PCRWR

Comparative Assessment of Changa Pani and Traditional Water Supply Schemes

(Bhalwal, District Sargodha, Punjab)

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Pakistan Council of Research in Water Resources (PCRWR)
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List of Abbreviations

µS/cm	Micro Siemens Per Centimeter
µg/l	Micrograms Per Liter
APHA	American Public Health Association
ASB	Anjuman Samaji Behbood
CPP	Changa Pani Program
GPS	Global Positioning System
IMF	International Monetary Fund
mg/L	Milligram per liter
LPS	Liters per Second
MoU	Memorandum of Understanding
NDWQS	National Drinking Water Quality Standards
NGVS	No Guideline Value Set
NRW	Non-Revenue Water
NTU	Nephelometric Turbidity Units
NWQL	National Water Quality Laboratory
PCRWR	Pakistan Council of Research in Water Resources
PHED	Public Health Engineering Department
PKR	Pakistani Rupee
PMDFC	Punjab Municipal Development Fund Company
PPP	Public Private partnerships
ppb	Parts Per Billion
R&M	Repair & Maintenance
TDS	Total Dissolved Solids
TMA	Tehsil Municipal Administration
TW	Tubewell
UCs	Union Councils
WSS	Water Supply Scheme
WAPDA	Water and Power Development Authority

Executive Summary

Provision of safe drinking water is the fundamental human right and the responsibility of the state. However, in Pakistan safe water is available to hardly 36% of the population, mainly due to intermittent water supply, improperly designed water supply schemes, cross contamination caused by the closely laid water supply and sewage pipelines, disposal of untreated sewage and industrial effluents, and inadequate technical capacity of the service providers. Various initiatives such as Clean Drinking Water for All (CDWA) in 2004 and Punjab Saaf Pani Company (PSPC) in 2014 failed to provide any breakthrough regarding provision of safe drinking water. The main reasons of their failure were provision of decentralized solutions, lack of ownership, poor water pricing and lack of service delivery concept.

The Changa Pani Program (CPP) is a classic model of cost sharing and service delivery concept on the basis of public-private partnership. It was initiated by the City Government of Bhalwal and residents, facilitated by a civil society organization Anjuman Samaji Behbood (ASB).

The current study has assessed the effectiveness of CPP with respect to economic viability of metered water, water supply efficiency and consumer's satisfaction level, water quality status, and water losses. The methodology included both the quantitative and qualitative assessments using structured questionnaire surveys and water quality testing to identify the key success factors and needs for improvements.

Three tubewells of CPP water supply scheme provide over 6 million gallons of water to 2100 metered water connections in two union councils of tehsil Bhalwal (23 and 25) by operating for 12-15 hours a day. From bill payments by the consumers, CPP recovers about 87% of the total monthly expenditures. Contrary to the CPP, TMA recovers only 16% of the total expenditures incurred annually on its water supply scheme operated for about 5 hours daily.

Each household connection of CPP receives about an average of 100 gallons per day or about 16 gallons per person per day in a family of six persons. The community keeps in mind, less they use water, less they will have to pay. This behavioural change has led to overcome the water wastage, while there is about 240 gallons daily water wastage due to uncontrolled water supply by the TMA operated schemes. Consequently, this also controlled the electricity charges of CPP scheme.

The quality of water being supplied by the CPP (74% safe) was comparatively better than TMA's water supply (52% safe) both at the source and at the consumer's end. The better water quality of CPP is attributed to the uninterrupted water supply, less leakage, regular preventive and corrective maintenance. Consequently, the consumer's satisfaction ratio was much higher for the CPP (i.e. 79%) compared to the TMA's water supply (42%).

There were some minor issues observed in the CPP water supply scheme such as wrong installation of water meters, optimization disinfection at source and inadequate manpower. These were brought in the notice of CPP management, who were found highly committed to address these issues.

Projects like CPP could help in shaping the consumer behaviour for responsible use of water and could also improve the availability of safe water to the people. However, the replication of CPP model in other areas of the country would require enhancement of institutional capacity, rehabilitation of existing water supply infrastructure, public-private partnership arrangements and adoption of service delivery concept.

Acknowledgments

The authors are highly indebted to all professionals of National Water Quality Laboratory, PCRWR Islamabad for their assistance in water sampling, field data collection, and samples testing. Sincere and warm gratitude is due to Ms. Saiqa Imran, Ms. Kiran Anwaar, Ms. Rahila Noureen, Ms. Rizwana Perveen, Ms. Irum Gul, Ms. Farah Naz, Dr. Fauzia Altaf and Ms. Mufeezah Ahsan for testing of water samples and analytical data quality control. Special thanks are to Assistant Commissioner Bhalwal, Tehsil Municipal Administration Bhalwal, Mr. Nazir Ahmad Watoo, Chairman Anjuman Samaji Behbood (ASB), Mr. Faheem Ahmed Manager Changa Pani water supply for their assistance and support during the field survey. The authors are also thankful to Mr. Sohail Anjum, Mr. Zeeshan Munawar and Mr. Qismatullah for data entry and formatting the report. We are also thankful to Mr. Abdul Rehman and Mr. Qaiser Khurshid for collecting samples.

1. Introduction

Access to safe drinking water is the basic human right. Pakistan Vision 2025 and UN Sustainable Development Goals (SDG's) 2030 also impose obligations to ensure access to clean drinking water for all. The provision of safe drinking water is the responsibility of the state as per the constitution of Islamic Republic of Pakistan. However, after 18th amendment in the constitution, provision of safe drinking water falls within the domain of the provincial governments. Consequently, the responsibility sets on the district government organizations such as Tehsil Municipal Authority (TMA), Water and Sanitation Agency (WASA), Public Health Engineering Department (PHED) etc. These organizations have invested a lot on the infrastructure such as water supply schemes and piped network as well as on the manpower. Billions of rupees have been invested on the water supply systems over the years with little success in terms of safe water supply.

SDG 6.1: Safe and Affordable Drinking Water
"By 2030, achieve universal and equitable access to safe and affordable drinking water for all"

Pakistan's National Drinking Water Policy
"Drinking water supply will be aimed at provision of safe, affordable and sustainable supply of water to every citizen of Pakistan"

Pakistan's Vision 2025 (Goal 15)
"Ensure access to clean drinking water for all Pakistanis"

Various water quality monitoring studies (2001-2019) undertaken by Pakistan Council of Research in Water Resources (PCRWR) have revealed that about 70% of the water sources in urban areas and 82% in rural areas were found to be unsafe for drinking. Moreover, the assessment survey of about 10,000 water supply schemes undertaken by the PCRWR has further showed that 72% schemes were operational out of which only 23% and 14% in urban and rural areas, respectively were supplying safe drinking water. The main reasons of unsafe supply of water were outdated infrastructure, leakage in distribution system, intermittent supply, inadequate technical capacity of water supply agencies, lack of public awareness on quality issues and improper disposal of solid and liquid wastes.

Most of the water supply schemes in the country were built only to provide water to the communities. The lack of ownership, poor water pricing and lack of service delivery concept in the water supply agencies has played a major role in this failure. Since there is no water pricing mechanism in water supply sector, there is no service delivery practice. The World Bank had analyzed how access, quality of service, operational efficiency and tariffs have evolved under 65 public-private partnerships for urban water utilities in the developing countries. The study estimated that public-private partnership projects have provided access to piped water for more than 24 million people in developing countries since 1990 (Marin, 2009). Philippines is an example which has

made impressive progress in water supply provision through public private partnership arrangements and improved service delivery concept i.e. from 25% of the population with access to improved water sources in 1994 increased to 92% in 2012 (Castro *et al.,* 2015). The Public-Private Partnership (PPP) arrangements in Philippine were laid by reaching a win-win arrangement, where the operator provided quality services that consumers were willing to pay for. In the developed country like Canada having largest fresh water resource, the domestic water is also provided on volumetric basis and a meter is installed for each household to measure the amount of water used. Mostly, the household water charges in the countries like Canada and United Kingdom are found almost the same as those of electricity or gas (Qureshi and Ashraf, 2019).

A good service delivery concept is established by a shared understanding of service objective clear roles and a balancing of risks with rewards. Taking the advantage of lack of service delivery in public water supply schemes and poor quality of water in Pakistan, there was mushroom growth of bottled water companies. However, water quality monitoring of these brands by PCRWR on quarterly basis since 2005 reveals the unsafe quality and market inconsistency of many brands.

To improve access to safe drinking water, the Federal Government in 2004 launched the “Clean Drinking Water for All (CDWA) project” aimed to install 7000 filtration plants at UC level with a cost of Rs. 16 billion. However, only 1,139 plants (16%) were installed. Likewise, Punjab Saaf Pani Company (PSPC) was established in 2014 with the mission to ensure 24/7 provision of equitable and free safe drinking water to an estimated 68.9 million rural population at the cost of Rs. 117 billion. Only 116 units were ever installed in Bahawalpur district, at a staggering cost of Rs. 570 million. A huge amount of government resources has been wasted on the installation of water filtration plants across the country due to expensive and inappropriate technology selection, hiring of foreign consultants and lack of operation and maintenance mechanism. Without learning any lesson from the past initiatives, the present Punjab Government also established the Aab-e-Pak authority in 2019 with the objectives similar to the PSPC. There is a real fear that this initiative will have results similar to PSPC or CDWA, if existing issues of sustainability and ownership as well as appropriate technical considerations are not dealt properly.

The Honourable Supreme Court has taken several actions from time to time to expedite the provision of safe drinking water in the country. A judicial commission was appointed by the Honourable Supreme Court through an order dated January 14, 2018 to probe the detailed investigation on unsafe water supply in Sindh province. The recommendations of this commission also focused on the supply of clean drinking water to the end-users/consumers. Setting aside the huge water supply infrastructure in the country, investments were mainly made on the decentralized solutions in the form of constructing new water supply schemes and installation of filtration plants

without strengthening the human capacity for sustainable operation and maintenance of already existing infrastructure. Consequently, much of Pakistan's water supply infrastructure is in poor condition, due to a culture of "build-neglect-rebuild".

The existing water supply set up and human resources could be efficiently improved and utilized by introducing the concept of service delivery through public-private partnership. The Changa Pani Program (CPP) in Bhalwal, district Sargodha is a classical model of this partnership and community involvement. Changa Pani is a joint initiative by the city government of Bhalwal and local community, facilitated by a civil society organization named as Anjuman Samaji Behbood (ASB) that has succeeded in developing and operating a viable metered water supply system for the local community on sustainable basis. The government has provided the external component, i.e., laying the pipelines up till the streets, whereas the CPP provided water supply lines and water meters at the household level. Collection of revenue, operation and maintenance is the responsibility of the CPP (Qureshi and Ashraf, 2019). It is an inclusive partnership and is different from the traditional public–private partnership models. In CPP model, the government has made a significant upfront public investment, determined water pricing, and has representation in the management committee. The community can better understand its needs, can cooperate with each other to develop mutually beneficial rules, and can revisit the arrangements, when required. Thus, local community has contributed in formulating the rules and then negotiated with the government to create a unique governance structure for the project execution (Iftikhar *et al.,* 2018).

The CPP is an effort to address the water quantity and quality issues and to bring a change in behaviour of local community towards water consumption. Before suggesting replication of CPP model in other areas of the country, it was important to assess the effectiveness and efficiency of this program comparing with traditional unmetered water supply schemes. The current investigation was therefore, undertaken with the following objectives:

a) Assess the key factors contributing to the success of Changa Pani Program model.

b) Examine the water quality status, water supply efficiency and consumers satisfaction level of metered and unmetered water supply schemes.

c) Analyze needs for improvements for replicating the improved Changa Pani Program model in other areas of the country.

2. Methodology

2.1 Study Area Description

Bhalwal Tehsil of the Sargodha District is situated in the centre of Punjab province, touching two rivers, the Chenab and the Jhelum. Tehsil Bhalwal is administratively subdivided into 53 union councils, four of which form the city Bhalwal (UCs 23, 24, 25, 26). These four UCs managed by Tehsil Municipal Administration (TMA) comprises a population of about 100,000 people.

The water quality studies of Bhalwal reported that groundwater was brackish and unfit for drinking and irrigation except at sites along the Jhelum Canal North (Farooq *et al.,* 2019). In addition to salinity, anthropogenic sources such as waste from sugar industries and heavy use of pesticides and fertilizers in citrus orchards have also contributed to water quality deterioration. The intermittent water supply has further aggravated the problem.

