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URBAN SMALL WATER ENTERPRISES FOR SMARTER CITIES

RAPID ASSESSMENT OF WATER SUPPLY: CITY OF VISAKHAPATNAM

NOVEMBER 2015

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ABOUT THE REPORT

The rapid assessment of water supply in the city of Visakhapatnam (Vizag) has been conducted as a part of a broader partnership between Safe Water Network and the US Agency for International Development (USAID) entitled Urban Small Water Enterprises (USWEs) for Smarter Cities under the USAID Urban Water, Sanitation and Hygiene (WASH) Alliance program. This study aligns with the agreement entered into between the Ministry of Urban Development (MoUD) and USAID to contribute toward Swachh Bharat Mission. The Vizag Rapid Assessment was undertaken, as it is one of the three cities selected by the government under their Smart Cities initiative.

The objectives of this assessment were to (i) evaluate the current landscape of piped water supply in Vizag, identify gaps, and provide recommendations on how to address those gaps in the context of Vizag's endeavors to achieve 24/7 piped water supply; (ii) evaluate the potential of small water enterprises (SWEs) to complement piped water supply, especially for those living beyond the pipe in urban slums; and (iii) assess the need and use for digital tools for e-governance, monitoring, and evaluation.

While detailed consumer research and water quality testing was done in slums to understand water supply to the urban poor, the overall city water supply assessment builds on field investigation and discussions with various Greater Visakhapatnam Municipal Corporation (GVMC) departments, especially the Water Supply and Maintenance (WSM) division conducted by the Safe Water Network team.

This report begins by introducing the USWE project, including the research methodology. Next, the report provides context on Vizag—its land, economy, and people—followed by details of water supply in Vizag, including water supply to slums. A section on 24/7 water supply documents some of the challenges the city has encountered in trying to pilot continuous and reliable water supply projects. The next section transitions to USWEs that have been set up to complement the piped water in slums. Finally, this report addresses digital tools for USWEs and their potential to make Vizag's water supply "smart."

The assessment was undertaken by Safe Water Network through the Fixed Obligation Grant Award No. AID-386-F-15-00002, for the program titled: "Urban Small Water Enterprises" Dec. 2014–Dec. 2016.

Front cover:

NTR Sujala plant operators and support staff at Nerella Koneru (ward no. 30). Plant operators are local self-help group members.

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EXECUTIVE SUMMARY

Vizag is a port city on the east coast of the Bay of Bengal in southern India. Though Vizag supports major industries and occupied the eighth rank in gross domestic product (GDP) contribution among the topmost cities of India in 2014—estimated at INR 1.6 trillion ($26 billion)[1] with a per capita income of INR 1,13,860 (US $1,836)[2]—44 percent of households under the Greater Visakhapatnam Municipal Corporation (GVMC) ambit fall under the slum category as per Census 2011. The population of the city was recorded as 1,728,128 with 439,335 households, making it the 17th largest city in India,[3] while its suburban area, which is now being served by GVMC, leads to a total population of more than 2,035,000[4] with 207,386 households in 793 slums. As per the data obtained from the Integrated Disease Surveillance Program 2014, the share of waterborne diseases was 22 percent of the total diagnosed cases in outpatient departments.

24/7 Water Supply Target Requires Bolstering of Piped Water Supply Infrastructure and Capacity Base

GVMC relies mostly on surface water for its raw water supply and serves 54.9 percent of the city's 439,335 households[5] through household-level piped connections.[6] There is also a supply gap of almost 66 million liters per day (MLD), and the infrastructure is in need of repair. Evaluated on the basis of the service level benchmarks as recommended by the MoUD, Vizag's piped water supply scored well on financial parameters (cost recovery and efficiency in collection), and all samples of the piped water tested for quality internally by GVMC and contractors complied with national standards.

Vizag's piped water supply, however, lagged far behind benchmarks for service availability, coverage, non-revenue water (NRW), and metering. Moreover, the high-cost recovery is attributable to the industrial connections that provide the majority (83.68 percent) of revenues.

Since 2005, GVMC has been assessing the feasibility of 24/7 piped water supply, but only recently has this goal gained traction under the Smart Cities program. The city has piloted several related projects, but none have succeeded, as the current infrastructure cannot support 24/7 supply.

Range of Water Delivery Mechanisms Employed in Effort to Meet Demand, But at High Cost

GVMC is doing a commendable job of providing water under its ambit despite the limited water supply at its disposal. Various water delivery mechanisms exist for the ~200,000 households (1 million people) living in slums within GVMC limits. GVMC-facilitated individual/community tap connections and tankers provide municipal water while hand pumps are the most common groundwater sources. Individual tap connections for below-poverty-line (BPL) households have been subsidized to promote uptake while areas beyond the city water supply network are diligently served by GVMC-hired tankers, free to the consumer, albeit at a high cost to the city.

Inadequate Water Supply and Lack of Awareness Puts Health of Urban Poor at Risk

Since the quantity of municipal supply is limited, averaging 88 liters per capita per day and supplied for about 45 minutes a day, there is a significant degree of reliance on groundwater sources; however, slum households receive a much lower allocation of water due to variation in supply. The urban poor seem to lack awareness about the impact of water quality on health and the appropriate end use of the various water sources, given their variance in quality.

