / educated

Financial status of consumers in the area: Rich

Current water usage by household

	WASA		Ground	✓	~~Both~~ Bottle	✓	ALL

Concluding Remarks

Evaluation/Selection for M/P pilot area

Name of area: MADINA TOWN BLOCK X
DMZ
DMA
Total area
Land use [✓] Domestic [ ] Industry [✓] Commercial [ ] Hybrid
Estimated household

1. Water Supply

1.1 Water Source

- [✓] Independent
- [ ] Direct connection to arterial main (without valve operation)
- [ ] Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type
[ ] dedicated [✓] Hybrid Underconstruction
Storage capacity 50000 + 100000
Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)
Estimated No. of refilling
Dedicated stroage: Is capacity sufficient for area (with extra supply hours)
Estimated No. of refilling
Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply
Estimated No. of refilling

N/A as water source is independent

Current condition of storage facility
Structure: Good
Any updataion Minor Repairs
Piping : Satisfactny
Any updataion Moderate repairs
Machinery: Satisfactny
Any updataion

1.3 Distribution Network:

Age of distribution network >10 years
Isolation of distribution network Not isolated

Capacity of distribution network (by hydraulic modeling/analysis): To be evaluated
Hydraulic efficiency of distribution network: To be evaluated
Any updation required in distribution network To be evaluated
No. of inflow points: OHR + Direct supply
No. of outflow points: >5
Intensity of valve operation during WASA supply to other area Frequently
Current inflow to the area (actual or estimated)
Current pressure of distribution network
Percentage of pumps on WASA line >70%

2. Sewerage & Drainage

Age of sewerage system >15 years
Sewerage type
[✓] Pipe [ ] Drains [ ] Both pipe & drains
Condition of sanitation facilities Poor
Storm water drainage system [ ] Yes [✓] No
Ponding / flooding areas [✓] Yes [ ] No
No of ponding points Approx 2

3. Consumers

Availability of all household database

Not complete database

Reliability of household database

Visibilty %age of water connection

Less than 50%

Estimated %age of illegal connections

>25 %

Current physical collection ratio of area

Educational status of consumers in the area

Moderate

Financial status of consumers in the area

Poor ~ moderate / middle

Current water usage by household

[ ] WASA [ ] Ground [✓] Both

* Remarks

- Network isolation / Block creation can be difficult.
- Sanitation conditions shall be checked & improved.
- Storage facility need to be constructed

Evaluation/Selection for M/P pilot area

Name of area: GULBERG
DMZ
DMA
Total area
Land use [✓] Domestic [ ] Industry [ ] Commercial [ ] Hybrid

Estimated household

1 - Water Supply

1.1 Water Source

[ ] Independent
[ ] Direct connection to arterial main (without valve operation)
[✓] Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type
[ ] dedicated [✓] Hybrid
Storage capacity 50000 + 200000
Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)
Estimated No. of refilling 4 ~ 5
Dedicated stroage: Is capacity sufficient for area (with extra supply hours)
Estimated No. of refilling
Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply
Estimated No. of refilling
Current condition of storage facility Satisfactry but non operative
Structure:
Any updataion Repairs Required
Piping :
Any updataion Major Reparirs
Machinery:
Any updataion May have to be checked

1.3 Distribution Network:

Age of distribution network > 10 yrs
Isolation of distribution network Not isolated

Capacity of distribution network (by hydraulic modeling/analysis):
To be checked
Hydraulic efficiency of distribution network:
To be checked
Any updation required in distribution network
To be checked
No. of inflow points: 1, To be determined
No. of outflow points: > 4
Intensity of valve operation during WASA supply to other area
Freqwent
Current inflow to the area (actual or estimated)
Current pressure of distribution network
Percentage of pumps on WASA line > 80 %

2. Sewerage & Drainage

Age of sewerage system > 15 yrs
Sewerage type
[✓] Pipe [ ] Drains [ ] Both pipe & drains
Condition of sanitation facilities
Storm water drainage system [✓] Yes [ ] No
Ponding / flooding areas [✓] Yes [ ] No
No of ponding points > 1

3. Consumers

Availability of all household database

Not Complete

Reliability of household database

Visibilty %age of water connection

Estimated %age of illegal connections

>25%

Current physical collection ratio of area

Educational status of consumers in the area

Middle

Financial status of consumers in the area

Poor ~ Middle

Current water usage by household

[ ] WASA [ ] Ground [✓] Both

Remarks

Evaluation/Selection for M/P pilot area

Name of area: SARFRAZ COLONY
DMZ
DMA
Total area
Land use [✓] Domestic [ ] Industry [ ] Commercial [ ] Hybrid
Estimated household