The lower Jhelum Canal (North) is about 3 km away from the main city and is the key source of fresh water. Most of the water supply schemes have been installed on the bank of the same canal (Figure 1). In UCs 23 and 25, the Punjab Municipal Development Fund Company (PMDFC) constructed the water supply scheme and after completion handed over to ASB. In UCs 25 and 26, the Public Health Engineering Department (PHED) developed the water supply schemes and handed over to the Tehsil Municipal Administration (TMA) for the provision of water to the consumer.

In UC No. 23 substandard pipes (as reported by the operating agency) were laid in wider streets and the schemes were left in completed. In this situation, ASB initiated its efforts and convinced people for the public-private partnership to switch to the Changa Pani Program. As a result, there was a considerable consensus of the community to adopt the CPP model. With dedication and vigilance of the founder of ASB and CPP, Malik Nazir Ahmad Wattoo, a Memorandum of Understanding (MoU) was signed between ASB as an intermediary organization and TMA Bhalwal (*Annexure-I*). Figure1 shows the water supply scheme and distribution network of the city.

The old city area comprising UCs No. 24 and 26 can be divided into two sections. A section having functional water supply network comprising of Mali Colony, Manzoor Hayat Colony, Asmat Hyat Colony, Chander Colony, Sakhi Suleman Town and Zahoor Hayat Colony. These localities are present in the vicinity of water storage reservoirs at Mogian. The other section having non-functional water network comprised of Noor Hyat Colony, Sulman Pura, Ashraf Colony, Hadi Pura, Faridabad and partially Zahoor Hyat Colony. These localities touch the boundary of UC No. 25. The data regarding

technical features and reasons of non-functionality of each area are provided in *Annexure-II*.

ASB ensured the service connections attached with water meters and convinced the local community for bill payment through social mobilization, awareness raising, motivational campaign and group discussions. Since the MoU was signed, about 2100 water supply connections have been provided. Considering the extent of metered and unmetered water supply setups, the current study was focused on CPP in UC No. 23, part of the UC No. 25 and TMA's WSS in UCs No. 24 and 26.

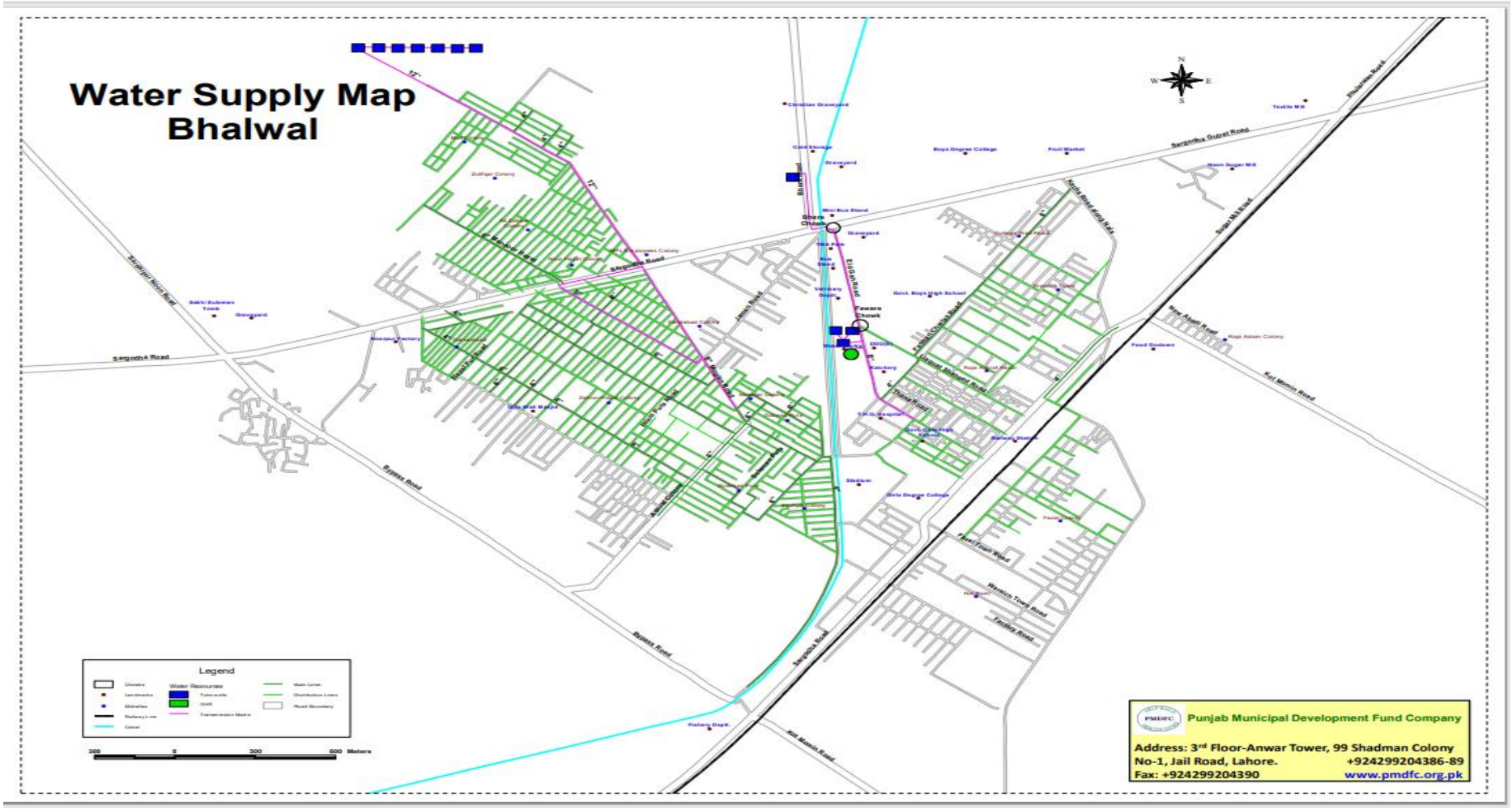

Figure 1: Map of Bhalwal water supply scheme (Source: Punjab Municipal Development Fund Company)

Questionnaire Development & Testing: Questionnaire was developed and provided for collection of data on operation, water quantity, expenditures, revenue generation, self-sustainability, water losses as well as for the collection of water samples from source and consumer's end (*Annexure-III*).

Figure 2: TMA water supply scheme

Figure 3: Changa Pani water supply scheme

The methodology consisted of collection of field data and water samples from source and point of use (PoU) of both CPP and TMA's water supply schemes, laboratory testing and questionnaire based interviews of the stakeholders including local community and district administrations. Three field teams of PCRWR each comprising two members were constituted to get the required data.

2.2 Assessment of Economic Viability and Water Supply Efficiency

The field teams visited all the operational sources (tubewells) of CPP and TMA's water supply schemes to inspect physical conditions of tubewells, turbines, pipe network, capacity and water discharge. Data on number of water connections, monthly bills of the consumers, billing system and water supply hours were obtained both from the ASB and TMA, and taken into consideration for financial analysis. Monthly expenditures of both types of schemes were estimated based on spending on the operation and maintenance of the tubewells and electricity bills.

2.3 Water Quality Assessment

Following the American Public Health Association Protocols (Baird, 2017) for sampling, laboratory testing and quality control, 119 samples were collected from source and consumers end or PoU i.e. 77 samples from CPP and 42 samples from TMA water supply schemes. Following uniform methodology, four types of samples were collected

from each site, preserved and transported to PCRWR National Water Quality Laboratory, Islamabad. The details of these samples and preservatives used for each sample are given below:

Type A – All sites – Pre-sterilized sampling bottles for microbiological analysis;

Type B – All sites – 2 ml/liter Nitric Acid (HNO_3) as preservative for trace elements;

Type C – All sites – 1 ml/100 ml, 1 Molar Boric acid as preservative for Nitrate;

Type D – All sites – No preservative for other water quality parameters.

Samples types B, C and D were collected for physico-chemical analysis in polystyrene bottles of 0.5 litter capacities. Before collecting these samples, bottles were washed properly and rinsed thoroughly several times with the same water. For microbial analysis, samples were collected in pre-sterilized bottles of 200 ml volume. Water samples (B, C and D) collected for chemical analysis were transported to laboratory without ice boxes, whereas type-A samples were transported to the under controlled temperature (2 and 8 ^{o}C) in the insulated ice boxes. Field blank and replicate samples[1] for quality control purpose were also collected (Figure 4). Ten sites were selected for replicate testing and analyzed to evaluate the reproducibility of analytical results.

Figure 4: Water quality sampling from CPP and TMA water supply schemes

Field observations and information regarding each sample (such as sample types, sample ID, sample code given to the sample, GPS reading, date and time of sample collection, physical conditions like water-table depth etc.) were recorded on the sample collection proforma. Using American Public Health Association (APHA) standard methods (Baird, 2017) as listed in Table 1, all samples were analyzed for physico-chemical and microbiological parameters.

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[1]***Field Blank*** *is a blank solution (Deionized water) that is subjected to all aspects of sample collection, field processing, preservation, transportation, and laboratory handling as an environmental sample.*

Table 1: Water quality parameters and methods used for analysis (APHA, 2017)

Sr.#	Parameters	Analysis Method
1	Alkalinity (mg/l as $CaCO_3$)	Standard Method No. 2320 (B)
2	Arsenic (ppb)	AAS Vario 6, Analytik Jena AG, [Standard Method No. 3111 (B)]
3	Bicarbonate (mg/l)	Standard Method No. 2320 (B)
4	Calcium (mg/l)	Ca-D, [Standard Method No. 3500 (B)]
5	Carbonate (mg/l)	Standard Method No. 2320
6	Chloride (mg/l)	Titration (Silver Nitrate), [Standard Method No. 4500 (cl-B)]
7	Conductivity (μS/cm)	E.C meter, Hach-44600-00, USA [Standard Method No. 2510(B)]
8	Hardness (mg/l)	EDTA Titration, [Standard Method No. 2340 (C)]
9	Magnesium (mg/l)	Standard Method No. 2340 (B)
10	Nitrate as Nitrogen (mg/l)	Cd. Reduction (Hach-8171) by Spectrophotometer [Standard Method No. 4500 (NO_3 B)]
11	pH	pH Meter, Hanna Instrument, Model 8519, Italy [Standard Method No. 45= H^+-B)]
12	Potassium (mg/l)	Flame photometer PFP7, UK [Standard Method No. 3500-K (B)]
13	Sodium (mg/l)	Flame photometer PFP7, UK [Standard Method No. 3500 Na (B)]
14	Sulfate (mg/l)	SulfaVer4 (Hach-8051) by Spectrophotometer [Standard Method No. 4500 (E)]
15	Phosphate (mg/l)	Colorimeters (HACH) [Standard Method No.8190 and 8048]
16	TDS (mg/l)	Standard Method No. 2540 (C)
17	Turbidity (NTU)	Turbidity Meter, Lamotte, Model 2008, USA [Standard Method No. 2130(B)]
18	Fluoride (mg/l)	ion-Selective Electrode [Method Standard No. 4500 (F-C)]
19	Bacteriological Contamination (presence/absence)	PCRWR Qualitative Field Testing Kit (presence/absence)

All test results were compared with the permissible limits of National Drinking Water Quality Standards of Pakistan and WHO Drinking Water Guidelines (Table 2) to evaluate the degree of fitness of water sources for drinking purpose.

Table 2: Water quality permissible limits for drinking water

Sr #	Parameter	Units	Permissible Limits	
			WHO	NDWQS
1.	Alkalinity	mg/l	NGVS	NGVS
2.	Bicarbonate	mg/l	NGVS	NGVS
3.	Calcium	mg/l	NGVS	NGVS
4.	Carbonate	mg/l	NGVS	NGVS
5.	Chloride	mg/l	250	250
6.	Colour	TCU	15	Colorless
7.	Conductivity	µS/cm	NGVS	NGVS
8.	Fluoride	mg/l	1.5	1.5
9.	Hardness	mg/l	NGVS	500
10	Iron	mg/l	0.3	0.3
11.	Magnesium	mg/l	NGVS	NGVS
12.	Odor	-	Odorless	Unobjectionable
13.	Nitrate-N	mg/l	10	10
14.	pH	-	6.5-8.5	6.5-8.5
15.	Potassium	mg/l	NGVS	NGVS
16.	Sodium	mg/l	200	NGVS
17.	Sulfate	mg/l	250	NGVS
19.	TDS	mg/l	1000	1000
20.	Turbidity	NTU	5	<5
22.	Arsenic	µg/l	10	50
23.	Total Coliforms	CFU/100ml	0	0
24.	E-Coli	CFU/100ml	0	0

CFU = Colony Forming Unit
TCU = Total Color Units
WHO = World Health Organization
NGVS = No Guideline Value Set
NDWQS = National Drinking Water Quality Standards

2.4 Consumer's Satisfaction Level

PCRWR teams have also conducted interviews of officials from the local government (Tehsil Municipal Administration, TMA) and community organization managing water supply schemes under Changa Pani Program and Tehsil Municipal Administration. These included Assistant Commissioner Bhalwal and Chief Officer of Tehsil Municipal Committee, Changa Pani Program Management, ASB, consumers and local political leadership. The focus of these interviews was to understand the challenges faced while initiating the CPP, consumer perspective about CPP, the impact of uninterrupted water supply metering for water consumption, and water pricing.