[1] "India's Top 15 cities with the Highest GDP." Yahoo Finance. Retrieved 15 July 2014.
[2] Ministry of Statistics and Programme Implementation, Planning Department. Socio Economic Survey 2013–14.
[3] Government of India. Office of the Registrar General & Census Commissioner, India Ministry of Home Affairs. (2011). Census of India.
[4] Ibid.
[5] Excludes households in Anakapalle and Bheemili, as their piped water connections are served by local infiltration wells and their associated distribution network and not by GVMC's treated water distribution network.
[6] Includes semi-bulk connections to apartment complexes, etc.

Sometimes, inadequate municipal water supply leads the urban poor to partially rely on groundwater sources. This, coupled with the fact that some parts of the city[7] were found to have nitrates and fluoride above acceptable limits, as specified by IS 10500: 2012, in groundwater, puts the health of the urban poor at considerable risk.

NTR Sujala Pathakam Scheme Serves as Model for SWE Water Provision

For the poor living in slums beyond the pipe, water has been supplied by way of tankers, hand pumps, and safe water kiosks since October 2014 under a statewide scheme called NTR Sujala Pathakam. The NTR Sujala Pathakam scheme facilitates small water enterprises operated and maintained by Self-Help Groups (SHGs) to provide safe affordable drinking water (INR 2/20L). Initially planned to be a rural scheme, this has been expanded to urban areas as well on the directions of the Municipal Administration & Urban Development (MA&UD) department of the state government. Although it was envisaged to be a corporate social responsibility-funded scheme, funding has remained limited, and GVMC funded all such kiosks in its area of jurisdiction.

RECOMMENDATIONS

Piped Water Supply: Pilot 24/7 Water Supply Initiative and Build Local Capacity

There are opportunities for improving the efficiency and effectiveness of the piped water supply to improve supply management, particularly through NRW reduction, increased number of subsidized tap connections for the urban poor, plugging leakages, and capacity building of engineers at all levels. A 24/7 water supply initiative should be piloted through stringent concessionaires' selection, in addition to a district-metered area (DMA) approach. GVMC could invite operator consultants or concessionaires to pilot in a specified area for 24/7 city water supply.

Small Water Enterprises (SWEs): Employ Kiosks to Complement Piped Water Supply

SWEs can complement piped water supply where the piped water network is limited and there is heavy dependence on tanker supply, and in areas with groundwater contamination. GVMC can potentially leverage these kiosks to deliver on political commitments in areas where its piped water network is limited and tankers play a key role in daily water supply. For reliable and efficient operations, special focus must be given to deploying remote monitoring systems, establishing a field service entity, and conducting capacity building for self-help groups (SHGs).

Digital Tools: Improve E-Governance for Vizag Leveraging Digital Tools

With the current IT infrastructure at GVMC, better processes for surveillance are needed. Incorporating digital tools into GVMC and SWE processes will allow for better monitoring of water availability to different parts of the city to improve demand management as well as leakage monitoring to realize a reduction in NRW. In addition, GVMC should deploy a robust Supervisory Control and Data Acquisition (SCADA) system to set up effective monitoring of its water supply network while upgrading and expanding its use of other e-governance tools.

Currently, no digital tools exist to monitor NTR Sujala kiosks or other SWEs. There is a clear need and demand for tools to identify the most cost-effective and appropriate technologies, particularly in light of overreliance on reverse osmosis (RO) technology; enable monitoring of operational effectiveness to reduce risks of breakdowns as plants age; and evaluate kiosks' financial sustainability to ensure longer life of the system and develop social entrepreneurs.

[7] Zone 4, suburban Anakapalle and Bheemili.

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LIST OF ABBREVIATIONS

AE	Assistant Engineer
APL	Above Poverty Line
BPL	Below Poverty Line
DMA	District-metered Area
DPR	Detailed Project Report
ELSR	Elevated-level Service Reservoir
GDP	Gross Domestic Product
GLSR	Ground-level Service Reservoir
GVMC	Greater Visakhapatnam Municipal Corporation
HH	Household
JUSCO	Jamshedpur Utilities and Services Company
KM	Kilometers
LPCD	Liters per Capita Daily
MLA	Member of Legislative Assembly
MLD	Million Liters per Day
MoUD	Ministry of Urban Development
NABL	National Accreditation Board for Testing and Calibration Laboratories
NRW	Non-Revenue Water
NWP	National Water Policy
O&M	Operation and Maintenance
OPD	Outpatient Department
PPP	Public-private Partnership
SCADA	Supervisory Control and Data Acquisition
SHG	Self-help Group
SWE	Small Water Enterprise
TDS	Total Dissolved Solids
UCD	Urban Community Development
ULB	Urban Local Bodies
USAID	United States Agency for International Development
USWE	Urban Small Water Enterprise
VMC	Visakhapatnam Municipal Corporation

KEY DEFINITIONS

Urban Small Water Enterprises (USWEs)

Urban Small Water Enterprises (USWEs) generally refer to a range of entities selling water to bottom-of-the-pyramid populations in urban areas, ranging from stationary water points, such as kiosks or standpipes, to mobile units, such as tanker trucks and door-to-door vendors. This assessment, however, was limited to water purification kiosks that sell affordable water to the urban poor.

Notified/Non-notified Slums

As per Census 2011, slums are defined as residential areas where dwellings are unfit for human habitation by reasons of dilapidation; overcrowding; faulty arrangements and design of such buildings; narrowness or faulty arrangement of street; lack of ventilation, light, or sanitation facilities; or any combination of these factors that are detrimental to the safety and health. A notified slum is an area notified as a slum by concerned municipalities, corporations, local bodies, or development authorities. The balance are non-notified slums.