1. Water Supply

1.1 Water Source

[ ] Independent
[ ] Direct connection to arterial main (without valve operation)
[✓] Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type
[ ] dedicated [✓] Hybrid
Storage capacity
Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours)
Estimated No. of refilling No. < 30 min OHR capacity
Dedicated stroage: Is capacity sufficient for area (with extra supply hours)
Estimated No. of refilling Yes for 12500 persons
Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply
Estimated No. of refilling Approx 20 times, 10~12 times during supply hours
Current condition of storage facility Good
Structure:
Any updataion Minor Repairs
Piping :
Any updataion Minor changes
Machinery:
Any updataion currently OK. But more efficient machinery is good Need electricity backup.

1.3 Distribution Network:

Age of distribution network < 10 years
Isolation of distribution network OK

Capacity of distribution network (by hydraulic modeling/analysis):
OK
Hydraulic efficiency of distribution network:
Ok
Any updation required in distribution network
Valve installation & meter caliberation
No. of inflow points: 1
No. of outflow points: Approx 2~3
Intensity of valve operation during WASA supply to other area
2~3 valves or make alternate arrangment
Current inflow to the area (actual or estimated)
Current pressure of distribution network < 0.2 bar
Percentage of pumps on WASA line more than 90%

2. Sewerage & Drainage

Age of sewerage system > 15 years
Sewerage type
[✓] Pipe [ ] Drains [ ] Both pipe & drains
Condition of sanitation facilities
Storm water drainage system [ ] Yes [✓] No
Ponding / flooding areas [✓] Yes [ ] No During rain
No of ponding points

3. Consumers

Availability of all household database

Fresh Survey for all houses

Reliability of household database

as above

Visibilty %age of water connection

Less than 50%

Estimated %age of illegal connections

20~30% estimated

Current physical collection ratio of area

Educational status of consumers in the area

Middle

Financial status of consumers in the area

Good

Current water usage by household

[ ] WASA [ ] Ground [ ] ~~Both~~ Bottle

✓ All of above

Remarks :-

* To confirm water pressure
* To make arrangments for alternate route/source of water for other areas connected to OHR.
* Sanitation services shall be confirmed from concerned O&M department.

Evaluation/Selection for M/P pilot area

Name of area: GM abad DA block
DMZ
DMA
Total area
Land use

	Domestic		Industry		Commercial
✓	Hybrid				

Estimated household

1. Water Supply

1.1 Water Source

	Independent
✓	Direct connection to arterial main (without valve operation)
	Direct connection to arterial main (with valve operation)

1.2 Storage Facilities

Storage type

✓	dedicated	✓	Hybrid

Storage capacity 300,000 Gal
Dedicated stroage: Is capacity sufficient for area (to be filled during normal supply hours) Yes 2 Times Filling
Estimated No. of refilling
Dedicated stroage: Is capacity sufficient for area (with extra supply hours)
Estimated No. of refilling Not Required
Hybrid storage: Is capacity sufficient for pilot area 24/7 + other serving area 6 hr supply Yes 2 times
Estimated No. of refilling
Current condition of storage facility Repairs required
Structure:
Any updataion Minor Repair
Piping :
Any updataion Flow measurment not available.
Machinery: Pumps to be checked
Any updataion Alternate electricity

1.3 Distribution Network:

Age of distribution network more than 10 years
Isolation of distribution network To be checked

Capacity of distribution network (by hydraulic modeling/analysis): To be checked in model
Hydraulic efficiency of distribution network: To be checked
Any updation required in distribution network

No. of inflow points: 1
No. of outflow points: To be confirmed
Intensity of valve operation during WASA supply to other area Check isolation of network
Current inflow to the area (actual or estimated)
Current pressure of distribution network
Percentage of pumps on WASA line Rarely

2. Sewerage & Drainage

Age of sewerage system
Sewerage type

✓	Pipe		Drains		Both pipe & drains

Condition of sanitation facilities Poor

Storm water drainage system		Yes	✓	No
Ponding / flooding areas		Yes		No

No of ponding points

} To be checked

3. Consumers

Availability of all household database

Need Fresh Survey

Reliability of household database

Need Fresh survey

Visibilty %age of water connection

Approx 50 %

Estimated %age of illegal connections

More than 30 %

Current physical collection ratio of area

Educational status of consumers in the area

Financial status of consumers in the area

Poor

Current water usage by household

[ ] WASA [ ] Ground [✓] Both

Remarks :-

Already supplied water pressure is good but duration is 6 ~ 7 hours. but collection ratio is less

- May need improve sanitation services also. confirm from O&M WASA
- Need to educate ~~more~~ people more.