In total, 53 consumers of Changa Pani Program and 21 consumers of TMA water supply schemes were interviewed to evaluate their level of satisfaction in terms of service quality, water quality, continuity of water supply and contribution of operating agency and water supply. The score for each parameter was fixed as 10. The consumer's opinions were scored and categorized as highly satisfied (score ≥9), satisfied (score ≤6 to ≥8) and unsatisfied (score ≥5). Documents were obtained from Anjuman Samaji Behbood (ASB) including the partnership agreements between the community and government, other reports and independent evaluations of the project, water bills etc.

3. Results and Discussion

The comparative analysis of CPP and TMA services was based on the field and laboratory data and questionnaire based information collected during discussion with the stakeholders. The detailed results are as below:

3.1 Factors Contributing to the Success of CPP Model

3.1.1 Operation and maintenance

The water supply scheme working under CPP was initially designed to supply water to about 4000 households. Under this scheme, 8 tubewells were installed along the Jhelum canal connected with an overhead tank of about 100,000 gallons storage capacity. The existing water supply pipes network was unable to support all of the eight TWs simultaneously and thus only three TWs of CPP were in operation and supplying water to 2100 households i.e. 53% of the total population (Figure 5). The CPP tube wells operate for 12-15 hours per day providing 6,326,757 gallons of water to 2100 water connections.

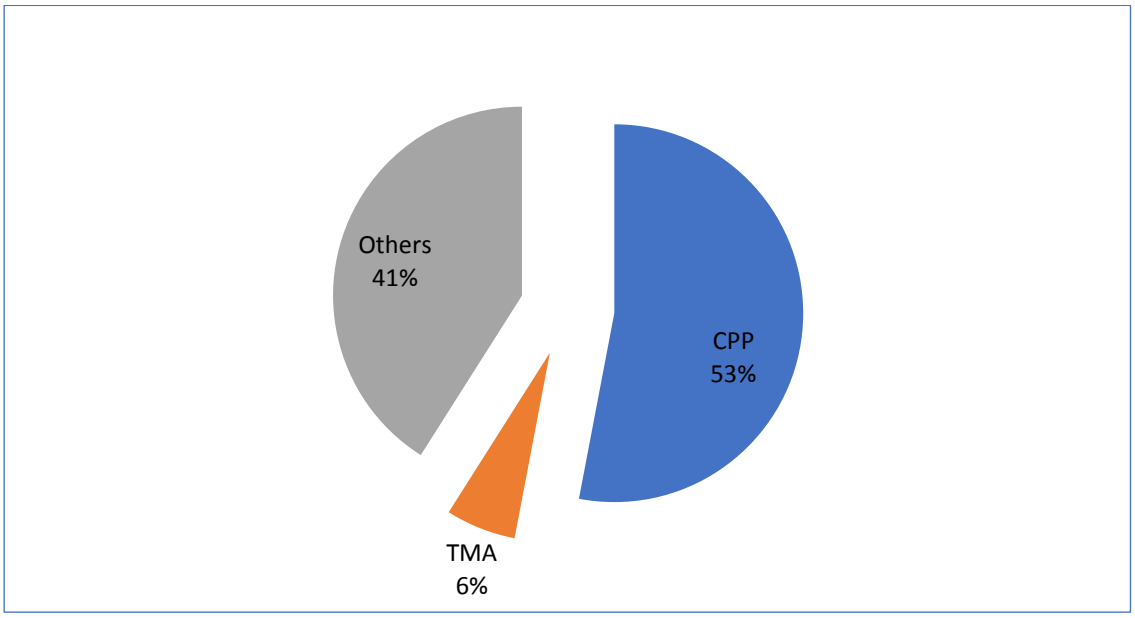

Figure 5: Percent population served by CPP (WSS) in UC No 23 & 25 and by TMA (WSS) in UC No. 24 & 26 and others[2]

The TMA water supply scheme was initially designed to supply water to about 5500 households of two union councils. Ten tubewells were installed along the Jhelum canal and connected with a storage tank of about 400,000 gallons capacity. Similar to CPP Water Supply Scheme (WSS), pipes network was unable to support all tubewells at a time and thus only three tubewells of TMA were found operational and supplying water to only 318 households (6% of the local population). These three tubewells of TMA

[2] *Other sources mean private filtration plants* Commercial Drinking Water Filtration Plants *and some other domestic wells*

schemes operate for about 5 hours per day. The remaining population of UC-24 and UC-26 were deprived of water supply and rely on domestic wells. The areas of Noor Hyat Colony, Sulman Pura, Ashraf Colony, Hadi Pura, Faridabad and partially Zahoor Hyat Colony do not have water connections despite having piped network and an overhead tank (presently non-functional). Most of the population of these areas depend on the groundwater for washing, while for drinking they rely on the Commercial drinking water filtration plants and other sources located far away from their houses. A comparison of capacity and financial implications of both CPP and TMA's water supply schemes is given in Table 3.

Table 3: Water supply and cost analysis of CPP and TMA schemes

Data Collected	TW No.	CPP		TMA	
Target No. of connections/households	-	4000		5500	
No. of connections provided for water supply	-	2100 including 7 commercial connections		318 households	
Monthly charges	-	Domestic	Commercial[3]	Domestic	Commercial
		450	650	250	0
		Industrial		Industrial	
		3,200		0	
Status of connections	-	All functional		3 non functional	
Operating hours of pump houses	All TWs	12 hrs.		5 hrs.	
Physical conditions of pumps (All TWs)	Units of energy required (KW)	30		30	
	Discharge in LPH	25,500 (7.08 LPS)		25,500 (7.08 LPS)	
	TW Head (meters)	75		75	
	Types of pumps	Turbine		Turbine	
	Electric conductance (Amperes)	68		68	
	Availability of power	Normal		Normal	
	Efficiency (%) as per label on TWs	85		75[4]	
Total water supplied monthly (US Gallons)	TWs 1	2,108,919		775,338	
	TWs 2	2,108,919		775,338	
	TWs 3	2,108,919		775,338	
	Total water supply per month	6,326,757		2,326,014	
	Estimated supply (Gallons per household per day)	100		244	
Average monthly electricity charges @ Rs 26/unit (Kw-hrs. x Rate x 30 days)	TWs 1	280,800		117,000	
	TWs 2	280,800		117,000	
	TWs 3	280,800		117,000	
	Total monthly electricity bill calculated (PKR)	842,400		351,000	
	Total monthly electricity bill received by CPP/TMA (PKR)	800,000		50,000	
Calculated monthly expenditures (PKR)	Estimates of salaries (as informed by agency) (PKR)	150,000		100,000	
	Repair and maintenance (PKR)	100,000		20,000	

[3] *For commercial connections rate is Rs 650 per unit of water supplied.*
[4] *Tubewell efficiency assessed during survey.*

Data Collected	TW No.	CPP	TMA
	including electricity bill, salaries, R&M **(A)**	1,092,400	500,000
Water bill payments from Consumers	Calculated to be paid by consumers on monthly basis**(B)**	952,750	80,000
Outstanding amount (PKR)	Monthly**(A-B)**	139,650	420,000
	Annually	1,675,800	5,040,000
Average cost recovery	**-**	**87%**	**16%**

The average monthly electricity bills reported by the CPP was Rs. 800,000/- for the operation of more than 12 hours daily, while the average monthly bills reported by TMA was Rs. 50,000 for 5 hours daily operation to supply water.

3.1.2 Water bills recovery rates

The CCP supplies water to about 2100 households on public-private partnership model without any contribution from the Government. These connections also include 7 commercial connections supplying water at the monthly rate of Rs. 650 and an industrial connection at the rate of Rs. 3200/month. About 2100 water meters were also installed at houses and buildings charging monthly instalments of PKR 50. The CPP charges the water consumption @100 PKR/unit (1 unit equivalent to 10,000 litres). The approximate total monthly electricity expenditures for three tube wells of CPP was estimated as PKR 842,400/- (Table 3). Including other expenses such as repair and maintenance and stipend for the volunteer operators, the monthly expenses generally becomes PKR 1,092,400 (Table 3 and Figure 6). From water bill payments by the consumers, CPP recovers about PKR 952,750 (87%) of the total monthly expenditures. Therefore, monthly average outstanding total estimated bill payment was about PKR 139,650/-. The ASB has informed that this payment is adjusted within volunteer's salaries or recovered by charging sometime extra bill payment from the high usage consumers.

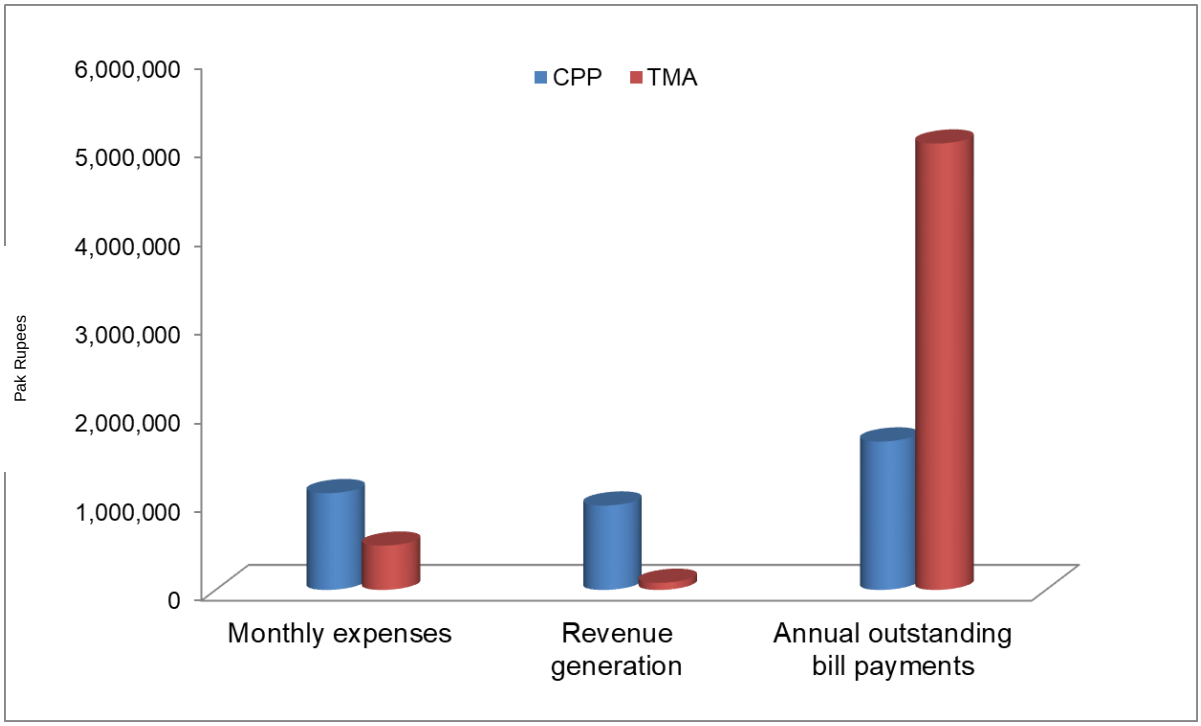

Figure 6: Cost analysis for water supply schemes working under CPP and TMA

Under TMA's schemes, water meters were not installed and all the consumers were billed at the flat rate of PKR 250 per month/connection. Consumers receive uncontrolled water supply. The monthly expenditures for 318 connections including electricity charges, repair and maintenance, and salaries of the employees were estimated to be PKR 500,000 (Table 3). Whereas, the monthly revenue from their WSS was about PKR 80,000 (16%). The outstanding amount to meet all the operational requirements was about PKR 420,000 per month which is paid by the Government (TMA). Therefore, a deficit of PKR 5,040,000 annually is paid by the TMA and indicates that Government resources are not being utilized efficiently and sustainably.