NTR Sujala Pathakam

An Andhra Pradesh government initiative for setting up Small Water Enterprises (SWEs) in rural areas and in slums to provide access to affordable safe water at INR 2 per 20L. It complements piped water supply in cities for the urban poor.[8]

National Accreditation Board for Testing and Calibration Laboratories (NABL)

NABL is an autonomous body under the Department of Science and Technology, Government of India, set up to certify technical competence in laboratories. The accreditation services are provided for testing, calibration, or medical laboratory in accordance with International Organization for Standardization (ISO) standards.[9]

Non-Revenue Water (NRW)

Non-Revenue Water (NRW) is the difference between the amount of water put into the distribution system and the amount of water billed to consumers.[10]

District-metered Areas (DMAs)

A district-metered area (DMA) is hydraulically discrete and ideally has only a single inflow point. The inflow and corresponding pressure is measured and monitored on a continuous basis.[11]

[8] NTR Sujala Pathakam, Govt. of AP. http://rwss.ap.nic.in/pred/NtrSujalaHomePage.html
[9] NABL India.
[10] Asian Development Bank. *The Issues and Challenges of Reducing Non-Revenue Water.*
[11] Ibid.

Attendants and visitors collecting drinking water from a Reverse Osmosis treatment facility in Andhra Medical College (AMC), donated by 1984 AMC batch.

1. INTRODUCTON

1.1 Background

With rapidly increasing urbanization in India, Prime Minister Mr. Narendra Modi announced in June 2014 his vision to build 100 smart cities by 2022. With investments for this massive project pouring in from government, private-sector, and international players, bilateral talks between US President Barack Obama and Mr. Modi concluded with the US government agreeing to help India in developing Allahabad, Ajmer, and Vizag into smart cities.

In November 2014, the United States Agency for International Development (USAID), under the Urban WASH Alliance, selected Safe Water Network India as a recipient for grants to assess the potential of urban small water enterprises (USWEs) to provide safe water access to urban poor, complementary to piped water and to building digital tools for improved management of USWEs as a part of its India Partnership Program. The signing of the Memorandum of Understanding between USAID and the Ministry of Urban Development (MoUD) in January 2015 officially marked the beginning of cooperation in the field of water, sanitation, and hygiene.

Safe Water Network India undertook the Vizag rapid assessment study as part of the Urban Small Water Enterprises for Smarter Cities project, with due cooperation from and agreement with MoUD and Greater Visakhapatnam Municipal Corporation (GVMC). As a part of this study, the city's water supply was assessed along with the prevailing water provision to the urban poor and the small water enterprises (SWEs) operating in Vizag. Other funders of this initiative included PepsiCo Foundation, Pentair Foundation, Newman's Own Foundation, and Cisco Foundation.

The The Urban Small Water Enterprises for Smarter Cities project aims to assess USWEs in four Indian cities. In the three cities of New Delhi, Mumbai, and Hyderabad, Safe Water Network is assessing USWEs in slums along several dimensions, including consumer, financial, operational, and technical, and also reviewing the policy and enabling environment in which USWEs operate. The project also aims to understand the current use and need for digital tools, and to develop three tools for facilitating better alignment and decision making among the state government, urban local bodies (ULBs), and USWE implementers.

In the fourth city, Vizag, we conducted a rapid assessment to understand how it can elevate itself to 24/7 piped water supply provision and adopt measures to address non-revenue water (NRW) to augment water supply to the citizens of Vizag. This study was done with due cooperation from MoUD and GVMC, and was facilitated by the Safe Water Network team and a consultant, Mr. G. S. Basu, to assess key aspects of GVMC's piped water supply as well as provide preliminary but tangible recommendations (Annexure 1—Scope of Work).

1.2 Objectives of this Study

The objectives of the Vizag rapid assessment described in this report are to:

- Understand the barriers and challenges to providing 24/7 piped water supply to Vizag citizens and provide suggestions to achieve this supply both in terms of hardware and software;
- Identify enablers needed to support USWEs to serve the urban poor; and
- Evaluate existing digital tools in water supply for e-governance and the potential need and application of other digital tools in Vizag.

1.3 Hypotheses

The following hypotheses were tested:

- Urban poor have limited access to piped water and other sources of municipal water and therefore rely on other unreliable sources of water.
- Limited, if any, USWEs are serving the urban poor in Vizag.
- There is little use of digital tools in e-governance of urban slum water supply in Vizag.
- The civic body, GVMC, is equipped with capability and expertise to effectively and efficiently manage the entire water distribution system of Vizag.