Table 3 shows that the CPP consumers were utilizing an average of 100 gallons per day per household. If we assume the same consumption rates for 318 households of TMA water supply consumers (i.e. 3000 gallon/month to a household), 318 households would require 954,000 gallons per month. Accordingly, the monthly electricity rates (Table 3) should be around PKR 143,960/- instead of PKR 351,000/-. This suggests that a water supply scheme under metered system would prove financially efficient and socially effective by inducing a behavioural shift towards responsible water consumption and related reduction in monthly electricity charges of TMA's schemes by 41%.

3.1.3 Estimated water supply per household and water losses

Three tube wells operating under CPP operate for 12-15 hours per day and the estimated monthly water extraction is about 6,326,757 gallons for 2100 connections. Therefore, each connection receives about 3,000 gallons/month and an average of about 100 gallons per day or about 16 gallons per person per day in a family of six persons.

According to CPP team, TWs are sometimes operated for more than 12 hours to meet the demand. There are no unbilled and unauthorized connections. However, sometimes overflows at utility's storage tanks are observed.

Under TMA's water supply scheme, three TWs operate for about five hours and the estimated monthly water extraction is about 2,326,014 gallons for 318 households. Considering the CPP average daily household water usage as 100 gallons as well as the World Health Organization's estimated average usage of 100-120 gallons per day, the 318 households of TMA's water supply would require 1,144,800 gallons monthly. The excessive quantity (1,181,214 gallons) may be considered as wasted or misused every month.

Since Pakistan has already been reported as the world's fourth-highest water user, its water intensity rate i.e. the amount of water in cubic meters used per unit of GDP is the world's highest. This reveals that no country's economy is more water-intensive than Pakistan's economy (Tariq *et al.,* 2020). The current study data also supports these facts and emphasizes on the need of behavioural changes of high water use. To control wastage, careful design and construction of the mains, combined with a vigilant supervision programme, preventive maintenance and leak detection is also mandatory for all existing and newly planned water supply schemes. The model of CPP is comparatively an efficient public water supply system that maintains a continuous programme of inspection and preventive measures regarding leakage etc.

Compared to CPP, TMA has not been able to provide uninterrupted water supply due to lack of service delivery. TMA's efficiency may be improved by installation of water meters at all properties and by encouraging consumers to repair leaks promptly and to avoid excessive use of water. The CPP model has modified the consumer's behaviour in UC No. 23, and part of the UC No. 25 due to water metering and ensured that the cost of wasted water will be borne by the individual consumer rather than by the CPP.

During this survey some of the consumers of TMA were also observed to recharge their private wells/bores within their homes through excessive usage of TMA's water supply. Moreover, water losses and unauthorized water usage have also been noticed in Mali Colony and Manzoor Hayat Colony.TMA has facilities for the inspection and repair of water supply infrastructure by its maintenance staff. However, its performance is suboptimal.

3.2 Water Quality Assessment

3.2.1 Physico-chemical quality

For water quality analysis, 41 samples from CPP and 21 samples from TMA's water supply schemes were collected. The water quality test results were compared with the Pakistan's National Drinking Water Quality Standards (NDWQS) in order to assess

degree of fitness for drinking purpose. As the tubewells of water supply schemes are installed at the bank of Jhelum canal, hence the chemical quality of both the TMA and CPP water supply schemes at source and at consumer's end were found within the safe limits (Tables 4 & 5).

Table 4: Physico-chemical parameters of CPP water supply (n = 41)

Test Parameters	Unit	Permissible Limit (NDWQS)	Min.	Max.	Mean
pH	-	6.5-8.5	7.63	7.84	7.75
Turbidity	NTU	5	0	3	0
Calcium	mg/L	200	24	36	25
Hardness	mg/L	500	100	120	107
Magnesium (Mg)	mg/L	100	5	15	10
Bicarbonates (HCO_3)	mg/L	NGVS	90	110	94
Chlorides (Cl)	mg/L	250	10	12	12
Potassium (K)	mg/L	NGVS	2.3	2.5	2.4
Sodium (Na)	mg/L	200	8	16	10
Sulphate (SO_4)	mg/L	400	20	28	25
Nitrate (NO_3)	mg/L	10	0.69	1.28	0.90
Total Dissolved Solids (TDS)	mg/L	1000	132	160	143
Arsenic (As)	µg/l	10 WHO 50 NDWQS	0	4	1

Table 5: Physico-chemical parameters of TMA water supply (n = 21)

Test Parameters	Unit	Permissible Limit (NDWQS)	Min.	Max.	Mean
pH	-	6.5-8.5	7.63	7.84	7.75
Turbidity	NTU	5	0	0	0
Calcium	mg/L	200	24	36	25
Hardness	mg/L	500	100	120	109
Magnesium (Mg)	mg/L	100	5	15	10
Bicarbonates (HCO_3)	mg/L	NGVS	90	110	93
Chlorides (Cl)	mg/L	250	10	12	12
Potassium (K)	mg/L	NGVS	2.3	2.5	2.4
Sodium (Na)	mg/L	200	8	16	10
Sulphate (SO_4)	mg/L	400	20	28	25
Nitrate (NO_3)	mg/L	10	0.38	1.24	0.87
Total Dissolved Solids (TDS)	mg/L	1000	132	157	140
Arsenic (As)	µg/l	10 WHO 50 NDWQS	0	2	0

In addition to water samples from CPP and TMA, 13 water samples were also collected from the private wells/borings of households in Bhalwal city for comparison with CPP and TMA's water supply (Table 6).

Figure 7: Unhygienic conditions at the site of domestic water sources

Most of these groundwater samples (92%) were found unsafe due to presence of microbes, hardness, chlorides, sodium, sulphate, nitrate and TDS. The possible causes of microbiological contamination include unsafe storage, lack of source protection and unhygienic conditions in the vicinity of source as shown in Figure 7. In comparison to TMA and CPP, samples of private wells and boring water show the excessive total dissolved solids (3322 mg/L), chlorides (816 mg/L) and nitrates (52 mg/L) possibly due to geological occurrence, or some mixing of sewage in the pipelines.

Table 6: Physico-chemical parameters of wells/borings of households in Bhalwal city (n = 13)

Test Parameters	Unit	Permissible Limit	Min.	Max.	Mean	%age samples beyond NDWQS
pH	-	6.5-8.5	7.2	7.9	7.5	0
Turbidity	NTU	5	0	0	0	0
Calcium	mg/L	200	24	88	57	0
Hardness	mg/L	500	120	710	378	23
Magnesium (Mg)	mg/L	100	15	129	58	0
Bicarbonates (HCO_3)	mg/L	NGVS	90	1150	541	0
Chlorides (Cl)	mg/L	250	16	816	409	69
Potassium (K)	mg/L	NGVS	2.3	12.3	7.3	0
Sodium (Na)	mg/L	200	9	980	593	92
Sulphate (SO_4)	mg/L	400	25	840	504	77
Nitrate (NO_3)	mg/L	10	0.79	52.00	13.64	23
Total Dissolved Solids (TDS)	mg/L	1000	147	3322	1983	92
Arsenic (As)	µg/l	10 WHO 50 NDWQS	0	5	2	0

Table 6 shows the excessive amount of salts in domestic borings having average depth of about 18-30 m. A past study on groundwater quality in Chaj Doab (i.e. the area

between the rivers Chenab and Jhelum), where tehsil Bhalwal also lies have reported the occurrence of acceptable groundwater quality (0.4-1.0 dS/m) at shallow depths near the rivers banks (2 to 10 m). At deeper depths (10 to 30 m), the salinity was reported to be very high (2.4-4.0 dS/m) (Ashraf *et al.*, 2012). As shallow freshwater layers exist in the same area underlain by saline water, thus installation of multi-strainer skimming wells may be preferred over single-strainer deep well to pump good quality water. This would require in-depth investigation in the form of blanket survey of the whole area as well as knowledge sharing and awareness of the native communities for the accurate installation and use of skimming wells for fresh water extraction from the shallow water.

3.2.2 Microbiological quality

The microbiological quality of CPP (74% safe) was comparatively better than TMA's water supplies (52% safe) (Table 7). The main contamination in both water supplies was of microbial type which may result in waterborne diseases particularly during summers due to favourable temperature for growth of pathogens.

Table 7: Summary of Microbiological test results of CPP and TMA water supply schemes

Scheme	Total samples	Safe		Unsafe	
		No	%	No	%
CPP WSS	41	30	74	11	26
TMA WSS	21	11	52	10	48

(Location wise detailed results are given at *Annexures IV, V and VI*).

A comparison of CPP water quality at source and at consumer's end indicates a better quality at sources (100% safe) than at its consumer's end (71%). The contamination at consumer's end was probably due to water supply pipes cross contamination and unsafe storage practices at household level (Table 8).

Table 8: Summary of water quality test results of CPP and TMA water supply schemes

Sample Type	Source					Consumer's End					Potential problems
	No of samples	Safe		Unsafe		No of samples	Safe		Unsafe		
		No	%	No	%		No	%	No	%	
CPP	3	3	100	0	0	38	27	71	11	29	Microbial contamination
TMA	4	2	50	2	50	17	9	53	8	47	Microbial contamination
Private Bore	-	-	-	-	-	13	1	8	12	92	Excessive total dissolved solids, chlorides, nitrates & hardness, microbial contamination

Table 8 shows that there is almost no difference in water quality of TMA supplies at source (50%) and at consumer's end (53%). However, water being supplied by the CPP water supply is better than TMA both at source and at consumer's end. The comparatively good quality of water by CPP water supply scheme is attributed to the continuous water supply approximating 12-15 hours per day, less leakage, preventive and corrective measures of their water supply network.

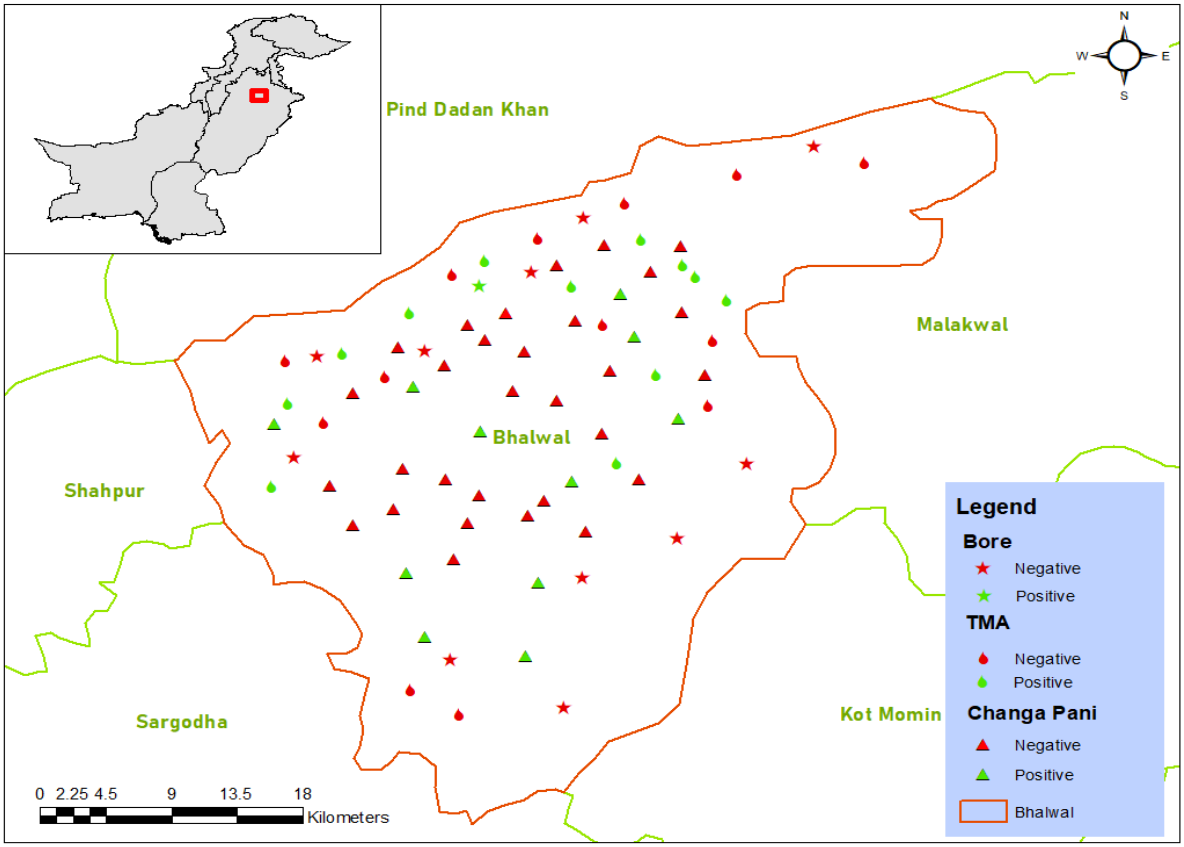

Figure 8: Microbial contamination in CPP,TMA's water supply systems and private bore holes

One of the reasons for the poor quality of water by the TMA (Figure 8) is the intermittent water supply. This results in development of negative pressures, which may carry backflow contamination of mains water. In addition, openly flowing sewage, deposits of rust, detritus and other sediments within the mains are added up and carried in suspension when water supply resumes. Air may also be drawn into the system, causing airlocks or water hammer thus disturbing the uniform water flow to the consumers. Our field teams have also observed that some consumers of TMA fill bathtubs and containers to be used during no supply period. In addition to continuous disinfection of source water with optimized disinfectant dose at consumer's end, the TMA should also maintain adequate pressure and balanced flow in the distribution mains to eliminate low or negative pressures.

3.3 Community Satisfaction Level

Public opinion is the most effective instrument that holds an essential role in mediating social integration and social change. The opinions of stakeholders including district administration, ASB and consumers of both TMA and CPP schemes were obtained and analysed.

3.3.1 Views of District Administration

The opinions obtained from the local community regarding CPP and WSS in terms of service delivery are shown in (Figure 9).

According to the Assistant Commissioner at the time of the current survey (Mr. Usman Jalees), Bhalwal CPP model provides a quasi-market, partnership-based solution for the Tehsil that enabled both government and community members to collaborate and take ownership of the service. According to him, this model emphasized the importance of water pricing and metering.

> Being Assistant Commissioner, Bhalwal Tehsil, I was also the administrator of Tehsil Municipal Administration (TMA) and responsible for the water supply. Most of the groundwater was brackish in the area with limited drinking water supply. The developmental work with insufficient funds was slow to replace the older water supply schemes. When the ASB proposed the idea of water supply on public-private partnership, several concerns were raised by different stakeholders. The biggest challenge was to bring all stakeholders on the same page. After several meetings with community in all the four UCs, ultimately a focus group was created to help in this process. The local community was convinced to realize the benefits of public-private partnership as a solution for sustainable water supply. We were little sceptical in handing over a newly built Govt. scheme to a private NGO.
>
> The opposition was not from the local community only; it was also from TMA's management. Ultimately, a committee of 11 people was constituted including a member from ASB (Mr. Nazir Ahmad Watoo), 2 members from Government and 8 members from local community of four UCs. Such public-private partnership reforms take time to get establish, as there was a risk of failure. The concerted efforts of all stakeholders resulted in Changa Pani Program (CPP), which actively involved the local community as well as other key stakeholders in planning, process and implementation.
>
> Mr. Altaf H. Sario, Assistant Commissioner, Bahawalpur (from October, 2012 to April, 2013)

3.3.2 Views of Anjuman Samaji Behbood (ASB)

The founder of CPP, Mr. Nazir Ahmed Watoo provided an overview of efforts undertaken to establish CPP model and the way forward to make this model sustainable and adoptable in other areas of the country. According to him, confidence building of local government, community and politicians on water pricing and metering system was the biggest challenge. Another barrier was the line agency i.e. local government which was

responsible for the operation of water supply scheme in Bhalwal and was not willing to handover it to ASB. After continuous meetings and discussions with all stakeholders, ASB convinced them on this public-private partnership model. ASB succeeded to convince that the government will provide funds for building the scheme and ASB will support the government and the community for its sustainable and efficient operation.

The water metering was an innovative concept to monitor and control the water use. It helped in changing the public behaviour towards water use. The system is a model in which every stakeholder had equal share. Perhaps, now due to increased electricity charges, the concept of water metering is disturbed. If the government supports CPP in this situation, it will be an ideal solution for the water supply on cost-sharing basis.

3.3.3 Views of General Public and Consumers

Consumer interviews provided insights about service delivery of both types of water supply schemes. In total, 53 consumers of CPP and 21 consumers of TMA were interviewed using questionnaire comprising 4 main questions about service quality, water quality, contribution of operational agency and water supply. To obtain insights about all the parameters scoring was fixed as 10 for each parameter/person. Each highly satisfied consumer was scored as ≥9, for satisfied (≤6 to ≥8) and ≥8 and ≤5 for unsatisfied. A summary of three different satisfaction levels is given in Tables 9 and 10. It can be seen that in term of service quality and contribution of the operating agency, the CCP water supply scheme was found far better than the TMA.

Table 9: Summary of Consumer's opinion on CPP water supply (n = 53)

Parameters	*Score Criteria/ Person*	Highly Satisfied (Score≥9)			Satisfied (Score≥8)			Unsatisfied (Score≤5)		
		No. of Person	*Score*	*%age*	*No. of Persons*	*Score*	*%age*	*No. of person*	*Score*	*%age*
Service Quality	10	21	189	40%	21	168	40%	11	55	20%
Water Quality	10	23	207	43%	19	152	36%	11	55	21%
Contribution of Operating Agency	10	12	108	23%	23	184	43%	18	90	34%
Water Supply	10	20	180	38%	30	240	57%	3	15	5%
Total	**40**	**-**	**684**	**-**	**-**	**744**	**-**	**-**	**215**	**-**

Table 10: Summary of Consumer's opinion on TMA's water supply (n = 21)

Parameters	Scoring Criteria/ Person	Highly Satisfied (Score ≥9)			Satisfied (Score ≥8)			Unsatisfied (Score ≤5)		
		No. of persons	*Score*	*%age*	*No. of persons*	*Score*	*%age*	*No. of persons*	*Score*	*%age*
Service Quality	10	3	27	14%	6	48	29%	12	60	57%
Water Quality	10	5	45	24%	7	56	33%	9	45	43%
Contribution of Operating Agency	10	2	18	10%	5	40	24%	14	70	66%
Water Supply	10	8	72	38%	12	96	57%	1	5	5%
Total	**40**	**-**	**162**	**-**	**-**	**240**	**-**	**-**	**180**	**-**

The main insights revealed from the above analysis are discussed below:

a. **Operation**: Overall 80% consumers of CPP were satisfied from the approach of water metering as well as of the overall operation, while 20% consumers were having some observations regarding improper billing, management and quality of the service. The satisfaction level of TMA consumers was found as 43%, whilst 57% were unsatisfied (Figure 9).

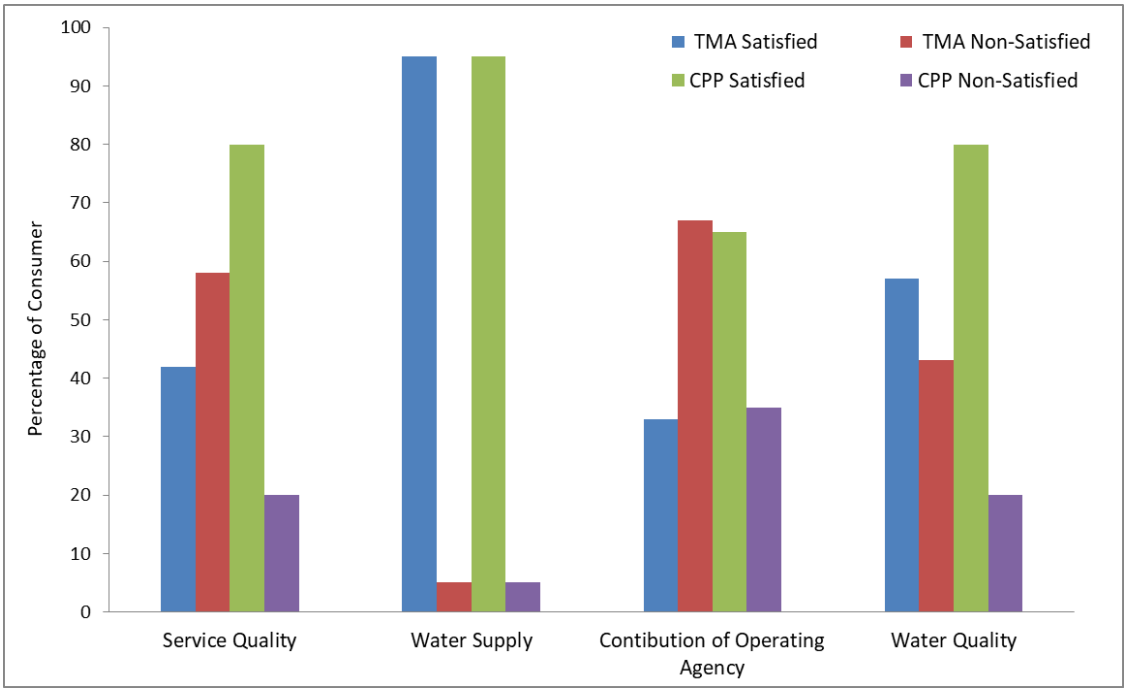

Figure 9: Consumer's feedback on TMA and Changa Pani water supply schemes

b. **Water supply hours**: About 95% of the CPP consumers were satisfied to have the uninterrupted piped water supply for the first time, while remaining (6%) showed some reservations. Whereas, 95% of the TMA water supply users were satisfied from the water supply duration, and 5% were having complaint from the supply hours.

c. **Management**: 66% of the consumers recognized the positive contribution of ASB that they have taken this initiative well in time, when there was very low performance level of water supply in Bhalwal city. The TMA consumers (34%) were having satisfactory opinion regarding management of water supply by the committee, while 67% had complaints regarding improper management of water supply responsible for the prevailing issues being faced by the consumers.

d. **Water quality:** 79% of the CPP consumers were satisfied with the quality of water and convenience of piped water availability instead of other expensive modes and confirmed that they could not get a full-time supply of water before the implementation of CCP. On the other hand, 57% of the TMA consumers were satisfied from their water quality.

> A consumer from Al-Fazal Town, Bhalwal stated that "*we are very satisfied from the Changa Panni Programme, only the billing is not proper and meter does not work properly*". He further stated that "*Before the Changa Pani program, there was no availability of drinking water and local government was unable to provide enough water for daily use*."

Figure 10: Obtaining consumer's opinion in the Factory Area

Figure 11: Obtaining views in the Fazal Town

Figure 12: Field teams interviewing the consumers in the Mali Colony

Figure 13: Field teams interviewing the consumers in Madina Colony

The ASB has also designated 20 to 25 members of the local community committee as line managers to coordinate with public regarding water metering and supply issues. The ASB representatives were also contacted by the public about the concerns of people regarding non-functional water meters probably due to low quality water meters, which can be easily replaced to resolve this issue.

3.4 Factors and Improvement Needs

The CPP is operating on the private- public partnership basis i.e. water supply scheme built and provided by the government is now owned by the local community and operated by a community based organization such as ASB. Consequently, the community is maintaining it and making the operation and management agency accountable. A strong working relationship between the consumers and operating agency was observed which is the key to success of CPP model. The ASB was not involved in the design and construction phase of water supply scheme. Therefore, proper operation and maintenance of this scheme was very difficult for ASB. However, they were able to manage it effectively.

The consumers are provided with water on metered basis and bills are collected accordingly. The recovery rates are good and there is willingness to pay, provided there is assurance of safe and reliable water supply throughout the day. The CPP was found to respond to the consumer's complaints promptly. Their quality of service was observed during the current survey when they identified and repaired the leakage of tubewell No. 8 of CPP water supply scheme within the same day.

Nevertheless, some laps with the standard operations of CPP water supply scheme have been observed by the PCRWR team including wrong installation of water meters, lack of optimized disinfection at source, and inadequate manpower. The water meter being a delicate instrument should be handled with great care. Rough handling including jerks or

fall is likely to damage it and affect its accuracy. Moreover, water meters should be installed in such a manner that top of the meter must remain below the level of the communication pipes so that meter always contains water, when there is no supply in the line. It is observed that such standard procedures were required to be followed during water meter installations by CPP. Consequently, to equate the cost balance, billings were manually estimated in case of several connections.

However, ASB and the whole CPP management were found very committed and motivated to bridge these gaps. In a follow up meeting with the CPP operational team, PCRWR professionals have provided complete technical guidance to rectify the leakages of pipes, de-rusting of meters and effective chlorination of source water to ensure the safe water supply at the consumer end.