1.4 Methodology

The overall process flow followed for the project is depicted in Figure 1. The methodology is divided into the following two sections according to the mode of water supply:

- **Piped Water Supply**
  - Field visits and interviews of GVMC personnel from the water supply and maintenance departments as well as the urban community development teams (Annexure 2—Questionnaire for Interviewing Urban Local Bodies)
  - Consumer research through interviews of 300 women in six different slums by Stratage Consulting (Annexure 3—Consumer Research Questionnaire)
  - Water quality testing of samples by Bhagavathi Ana Labs, a National Accreditation Board for Testing and Calibration Laboratories (NABL)-accredited laboratory (Annexure 5—Consolidated Water Quality Report)
- **Small Water Enterprises for Beyond-the-Pipe Households**
  - Field visit by Safe Water Network India team to six different slums
  - Consumer research through interviews of 300 women in six different slums by Stratage Consulting (Annexure 4—SWE Entrepreneur/Operator Questionnaire)
  - Water quality testing of samples by Bhagavathi Ana Labs
  - Focus group discussions in slums
  - Multi-stakeholder consultation

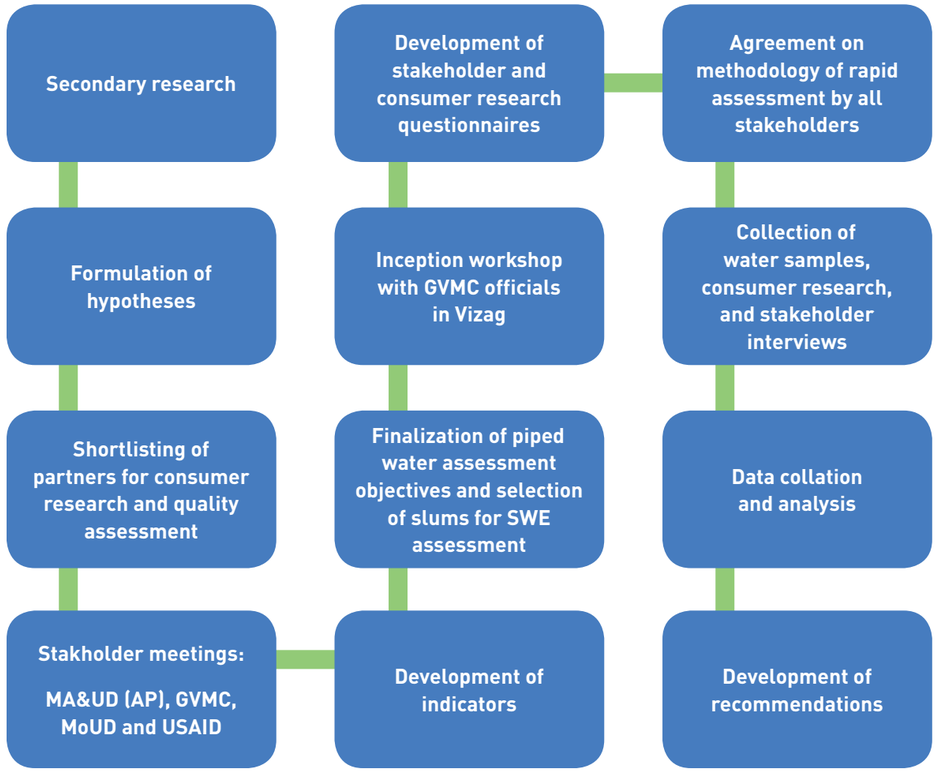
The discovery phase of digital tool preparation involved both the specialists of Safe Water Network India and the supportive expertise of the organization's global technical support program. In general, the India team led the direct conversations with expected tool users in Indian municipalities, and global specialists from outside India focused on internet investigations, conversations with sector experts, and analyses of other tools and their history.

1.5 Indicators

The following broad sets of indicators for the Vizag assessment were used:

- **Water supply:** quantity supplied; time of supply; quality
- **Water payment:** willingness to pay
- **Sustainability:** capacity to operate and maintain; financial viability of SWEs
- **Community participation:** water security

Figure 1. Process Flow of the Project

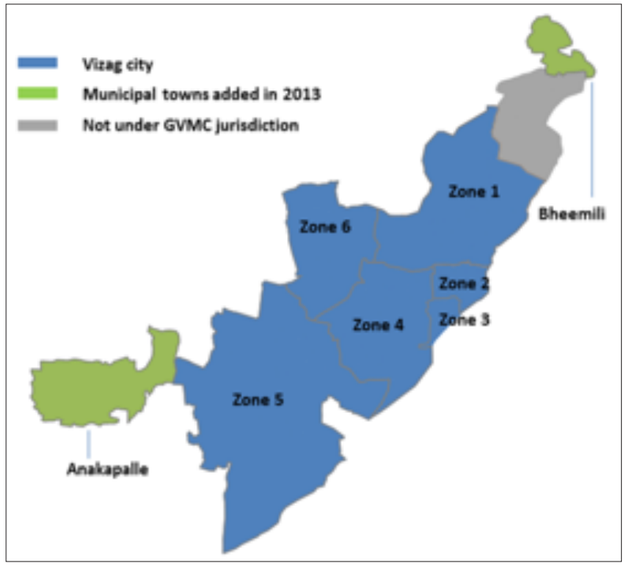


1.6 Selection of Slums

The slums selected for consumer research were spread across the zones of GVMC jurisdiction (Figure 2). On the basis of discussions with GVMC, the following three slums with NTR Sujala Pathakam kiosks and three without them from different zones were selected:

- **Zone 1** – Mustafa Colony, Arilova
- **Zone 2** – Pedajalaripeta
- **Zone 3** – Kobbarithota
- **Zone 4** – Chukkavanipalem
- **Anakapalle** – Velapula Veedhi
- **Bheemili** – Reeliveedhi

Figure 2. GVMC Jurisdiction of Vizag



1.7 Limitations

Having described the scope and methodology above, there are limitations to the assessment:

- Geographical location of the areas chosen and the timeline during which the assessment was done (March, summer season) can play a role in the outcome of the results, as quality may degrade during rainy seasons.
- Response bias of the consumers is inherent in this type of study and may affect the resulting insights gathered from the field research.