The infrastructure deployed in CPP water supply scheme was found effective enough to manage the water supply to the consumers. However, ASB requires support from the community and government to meet the expanding demands of their water connections. The increasing interest of local communities in CPP requires optimization and rehabilitation of existing water supply infrastructure. Though water supply infrastructure in Bhalwal city was found sufficient to meet the demand of 70,000 people, the construction of overhead reservoir of capacity 100,000 gallons in Sultanabad would be required. This would benefit the residents of Noor Hyat Colony, Goband Pura, Hadi Pura, Mukhtar Colony, Shafqat Colony and 50% of Zahoor Hayat Colony, which are currently deprived of safe water.

Thinking Collectively

Models like Changa Pani Bhalwal affirm the importance of community engagement in developing and implementing shared schemata in partnership with the public sector.

The key issues like water and sanitation need to be solved through the process of continuous collective thinking.

These localities are linked with already working areas of ASB such as UC 23 and 25. Except Ashraf Colony, Mukhtar Colony and Faridabad, rest of all colonies have distribution network. As far as socio-economic conditions of these colonies are concerned, the people are below the line of poverty but showed a great deal of motivation and awareness regarding supply and quality of water. In total, 10,000 to 11,000 households were found willing to be connected to the CPP scheme. This is achievable by bringing the remaining tubewells to operational state and allocation of necessary resources by the local authorities.

"Community share must be according to component sharing model philosophy as by this way community remain fully involved in the planning, installation, developing, monitoring and maintenance of the water supply scheme"

(Mr. Nazir Ahmed Wattoo, CEO CPP).

Load shedding affects pumping of groundwater, which are 6 km away from the locality. Recently, the electricity bills tariff scheme for CPP water supply scheme was changed by Water and Power Development Authority (WAPDA) from D-1 to A-3A (66) which has burdened this water supply scheme to pay the heavy electricity bill. There is a risk that public would be deprived of the water supply under this scheme. For sustainable operation of this water supply scheme, Government should consider to restore its bill payment under D-1 Tariff policy.

PCRWR technical team has also discussed with the head of TMA, Mr. Nasrullah Khan the issues related to TMA's water supply schemes specifically, the microbiological contamination, water losses, required rectification measures as well as outcomes of comparative evaluation of CPP and TMA. He ensured to identify the causes of microbiological contamination and continuous monitoring of water supply schemes.

This project is reflection of my successes and failures in the water and sanitation sector. I believe that Changa Pani Program will add and un-veil new dimension of development in the cities of Punjab. I see a great potential in this program for scaling up due to its innovation and partnership.

I see this project as a beacon of life for the people, which has implication on their wellbeing through 24/7 water supply and sanitation for sustainable development. In Changa Pani, I can visualize Dr. Akhtar Hameed Khan's Dreams turning into reality through able guidance of Chairman P&D Board Mr. Suleman Ghani.

(Mr. Nazir Ahmed Wattoo, CEO CPP)

4. Conclusions

The CPP supplies uninterrupted water to the native community for 12-15 hours a day. Under the effect of public-private partnership, the consumer's satisfaction percentage is much higher for the CPP (i.e. 80%) compared to the TMA's water supply (43%). This reputation had drawn interest of more people in CPP water supply scheme. As a result, number of water connections increased to 2100. With such a number of water connections paying their water bills regularly, and with proper infrastructure and governance, improved sustainability along with higher cost recovery of up to 87%. The cost recovery rate of TMA's water supply was found as low as 16%. The CPP water supply scheme pay their charges for electricity, operation and maintenance, and salaries from the revenue while in case of TMA scheme, the community usually do not pay any proper bills.

The quality of water supplied by the CPP (i.e. 74% safe) was better due to uninterrupted water supply compared to the TMA (52% safe).

An effective water management due to adoption of service delivery concept including metered water, pricing system and quality services is clearly observed in case of CPP. The community keeps in mind, less they use water, less they will have to pay. As a result, there is a clear message from the community regarding water management and controlled water usage. This behaviour modification of CPP consumers led to overcome the water wastage problems, as compared to a wastage of around 240 gallons per day due to uncontrolled water supply by the TMA.

5. Recommendations and the Way Forward

Based on the study outcomes, the following measures are recommended for improvement of CPP and TMA's water supply schemes.

- The microbial contamination was found comparatively higher in TMA's water supply schemes than that of CPP, however, both the CPP and TMA need to track the possible causes of microbial contamination i.e. leakage in water supply pipes, unhygienic physical situation at source, inadequate chlorination etc. In this case, leakage repair as well as use of water purification and disinfection methods (e.g. chlorinators) either at source-to-supply network or at household level should be regulated.
- A regular water quality monitoring and replacement of outdated water meters will help to increase performance efficiency, consumer's satisfaction and will prevent the health risks.
- Bill payment system should be made easy such as using a mobile application.
- It is suggested to promote the public-private partnership models in water sector and replicate this model in different residential and commercial sectors of major cities. The rationalized water prices for volumetric use of water by different social categories will result in revenue generation which can ultimately be used to improve water supply and treatment infrastructure. However, complete rehabilitation of main and distribution pipe network is very important for uninterrupted and good quality water supply.

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Memorandum of Understanding (MoU) between ASB as an Intermediary Organization and TMA Bhalwal

MEMORANDUM OF UNDERSTANDING (MOU)

Between

Tehsil Municipal Administration (TMA) Bhalwal & Anjuman Samaji Behbood (ASB)

For

PROVISION OF WATER SUPPLY SERVICES AT BHALWAL CITY

Memorandum Of Understanding For Collaboration Between Anjuman Samaji Behbood (ASB) and Tehsil Municipal Administration (TMA) Bhalwal For Changa Pani Program

Based on successful model of Changa pani model (Lahore). Anjuman Samaji Bahbood (ASB) (A Faisalabad based NGO) registered office at 40-A main bazaar dhuddiwalan faisalabad and Tehsil Municipal Administration (TMA) Bhalwal District Sargodha are joining hands for Punjab Municipal Development fund company (PMDFC) funded and executed water supply project at Bhalwal city to demonstrate that communities can finance, manage and build internal development, organized and are provided with needed technical support and managerial guidance.

Anjuman Samaji Bahbood hereinafter called `` ASB`` and Tehsil Municipal Administration Bhalwal hereinafter called ``TMA`` entered in to The memorandum of understanding for collaboration hereinafter called ``MOU``.

The purpose of this MOU is to provide a framework of cooperation and facilitate collaboration between the parties on a non- exclusive basis in areas of mutual interest.

WHEREAS, the government of Pakistan is a signatory to the Millennium Development Goals (MDGs) and therefore it is binding on Local Government Authorities and Civil Society Organization (CSOs) to strive for enhancing the achievement of MDGs.

WHEREAS, ASB and TMA are interest in provision of 24/7 water supply. Through metering by using all their logistics administrative and technical support to eliminating the incidence of diarrhea and other water borne diseases in the PMDFC funded and executed project in Bhalwal.

WHEREAS, under devolution of power, ASB is encouraged to determine and implement local development agenda, using component sharing Change Pani model – Successfully implemented recently in Lahore, enable society to participate in community work and development – related activities.

WHEREAS, ASB interested to provide basic facilities regarding pure drinking water and eliminate the water diseases, for this purpose ASB wants to enter in to MOU with TMA.

WHEREAS, Civil Society Organizations (CSOs) can play a signification role in determining, implementing, and monitoring local development agenda under these circumstances ASB entered into MOU and agreed to cooperate as follows and the TMA Bhalwal in consultation with LG&CD Department, DCO and concerned Officers of Local Government, Agreed to enter into MOU and hereby agree to cooperate as follows:

- As scheme is funded by PMDFC / World Bank, the contractor shall complete this scheme as per agreement / terms and conditions of contract. ASB /TMA will not make any

interference to reduce / enhancement of any item of estimate, after the completion of this scheme ASB /TMA will start metering system etc. as per below mentioned terms and conditions.

1. Establishment of a steering committee amongst the parties to holistically look at the opportunities and challenges in smooth running of 24/7 water supply scheme through metering in the specified PMDFC project area.
2. After completion of scheme, TMA/ASB will takeover the scheme from PMDFC/ unique construction company Directly, to ensure provision of 24/7 clean drinking water to all households in the project area through metering system by mobilizing financial, human resources by the local community.
3. ASB will be authorize to build, bill , promote, establish, assist set-up administer, enter in to agreements, contract with non Government or government organization or national, international donors or institutions to establish, undertake, contribute, obtain any rights, representation privileges and concession provident benevolent or charitable or development fund.
4. ASB will be authorize to obtain loans to run, manage, operate and maintain both internal and external component of the water supply services operation and maintenance of scheme will be made by ASB, upon its own cost and responsibility and TMA will not have any liability of these loans.
5. All expenditures for running of water supply scheme i.e. Operational and Maintenance, Salaries of staff, electricity bills, repair works etc. will be got by ASB.
6. On the completion of this MOU / Agreement ASB will return this scheme functional and clear from every liability in all aspects including salaries of staff, electricity charges or other allied expenses etc.
7. ASB will create opportunities to local communities to build their capacity to self financed, self managed, self maintained and to approach donors for support required for 24/7water supply scheme through metering and training plan for the local communities on low cost water treatment and safe storage.
8. ASB will create social behavior change through organizing, mobilizing, financial & human resources for social & infrastructure development through using participatory approaches and cadre of activists
9. ASB will create sense of ownership by involving the community in the development process to change the mindset, that project can be done with out help of government and contractors
10. TMA will facilitate the partner by providing basic information available with the TMA such as maps demography, existing scheme, upcoming development plans etc.
11. Consultation and exchange of information and documents which may be required to facilitate the scheme. TMA and ASB will convene meetings to review the progress of activities being carried out and to plan future activities

12. The parties acknowledge that they are familiar with each other ideas and objectives and recognize that their names and emblems may not be associated with any political or sectarian cause or otherwise used in a manner inconsistent with the status, reputation and neutrality of either party.
13. The proposed cooperation under this MOU is non- exclusive and shall have duration of an initial period of ten years, and may be amended by mutual consent of the parties reflected in writing.
14. Any notice or request required to be given or made under this MOU shall be in writing. Such notice or request shall be deemed to have been duly given or made when it shall have been delivered by hand , mail, telex, or made at the addresses notified
15. In case of disputes the parties shall use their best efforts to settle amicably any dispute, controversy or claim arising out of this MOU be referred to DCO Sargodha as a single arbitrator.
16. ASB will ensure gender mainstreaming service connections through 100% water metering for 24/7 water Supply with justice in distribution, Water conservation reduction of waste water and adoption of hygienic practice expenditure upon it will be mobilized by the Local Community through social mobilization awareness raising consumers meeting.
17. ASB will ensure constitute and train self Finance, self maintained and self managed a sustainable smooth running consumer committee which will be registered under Voluntary Agencies registration and control Ordinance, 1961 during the execution.
18. ASB will implement the water management components for the city development plan.
19. In the light of this MOU both parties or committees of their representatives will be responsible for overall monitoring the project activities, whose regular meetings will be conducted after every three months and authorized to rechecking the work or inspection or take any appropriate action against illegality or irregularity.
20. ASB will be authorize and responsible for permitting domestic, commercial and industrial water connections, sending demand notices, connection charges, printing/sending monthly bill to the water consumers. However 15% of water rate charges shall be deposited in TMA Account, which also shall be used on water supply scheme.
21. Tehsil Municipal Administration Bhalwal will provide an adequate, office for use of ASB.
22. Documentation of good practices regarding water scheme will be encouraged.
23. Not anyone from public/private organizations/individuals will carry out the activities of providing water supply connections in the project area without permission/consent of the parties of MOU.

24. Action as according to the civil laws will be taken against any one found guilty on any illegal water supply connections in the project area.
25. Upon notice or request TMA will provide all regulatory social help and Local Staff of C.O Unit will provide full support and help to ASB in terms of Introducing in the local Community, arrangements for community meetings and identification of reliable community leaders and activists.
26. All local laws/ Pakistani laws will be applicable on both parties.
27. Both parties of MOU will be responsible for its own actions / acts and its consequences. Either of the party of MOU will not responsible or liable of any action taken or act done by other.
28. ASB will be responsible to resolve all public objections or other consequences regarding the above mentioned water Scheme.
29. ASB will provide the solid guarantee to ensure to fulfill the terms and conditions of MOU in accordance with law and to perform obligation deliberately.