Safe Water Network field assessment team with NTR Sujala plant operators and Mission for Elimination of Poverty in Municipal Areas personnel (extreme left) at Mustapha Colony (ward no. 2)

Safe Water Network staff holding discussions with stakeholders in Vizag.

2. CONTEXT: VISAKHAPATNAM

2.1 Introduction

Visakhapatnam, commonly known as Vizag, is a port city on the east coast of Bay of Bengal in southern India. Spanning across an area of around 682 square kilometers, it houses a population of about 20.35 lakhs (~2 million)[12] (Census 2011). One of the earliest municipalities (set up in 1858), Vizag was divided into 45 wards before 2005 and was served by the Visakhapatnam Municipal Corporation (VMC), the city's official civic body. With 32 gram panchayats (village councils) and the Gajuwaka municipality added to its jurisdiction in 2005, VMC, after mergers, grew into the 72-ward GVMC. Also, in 2013, a resolution was passed expanding GVMC further by adding Anakapalle and Bheemili to its jurisdiction (Figure 2).

The city, which supports several major industrial sectors, such as information technology (IBM, Wipro, etc.), manufacturing (Hindustan Zinc, Vizag Steel Plant, etc.), and the fishing and sea trade, contributes around $26 billion toward India's gross domestic product (GDP), ranking eighth in GDP contribution by cities (2011–12 statistics). Vizag, with a per capita income of Rs. 1,13,860 (FY2013/14), outranked all other cities of Andhra Pradesh. Though more economically advanced than many of its peers, Vizag City had almost 45 percent of households (HH) falling into the category of slums (1,95,670 HH out of total 4,39,335 HH, including notified and non-notified slums), according to the Urban Community Development (UCD) wing of GVMC and the Census 2011.

2.2 Slum Population

GVMC has more than 200,000 households in slums in its ambit, home to almost 1 million people. Vizag has experienced a population increase due to migration from rural areas and smaller towns, and the number of slums has grown drastically and inorganically. GVMC limits had about 450 slums until 2005. With the inclusion of 32 gram panchayats and the Gajuwaka municipality in that year and then two satellite towns in Anakapalle and Bheemili, this number increased by 75 percent to 793 by 2013 (Table 1). Per the data available with the UCD wing, GVMC has 711 slums in Vizag City, 30 in Anakapalle, and 52 in Bheemili.

TABLE 1 **Slum Count in Vizag**

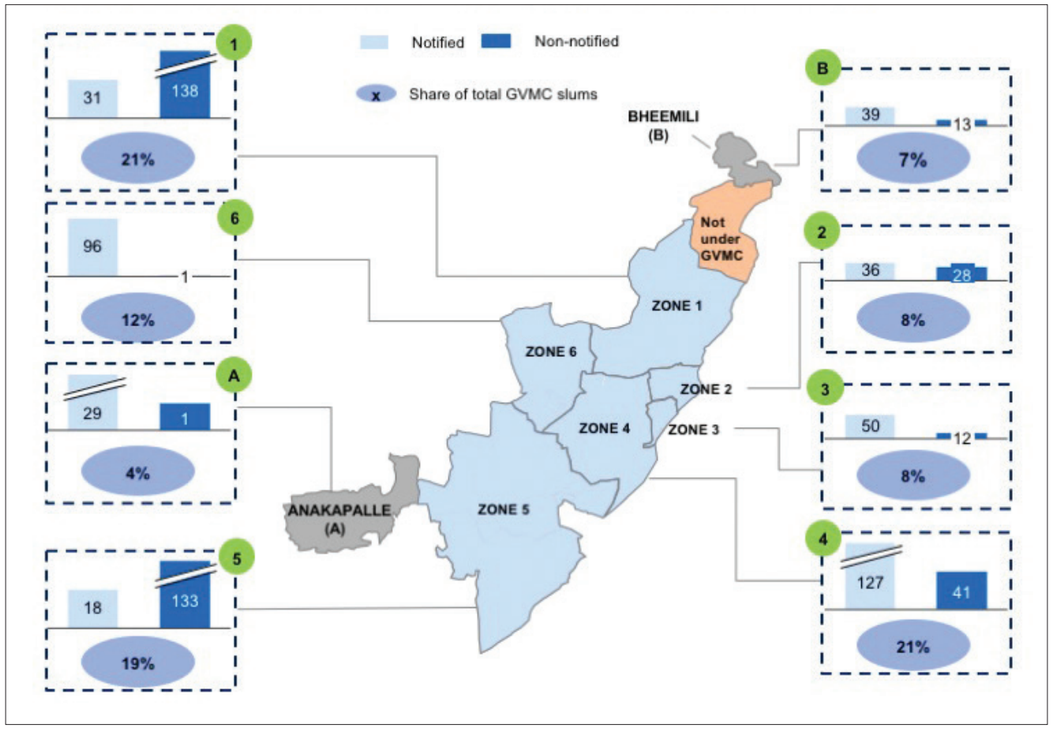
Area	Total slums	<60 HHs	60-100 HHs	>100 HHs
Vizag City	711	58	89	564
Anakapalle	30	3	5	22
Bheemili	52	15	10	27
Entire GVMC area	793	76	104	633

Interestingly, the Ministry of Urban Development's baseline assessment of GVMC in 2013 highlighted that the "lack of dependable data on various aspects of poverty including number of slums, slum population, and access to services like water and sanitation, livelihood, etc. is affecting the preparation of slum improvement plans for the city."