IN WITNESS WHEREOF, the duly authorized representatives of the parties affix their signatures below:

(Nazir Ahmad Wattoo)
President /Team coordination
Anjuman Samaji behbood (ASB)
40-A main bazaar dhuddiwalan faisalabad

PRESIDENT
Anjuman Samaji Behbood (ASB)
Dhuddiwala Faisalabad.

Tehsil Municipal Officer
Tehsil Municipal Administration
Bhalwal

Administrator
Tehsil Municipal Administration
Bhalwal

Dated 31-12-2012

Witness: Shahzad Ahmed
Project Director
ASB, Faisalabad

Counter signed

Water Supply Situational Analysis of TMA Water Supply

S #	Name of Locality	Water Supply Situation	Piped Network	No. of Connections	Drinking Water Source
1	Noor Hayat Colony	Non-Functional	8” main line is passing but distribution line damaged	-	Commercial Drinking Water Filtration Plants
2	Ashraf Colony	-do-	8” main line is passing but distribution line absent	-	-do
3	Islampura	-do-		-	Filter Plant of Fauji Foods
4	Faridabad Colony	-do-			Filter Plant of Fauji Foods
5	Zulfiqar Colony	-do-		-	Commercial Drinking Water Filtration Plants
6	50% Area of Zahoor Hayat Colony	-do-	12” Rising main and 8” main present	-	Filter Plant of Fauji Foods
7	Suleman Pura	-do-	Water supply network un-available.	-	Filter Plant of Fauji Foods
8	Mukhtar Colony	-do-		-	Filter Plant of Fauji Foods
9	Hadi Pura	-do-		-	Filter Plant of Fauji Foods
10	Mazoor Hyat Colony	Functional	6” & 3” Network present	150	Filter Plant of Fauji Foods
11	Sakhi Suleman Town	Functional	-do-	25	Water Supply
12	Mali Colony	Functional	-do-	60	Water Supply
13	Asmat Hyat Colony	Functional	-do-	50	Water Supply
14	Zahoor Hyat Colony	50% Functional	-do-	30	Filter Plant of Fauji Foods

Questionnaire for Comparative Assessment of Changa Pani Program with other Water Supply Schemes (WSS Section)

Section I: Water Supply Scheme

Date of Survey						
Survey team members		• ---------- • ----------				
1.	**Name of Location of Scheme:**					
a	Name of the Scheme					
b	District					
c	Tehsil/Town					
d	Union Council					
e	Area/Type	Rural ☐	If yes go to Q.1 f	Urban If yes go to Q.1g ☐		
f	Village/Basti					
g	Mohallah/Block/Street					
h	GPS Reading					
2.	**Scheme Information:**					
	Scheme owned by (Name and address of agency):					
a	Funding Source: Government ☐	Int: Agency ☐	Community ☐	NGO ☐	Others ☐	
b	Current Status: Functional ☐	Non Functional ☐	☐ Since Years			
c	Operating Agency/Authority:		d	Construction Agency		
e	Year of Construction:		f	Year of Operation		
g	Design Capacity (Gallons/head/day) ☐		h	Provision of Fire Hydrant Yes ☐ No ☐		
3.	**Incharge of Scheme for Day to Day Administration /Operation:**					
Name:		Scheme Operators Number ☐				
Designation:		Name/s				
Address		Qualification/s Contact Nos.				
Interest in WSS	High	Average	Low			
4.	**Consumers Detail:**					
Water Connections (Total) ☐	Functional ☐	Non-Functional ☐				
Total Domestic Connection (Total) ☐	Total Industrial/ Commercial ☐	Total Public ☐				
Population of Community (Total) ☐	Population served by Scheme ☐	Population Unserved ☐				
Economic Condition of Community	Lower ☐	Lower Middle ☐	Higher Middle ☐	High ☐		
Water Source for un-served population	Private TW ☐	Dug well ☐	Hand pump ☐			
	Tank/ Donkey ☐	Stream/ Nala ☐	Other ☐			

5. Income & Expenditure:

a. Nature of Supply Metered ☐ Un-Metered ☐

Rate Rs Per Domestic Rs ☐ Commercial Rs. ☐ Public Rs. ☐ Total Rs ☐

b. Single Connection Charge

c. Total Revenue of Scheme Domestic

Domestic (Monthly) ☐ Rs ☐ Commercial (Monthly) Rs ☐ Public (Monthly)

d. Average Expenditure:

Staff Salary Rs. ☐ Electricity Diesel Rs ☐

Water Treatment Rs ☐ Other (O&M) Rs ☐

Total Rs ☐

Scheme meets Monthly Expenditure Yes ☐ No ☐

If no Specify other source

6. Pumping & Distribution Network Distribution:

Distribution System Above Ground ☐ Below Ground ☐ Both ☐

Description Transmission/Main/Distribution	Type of Pipe MS, CL, GI,PVC, Asbestos etc	Size of pipe inches	Length of Pipe (ft)	Age of Pipe years	Present Condition
Quantity of water supplied (Gallons)	Daily	Monthly		Annually	

7. Detail of Water Storage **If storage more than one, Fill Performa C**

Scheme Water Storage

a. Scheme Water Storage

Direct Supply ☐ Supply with Storage ☐ Both ☐

Surface Cleaned ☐ Tank If yes Specify ☐ No. of Tank s ☐ Last

Overhead Last Cleaned ☐ tank If yes, Specify No of ☐ Tank

Material of tank bricks concrete

Metal C Fiber/PVC Other

Physical Condition

Good ☐ Satisfactory ☐ Poor ☐

Hygienic Condition Hygienic ☐ Un Hygienic ☐ Capacity of Tank Gallons or/Cubic Feet ☐ Time to fill Tank Hours _____Min_____

b. Water Storage at Consumer End

Material of Fiber/PVC ☐ Tank ☐ Other Bricks ☐ Concrete Metal ☐

Good ☐ Satisfactory ☐ Poor ☐

Hygienic ☐ Un Hygienic ☐ Last Cleaned Year ☐

8. Water Treatment Detail:			
9. Water Treatment Practiced:	☐ Yes No ☐ If yes fill proforma D		
If Yes, which treatment	☐ Chlorination_____ ☐ Ozonization ☐ Sand filtration	☐ Reverse Osmosis ☐ Combination Treatment ☐ Other_____	
If No treatment, given reason			
10. Prevalence of common Health Problems in community, if any	Yes ☐ No ☐ If Yes mention disease type ☐		
11. Past & Current Interventions captured through community Survey	Date of ☐ survey ☐ Date to last R&M		
12. Nature of Survey	Community Assessment ☐ Mobilized ☐ Technical CBO ☐ Registration ☐ R&M		Other
	Pipe line Extended ☐ renewed ☐ Pipe line Storage Enhanced ☐ capacity Pumping Enhanced ☐ Capacity		Other
13. Nature of agreement required for Up-gradation of existing scheme	Tenure Track ☐ based ☐ Life time Based Proportational Asset sharing ☐ Task Sharing ☐		Other

(Section II: Consumer's Data Collection from Households)

Name of consumer and address			
Obtained connection on date		**No. of hours water is supplied**	
No of family members		**Views about color, odor and taste of water**	
If not drinking piped municipal corporation water, why?	Smell & ☐ Taste ☐ Not available in area Fear of ☐ health ☐ Effect other		
What is alternate drinking water source used by household			
Do you buy bottled water?	Yes ☐ No ☐		
What are the total monthly expenditures on bottled water for household?	Rs._____ per month		
Which bottled water brand household uses?			
For what household uses piped water supply ?	Washing ☐ Bathing ☐ Drinking ☐ Water the ☐ gardening	General Cleaning & house hold purposes Other	
Water Supply Hours per day	_____Hours		
What is your level of satisfaction with piped water supply?	Not satisfied ☐ Satisfied ☐ Highly satisfied ☐ If highly go to Q.20 ☐	Other	
Main reason of dissatisfaction with the current Water Supply?	Makes Sikh ☐ Cost too High ☐ Taste and Smell ☐ Insufficient supply hours ☐	Other- Specify	
Availability of Drainage system	Yes ☐ No ☐	If no go to Q.22	
What kind of drainage system?	Katchi Nali ☐ Pakki Nali ☐ Open ☐ Under Ground ☐	Other if any	
Passage of Water supply line to drainage?	Yes ☐ No ☐		
Drainage system with in the current house hold.	Katchi Nali ☐ Pakki Nali ☐ Open ☐ Under Ground ☐	Other if any	
Monthly bill paid by consumer for piped water (Rs)			
Sample collected from household piped water	☐ Yes ☐ No		
Sample Code		**Signed by team leader**	

(Section III: Sample Collection Profile)

Date:_____ Form No._____

Part-A: to be filled in by the Field Team

1. Water Quality Laboratory: ☐ **2. Sampled WSS**: ☐

3. Air Temp: ☐ **4. Water Temp**: ☐

5. Humidity: ☐ **6. Site ID**:

7. Sample ID: ☐ **8. Sample Time**: ☐

9. WSS Source: WSS Source (site-1) ☐ WSS Source (site-2) ☐ Consumer End ☐

9. WSS name and Address:

10. Description of Water Source: (i) Surface Water ☐ (ii) Ground Water ☐

11. If waste water, select Sewage (treated) ☐ Mining waste water ☐ Sewage (untreated) ☐ Industrial ☐

11. Nature of Source:

Hand Pump	Tubewell	Well	W.Supply	Cistern	Tap	Pond	Ind. Effluent
Spring	Nullah	Dam	Irrigation	River	Lake	Sewage	Other

12. Other Information:

Water Table (ft)		Screen Depth (ft)	
Depth of Sample (ft)		Year Installed	
Allied Source		Owner/ Caretaker	
No. of Users			

13. General Observation and Field Analysis:

Odour? (rotten eggs)	Sat	Unsat	Taste	Sat	Unsat
Colour			pH		
Conductivity (µS/cm)			DO	mg/l	

14. Samples collected for quality control:

Cross analysis ID	_____	-E	A	B	C	D
Field Blank ID	_____	-F	A	B	C	D
Replicates ID	_____	-G	A	B	C	D

15. GPS Reading:

Altitude	
Latitude	
Longitude	

16. Picture taken: Yes No

17. No. of consumers using Water of Sampled Source: ☐

18. Complaints of people at the location regarding water quality e.g. Diarrhea etc. ☐

19. Source protected Yes No

20. Comments: (if any) _____

Collected by: _____ **Supervised by**: _____

Type A - All sites - Microbiological analysis

Type B - All sites - Trace elements (2-10 ml/litre HNO3 as preservative)

Type C - All sites - Nitrate Nitrogen (1 ml/100 ml, 1 M Boric acid as preservative)

Type D - All sites - Other water quality parameters (no preservative)