[12] Government of India. Office of the Registrar General & Census Commissioner, India Ministry of Home Affairs. (2011). Census of India.

The number of slums is overstated for several reasons per academia and GVMC. About 10 percent of the settlements categorized as slums in GVMC limits comprise less than 60 HH, which is the threshold per the national definition of slums set by Census India. Another 13 percent of slums comprise 60–100 HHs. Since the slum enumeration process in Vizag was also completed to help implement the Mission for Elimination of Poverty in Municipal Areas (MEPMA), areas with 20 HHs were also considered as slums per its guidelines. In the last decade, significant parts of satellite areas, which have been brought under GVMC's ambit, have come to be categorized as slums. A lot of these settlements are small hamlets that are now being viewed through an urban lens and hence are being categorized as slums. The lack of regularization of "developed" slums has also contributed to an inflated number. Experts believe that Vizag City has 175–225 settlements that should be categorized as slums and targeted for improvement. Acknowledging the lack of reliable data, GVMC, with the help of external consultants, intends to soon finalize a list of slums and categorize them by degree of development needed. This will be important to facilitate a more cohesive approach and plan.

Figure 3. No. of notified and non-notified slums and share of total GVMC slums by zone



2.3 Health

At a district level, 22 percent of total diagnosed Outpatient department (OPD) cases at government health centers are waterborne in Visakhapatnam district, as reported under the Integrated Diseases Surveillance Program (IDSP).

Total OPD in Table 2 includes diseases diagnosed and categorized by geography.

TABLE 2 **Analysis of IDSP Data at a District Level (2014)[13]**

District	Population	Total diagnosed cases in OPD[14]	Share of waterborne diseases[15]
Visakhapatnam	4,288,113	223,563	22%
Vizianagaram	2,342,868	316,821	19%
Srikakulam	2,699,471	195,973	17%
East Godavari	5,151,549	246,297	13%
West Godavari	3,934,782	209,976	13%

GVMC's Public Health division maintains daily OPD records of urban health centers (UHCs) and dispensaries. Cumulatively these cover the majority of GVMC limits (i.e., excluding Zone 5, Zone 6, Anakapalle, and Bheemili). Table 3 shows an analysis of the OPD cases from 2014. Assuming that the majority of the urban poor rely on government health centers for their diagnoses, certain pockets of Zones 3 and 4 appear to have high percentages of waterborne diseases.

TABLE 3 **Analysis of IDSP Data of UHCs in GVMC Area**

UHC area	Total OPD cases (2014)	Share of waterborne diseases[16]	Wards being served	Zone
Sriharipuram	1,423	50%	46–48	4
One Town	1,258	35%	21, 22, 25, 29	3
Allipuram	1,602	32%	27, 28, 30	3
Kapparada	2,051	30%	35, 37 (38, 39)	4
R.P.Peta	1,692	25%	36, 40	4
Prasad Gardens	1,786	24%	26	3
Butchirajupalem	1,763	21%	41, 42	4
Vidyuth Nagar	1,302	21%	12, 32–34	2, 4
Gnanapuram	1,792	17%	43, 44	4
Arilova	690	16%	1, 2, 7, 8	1, 2
Chinawaltair	1,676	11%	9, 16–18	2, 3
Malkapuram	1,549	9%	45, 49	4
Total	**18,584**	**24%**	-	-

[13] Integrated Disease Surveillance Program (IDSP) database, 2014.
[14] Based on presumptive surveillance reports.
[15] Includes acute diarrheal diseases, bacillary dysentery, viral hepatitis, and enteric fever.
[16] Waterborne diseases being acute diarrheal diseases, bacillary dysentery, viral hepatitis, and enteric fever as per hospital records.

2.4 Consumers

Table 4 shows people's preferences and usage of various water sources and the different activities or purposes for which people use each water source. Household, community-level taps, and bore wells are the sources most widely used. Households using these three sources generally use them for all purposes, from drinking to washing and bathing.

NTR Sujala kiosks are more regularly used than water bought from the market in cans/bottles, even though there is less availability of these kiosks and fewer people have tried using them (see Section 4). There is a price advantage with these kiosks (INR 2 per 20L can versus INR 20+ per 20L can or INR 10+ per 1L bottle), and it seems people also like the water provided through these kiosks. The highest use for kiosk water seems to be for drinking purposes.

TABLE 4 **Consumer Research—Type of Activity by Water Source**

Water source	Drinking	Cooking	Washing/cleaning food items	Other uses like washing, bathing
Tap water available at home	48%	53%	45%	43%
Community tap	18%	21%	21%	17%
Bore well/boring water	16%	17%	21%	23%
Tanker water	1%	0%	0%	1%
Hand pump	4%	4%	8%	11%
NTR Sujala kiosk	10%	3%	3%	0%
Market— bottles/cans	3%	1%	1%	0%
Well	0%	0%	0%	4%
Total	**100%**	**100%**	**100%**	**100%**

Lifeline for the urban poor: Greater Visakhapatnam Municipal Corporation tankers refilling at TSR Complex.

Safe Water Network field assessment team member with NTR Sujala plant operators and Mission for Elimination of Poverty in Municipal personnel (second from right) at Bapuji Nagar (ward no. 37). Plant operators are local self-help group members.

3. WATER SUPPLY

3.1 Overview

According to the service level benchmarks (SLBs) set by the MoUD, water utilities are expected to provide a minimum of 135 liters per capita daily (LPCD) to all. With a population of around 20.35 lakhs (~2 million) people, the overall demand is of around 275 million liters per day (MLD) for the GVMC area, with additional bulk (industrial, commercial, and institutional) demand of 82 MLD[17], totaling 357 MLD. With GVMC's present sources of water supply, a total of 291 MLD of treated water is supplied as piped water, which leads to a shortage of almost 66 MLD.

Taking into account a transmission efficiency of approximately 80 percent, the total water supplied is expected to be about 186 MLD and thus the calculated per capita water supply through piped network in Vizag comes out to be 88 LPCD[18] (Table 5).

There is a gap between the amount of raw water supplied to Vizag and the per capita supply due to tankers and transmission losses.

TABLE 5 **Per Capita Supply of Water by GVMC**

Total water supply [A] (GVMC WSM, Q1 2015)	291 MLD
Bulk water supply [B] (GVMC WSM, Q1 2015)	68 MLD
Transmission losses [C]	20%
Piped water supply for domestic consumers (([A]-[B])*(1-[C]))	178 MLD
Total population	20.35 lakhs
Per capita supply (LPCD)	88

This illustrates the need to augment water sources to enable GVMC to reach the standard requirements for water supply, assuming water is supplied solely through piped water supply. In addition to the scarcity of water sources, huge losses occur during transmission of raw water from source to water treatment plants (WTPs) to the tune of almost 95 MLD. This loss can be attributed mainly to the open channel flow.

Though GVMC employs three modes of water supply in the city of Vizag—piped water supply through last-mile connections, tankers, and public stand posts—only 2,41,353 HH (out of 4,39,335 HH) are supplied through piped connections (Table 6). With this, the coverage of piped water supply in Vizag stands at 54.9 percent. In areas underserved by piped water supply, due to their recent inclusion into GVMC's area of jurisdiction, tankers are plied extensively for free water supply. With the Smart Cities project requiring a 24/7 water supply to all, GVMC must upgrade its infrastructure to meet the requirement.

[17] As shared by GVMC WSM team.

[18] GVMC's reported daily water supply is 110–115 LPCD. Calculations are based on total water supplied to the distribution system and total domestic consumers served; however, there is limited understanding of the losses at various stages, so the actual water supplied is unknown. A practical way of estimating daily water supply is the following: Most (~85 percent) domestic tap connections in GVMC area are of 15mm diameter, which supply between 1–1.25 gallons per minute (gpm) for 45 minutes; one can calculate that 52–65 LPCD is the more accurate range of supply. This provides a better sense of the inadequacy of the quantity of water made available through piped water supply.

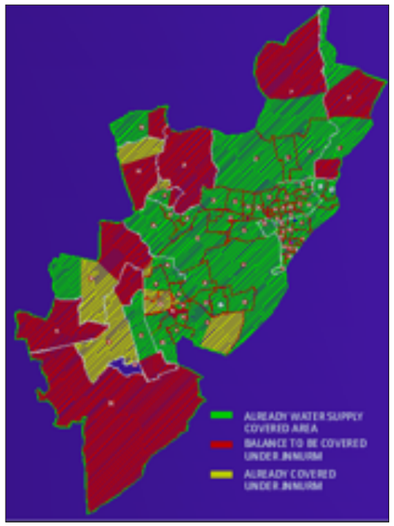
GVMC supplies water daily for 45 minutes in 70 wards, while the other two wards (51 and 62(p)) receive water on alternate days; however, more than two-thirds of the slum HHs in Vizag do not have a household-level connection, which means they are dependent on the same 45 minutes of water supply from community level taps, which are each being shared by 10 to 30 households.

TABLE 6 **Coverage of Piped Water Supply by GVMC**

Total HH (Census 2011)	4,39,335
# of domestic connections (as on March 31, 2015)	1,68,313
HH served through domestic connections (1 HH per connection) [A]	1,68,313
# of semi-bulk connections (as on March 31, 2015)	3,652
HH served through semi-bulk connections (20 HH per connection) [B]	73,040
Total HH served through domestic and semi-bulk connections [A+B]	2,41,353
% HH served	54.9%

The piped water of the GVMC relies mostly on surface supply and serves 54.9 percent of the households in Vizag.

Figure 4. GVMC Water Supply in Vizag



The MoUD identifies key performance indicators for piped water supply in urban areas and establishes service-level benchmarks for the same. The piped water supply of Vizag is assessed on these indicators below (Table 7).

TABLE 7 **Vizag Piped Water Supply Report Card**

Indicator	Benchmark	Vizag score
Coverage of piped water supply connections	100%	54.9%
Per capita supply of water through piped connections	135 LPCD	112.9
Extent of metering of water connections	100%	2.16%
Extent of non-revenue water (NRW)	46.5%	30%
Continuity of water supply	24 hours	45 minutes
Quality of water supplied	100%	100%
Cost recovery in water supply services	100%	153.2%[19]
Efficiency in collection of water supply-related charges	90%	81%
Efficiency in addressing customer complaints	80%	100%

3.2 Water Supply to Slums

People in slums of Vizag have access to water through multiple sources—household-level tap connections for some, community taps, hand pumps, and GVMC-hired tankers. Since the average piped water supply throughout the city runs for about 45 minutes, people rely on a mix of sources. There are ~66,000 BPL connections, which one can safely assume are mainly in slums, meaning that about one-third of the slum HHs have a BPL tap connection while the ~8500 community taps cater to 10–30 HHs each. GVMC owns 3 tankers and has a fleet of 58 hired tankers that cumulatively make 350–450 trips daily. All of these provide municipal water. There are more than 6,000 hand pumps in the city, in addition to private bore wells, extracting groundwater.