Water Quality Test Results of Water Supply Schemes of Changa Pani Program

Sr.No	Address	Water Source	EC	pH	Turb	Ca	Hard-ness	mg	HCO_3	Cl	K	Na	SO_4	NO_3	TDS	As	Total Coliform	Results
			NGVS	6.5-8.5	5	NGVS	500	NGVS	NGVS	250	NGVS	NGVS	NGVS	10	1000	50	Nil	Safe
1	UC-23 Main Source Tubwell No 7	Tub well	290	7.8	2	24	120	15	110	12	2.4	12	27	0.69	160	0	-ve	Safe
2	UC-23 Main Source Tubwell No 8	Tub well	254	7.8	3	24	100	10	90	12	2.3	9	24	0.94	140	0	-ve	Safe
3	Naeem Block No 5 Main City Bhalwal	Tap	269	7.8	0	24	100	10	100	12	2.5	11	27	0.84	148	0	-ve	Safe
4	House of Qaiser, Near Masjid		255	7.7	0	24	110	12	90	12	2.3	9	28	0.86	148	4	+ve	Unsafe
5	Wasal Ali Alfazl Tawon	Tap	254	7.7	0	24	110	12	90	12	2.3	8	25	0.87	140	0	-ve	Safe
6	Muhammad Amir	Tap	240	7.6	0	24	110	12	90	10	2.4	8	25	0.87	132	0	-ve	Safe
7	Govt primary school madrasa Islamia	Tap	250	7.8	0	24	110	12	90	12	2.3	9	26	0.87	138	0	-ve	Safe
8	Mrs. Inayat Alfazal Town	Tap	245	7.8	0	24	110	12	90	12	2.4	8	27	0.95	135	3	+ve	Unsafe
9	M.Shafiq Alfazal Towm	Tap	286	7.8	0	24	120	15	110	12	2.4	16	27	1.24	157	0	-ve	Safe
10	Nasir Wariach Ex MPA Candidate Main Road Chak No. 8 NB Bhalwal	Tap	253	7.8	0	36	110	5	90	12	2.3	9	25	0.89	139	1	+ve	Unsafe
11	Ejaz Ahmad Chak No 8	Tap	252	7.7	0	24	110	5	90	12	2.4	8	25	0.87	139	2	-ve	Safe
12	Imran Ali Factory Area UC-23	Tap	232	7.8	0	24	110	5	90	12	2.3	9	24	0.87	139	2	+ve	Unsafe
13	Nadeem Sarwar Shalimar Town	Tap	290	7.8	0	24	100	10	110	12	2.4	16	22	1.28	160	1	+ve	Unsafe
14	Ghulam Mustafa UC-23	-	248	7.8	0	24	100	10	95	12	2.3	8	20	0.88	136	0	-ve	Safe
15	Mohammad Afzal Aftab	Tap	254	7.8	0	24	100	10	90	12	2.3	9	24	0.74	140	0	-ve	Safe
16	Muhammad Akram Iqbal	Tap	256	7.7	0	24	100	10	90	12	2.5	13	25	0.88	141	0	-ve	Safe
17	Nawaz Khan	Tap	258	7.8	0	26	100	10	90	12	2.4	10	26	0.86	142	0	-ve	Safe
18	Afsar Ali Alfazal Town	Tap	258	7.7	0	26	100	10	90	12	2.4	10	26	0.86	142	0	-ve	Safe
19	Mohammad MuneerAlfazal Town	Tap	Samples for chemical Analysis were not collected														-ve	Safe
20	Nadeem Anjum Alfazal Town	Nil															-ve	Safe
21	Najmul Hasan Kazmi Sb Satellite town	Tap															-ve	Safe
22	Mohammad Nawaz Satellite town UC-24	Tap															-ve	Safe
23	Mubarak House	Tap															+ve	Unsafe
24	Ayub Sb Satellite Town	Tap															-ve	Safe
25	House of Wali Moh. Main Bazar near Masjid	Tap															-ve	Safe
26	Muhammad Sagheer	Tap															-ve	Safe
27	Usama Main Bazar	Nil															-ve	Safe
28	Bashir Baloch	Tap															-ve	Safe
29	Ashiq Ali Block 3	Tap															-ve	Safe
30	Khwaja Babo Shafiq Block-3	Tap															-ve	Safe
31	Muhammad Mumtaz Mander Rd	Tap															-ve	Safe
32	M. Ramzan Block-4 Gali no-1	Tap															+ve	Unsafe
33	Shaikh Naeem Sb Block-4	Tap															+ve	Unsafe
34	Iftakhar Hussain Block-4	Tap															+ve	Unsafe
35	Mohammad Afzal Mubashir Block 4	Tap															+ve	Unsafe
36	Rana Umer Pervaz	Tap															-ve	Safe
37	Khuja Munir	Tap															-ve	Safe
38	Abdul Aziz	Tap															-ve	Safe
39	Shawkat Bastmehr Abad	Tap															-ve	Safe
40	Umer Farooq	Tap															-ve	Safe
41	Taj Muhammad mehr Abad	Tap															+ve	Unsafe
		Minimum	*232*	*7.63*	*0*	*24*	*100*	*5*	*90*	*10*	*2.3*	*8*	*20*	*0.69*	*132*	*0*		
		Average	*258*	*7.75*	*0*	*25*	*107*	*10*	*94*	*12*	*2.4*	*10*	*25*	*0.90*	*143*	*1*		
		Maximum	*290*	*7.84*	*3*	*36*	*120*	*15*	*110*	*12*	*2.5*	*16*	*28*	*1.28*	*160*	*4*		
	No. of samples beyond permissible limit		**-**	**0**	**0**	**-**	**0**	**-**	**-**	**0**	**-**	**-**	**-**	**0**	**0**	**0**	**11**	**11**

Water Quality Test Results of Water Supply Schemes of TMA

Sr.No	Address	Water Source	EC	pH	Turb	Ca	Hard-ness	mg	HCO_3	Cl	K	Na	SO_4	NO_3	TDS	As	Total Coliform	Results
			NGV	6.5-8.5	5	NGVS	500	NGVS	NGVS	250	NGVS	NGVS	NGVS	10	1000	50	Nil	Safe
1	Purana Bhalwal on the land of land of M. Sher s/o M. Dari	Tap	252	7.75	0	24	110	5	90	12	2.3	9	24	0.87	139	0	+ve	Unsafe
2	on the left bank of Lj Canal Purana Bhalwal city.	Tap	248	7.83	0	24	100	10	95	12	2.3	8	20	0.38	136	0	-ve	Safe
3	on the left bank of Lj Canal Purana Bhalwal on the land of...	Tap	245	7.75	0	24	110	12	90	12	2.4	8	27	0.95	135	0	-ve	Safe
4	OHR , Mohallah Ogian Bhalwal city	Tap	253	7.84	0	36	110	5	90	12	2.3	9	25	0.89	139	2	+ve	Unsafe
5	Muhammad Shabir s/o Muhammad Bashir Mali Colony	Tap	252	7.66	0	24	110	5	90	12	2.4	8	25	0.87	139	0	-ve	Safe
6	Subtain Shah Mali Colony	Tap	255	7.69	0	24	110	12	90	12	2.3	9	28	0.86	140	0	-ve	Safe
7	Waqas Ahmad s/o Zahoor Ahmad, Fauji Food	Tap	254	7.72	0	24	110	12	90	12	2.3	8	25	0.87	140	0	+ve	Unsafe
8	Ghulam Hussain Manzoor Hayat Colony	Tap	240	7.63	0	24	110	12	90	10	2.4	8	25	0.87	132	0	-ve	Safe
9	Tanzeel ur Rehman	F P	256	7.72	0	24	100	10	90	12	2.5	13	25	0.88	141	0	+ve	Unsafe
10	Nasir Mehmood	Tap	286	7.8	0	24	120	15	110	12	2.4	16	27	1.24	157	0	-ve	Safe
11	Talib Hussain Manzoor Hayat Colony	Tap	Samples for chemical Analysis were not collected														+ve	Unsafe
12	Arshad Mehmood s/o Ghulam Rasul Filtration Plant of Fauji Foods Bhalwal	Tap															+ve	Unsafe
13	Tariq Ejaz s/o Muhammad Nazir from Fauji Food Plant	Tap															+ve	Unsafe
14		Tap															+ve	Unsafe
15	Muhammad Munir Skahi Suleman Town Bhalwal	Tap															-ve	Safe
16	M Imran Skahi Suleman Town Bhalwal	Tap															+ve	Unsafe
17	Gulzar Ahmed S/o of Jumma Khan	Tap															-ve	Safe
18	Water form Filtration Plant of Fauji Food	Tap															+ve	Unsafe
19	Malik Munsaf Zahoor Hayat Colony	Tap															-ve	Safe
20	Muhammad Yousaf (Ali Raza) Asmat Hyat Colony	Tap															-ve	Safe
21	Muhammad Aslam s/o M. Yousaf	Tap															-ve	Safe
		Minimum	*240*	*7.63*	*0*	*24*	*100*	*5*	*90*	*10*	*2.3*	*8*	*20*	*0.38*	*132*	*0*		
		Average	*254*	*7.74*	*0*	*25*	*109*	*10*	*93*	*12*	*2.4*	*10*	*25*	*0.87*	*140*	*0*		
		Maximum	*286*	*7.84*	*0*	*36*	*120*	*15*	*110*	*12*	*2.5*	*16*	*28*	*1.24*	*157*	*2*		
	No. of samples beyond permissible limit		**-**	**0**	**0**	**-**	**0**	**-**	**-**	**0**	**-**	**-**	**-**	**0**	**0**	**0**	**10**	**10**

Water Quality Test Results of Private Bores

Sr.No	Address	Water Source	EC	pH	Turb	Ca	Hard-ness	Mg	HCO_3	Cl	K	Na	SO_4	NO_3	TDS	As	Total Coliform	Results
			NGV	**6.5-8.5**	**5**	**NGVS**	**500**	**200**	**NGVS**	**250**	**NGVS**	**200**	**400**	**10**	**1000**	**50**	**Nil**	**Safe**
1	NasirRizwan Block No 5 H # 493 Uc-23	Bore	2760	7.6	0	30	190	28	520	288	4.5	500	360	5.01	1518	5	+ve	Unsafe
2	Ihsan Ali Iqbal Colony	Bore	3680	7.9	0	40	200	24	470	540	4.4	760	573	1.36	2024	2	+ve	Unsafe
3	Raja Muhammad HanifChak No. 8 Shumali	Bore	3450	7.6	0	72	410	56	400	440	12.3	620	658	3.39	1898	0	+ve	Unsafe
4	Ghulam Ali Rose Inn Hotel Factory Area	Bore	268	7.8	0	24	120	15	90	16	2.3	9	25	0.79	147	5	-ve	Safe
5	MarizaMehmoodBaig UC-23	Bore	3410	7.4	0	60	580	104	600	244	9.5	570	588	48.00	2182	2	-ve	Unsafe
6	SafdarIqbqliqbql colony UC-23	Bore	3270	7.4	0	88	400	44	400	480	6.6	510	417	4.63	1799	2	-ve	Unsafe
7	Shaikh Muhammad RaizAlfazal Town	Bore	2090	7.7	0	40	210	27	550	144	4.9	380	302	1.35	1254	4	-ve	Unsafe
8	Main Tariq Alfazal Town	Bore	5160	7.5	0	60	450	73	650	816	8.5	980	840	3.42	3199	4	-ve	Unsafe
9	Manzoor Hayat Colony	Bore	3270	7.4	0	88	400	44	400	480	6.6	510	417	4.63	1799	0	-ve	Unsafe
10	Muhammad Isshafiq S/O Muhammad Rafique	Bore	3410	7.3	0	60	580	104	600	264	9.5	570	588	48.00	2182	0	+ve	Unsafe
11	Muhammad Qasim Bashir	Bore	5190	7.1	0	76	710	129	1150	648	12	940	642	52.00	3322	0	+ve	Unsafe
12	Imran Haider Ashraf colony.	Bore	5160	7.4	0	60	450	73	650	816	8.5	980	840	3.42	3199	4	-ve	Unsafe
13	KhurramShehzad	Bore	2090	7.6	0	40	210	27	550	144	4.9	380	302	1.35	1254	0	+ve	Unsafe
		Minimum	*268*	*7.2*	*0*	*24*	*120*	*15*	*90*	*16*	*2.3*	*9*	*25*	*0.79*	*147*	*0*		
		Average	*3324*	*7.5*	*0*	*57*	*378*	*58*	*541*	*409*	*7.3*	*593*	*504*	*13.64*	*1983*	*2*		
		Maximum	*5190*	*7.9*	*0*	*88*	*710*	*129*	*1150*	*816*	*12.3*	*980*	*840*	*52.00*	*3322*	*5*		
		No. of samples beyond permissible limit	**-**	**0**	**0**	**-**	**3**	**-**	**-**	**9**	**-**	**12**	**10**	**3**	**12**	**0**	**6**	**12**

About PCRWR

PCRWR is an apex body of the Ministry of Science and Technology and is mandated to conduct, organize, coordinate and promote research on all aspects of water resources including irrigation (surface and groundwater), drainage, soil reclamation, drinking water and wastewater. It has eight regional offices located at different agro-ecological zones and each centre conducts research on water-related issues of the respective zones. These Regional Offices are located at Lahore, Bahawalpur, Tandojam, Quetta, Peshawar, Karachi, Gilgit and Muzaffarabad. Besides these eight Regional Offices, PCRWR has a setup of 24 water quality testing and research laboratories in major cities of the country. This includes ISO-17025 accredited National Water Quality Laboratory having its own Laboratory Information Management System (LIMS). PCRWR has all types of infrastructure such as soil and water testing laboratories, groundwater assessment equipment, research farms to conduct and disseminate the research. It is the only organization in Pakistan that owns drainage type lysimeters in Lahore, Tandojam, Quetta and Peshawar. PCRWR has done considerable work on crop water requirements, tile drainage, soil reclamation, on-farm water management technologies, rainwater harvesting, artificial recharge, groundwater assessment and management, skimming wells, drinking water, and indigenous development of salinity and moisture sensors. To help in developing the capacity of in-service professionals and fresh graduates, PCRWR has also a well-equipped National Capacity Building Institute in Islamabad.

PAKISTAN COUNCIL OF RESEARCH IN WATER RESOURCES

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