Low-level tanks, set up in GVMC Zones 2 and 3 for increasing water availability, now lie defunct due to lack of operation and maintenance (O&M).

[19] This includes recoveries from industrial water supply.

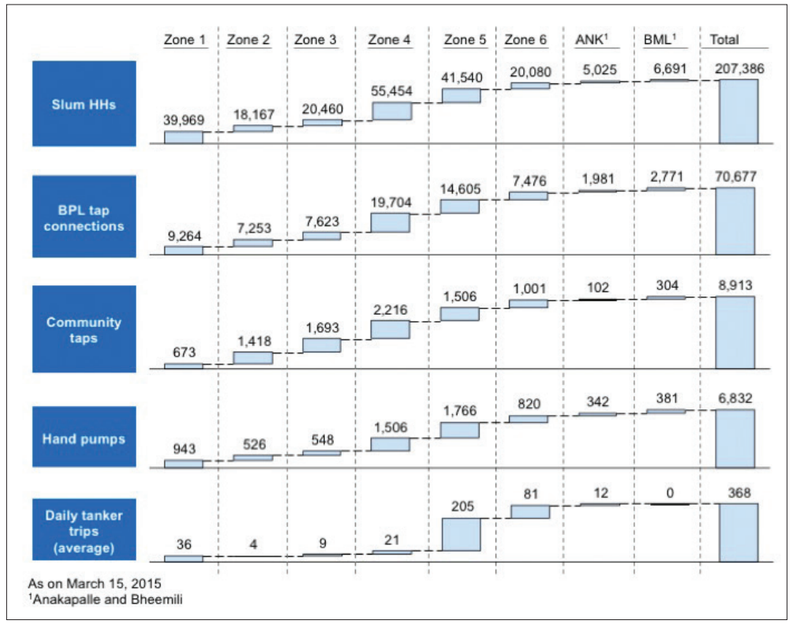
Zone 1 has 19 percent of the city's slums but only 13 percent of BPL connections. This is primarily because ~80 percent of the slums here are non-notified, which drastically affects the eligibility to apply for a tap connection. Urban poor in this zone rely significantly on hand pumps. Zone 2 and 3 are the core city area, which are densely populated and also home to hilly slums. These zones are also at the tail end of the network and have lower water pressure, thereby resulting in less supply in the same 45 minutes as compared to other parts of the city.

Since 2010–11, GVMC has set up 200–300 low-level tanks/reservoirs primarily in slums of Zones 2 and 3. With capacity varying between 2,000–5000L, these tanks were intended to reduce the water shortage burden experienced during peak summers in these zones, which are densely populated and at the tail end of the supply network. They were expected to reduce unreliability by ensuring longer durations of water availability, as opposed to inconsistent timings of direct supply by tankers at a community level. GVMC-hired tankers would fill these tanks, and people would then collect water from them; however, lack of operation and maintenance (O&M) and technical oversight has resulted in most of these tanks now lying defunct. Broken taps, missing covers, and damaged bodies have largely driven away people who were expected to benefit from this. Locals were also not involved in the upkeep of these tanks. Their location within slums is also questioned by people as they frequently complain about minor accidents being caused due to the blind spot created by these tanks at road corners and intersections.

Zones 4 and 5, consisting largely of industrial and rural areas respectively, account for half of the city's slum HHs, which lack household-level tap connections. Zone 4 is home to most of Vizag's industrial sector, which comprises fertilizer, oil, steel, port freight companies, etc. Most of the local urban poor are employed in these companies and their ancillary units, and rely significantly on groundwater for their daily water needs, including consumption purposes. Significant parts of Zone 5, specifically Gajuwaka area and 16 of the 32 gram panchayats, which were brought under GVMC's ambit in 2005, are in the process of being completely connected to the city supply network in the next three to five years. Currently they rely significantly on GVMC-hired water tankers and groundwater through hand pumps. Zone 6 includes 9 gram panchayats (village councils) out of the 32, which were brought under GVMC's ambit in 2005. Like similar municipal water-deficient areas in Gajuwaka, these areas also are served by GVMC-hired tankers.

The peri-urban towns of Anakapalle and Bheemili are largely self-sufficient in water supply and rely heavily on local infiltration wells and the associated distribution network. There is some GVMC-piped distribution network in these satellite areas, which were brought under its ambit in 2013. Future plans for these two areas are also improvement schemes of the existing network.

Figure 5. Slum Households and Various Water Delivery Mechanisms by Zone



GVMC subsidizes water connections for BPL households. It has implemented various schemes, namely Amrutham, APIIC, BPL, Gajuwaka, Jeevandhara, and National Slum Development Project (NSDP) since the 1980s, catering to urban poor households through piped water. The documentation required to apply for a BPL tap connection under any of these schemes is the same. Anyone with a white ration card (which proves the BPL status) and property tax papers for a dwelling of up to 100 square yards (i.e., annual property tax of less than INR 1,000) on undisputed land can apply for a BPL connection. People without property tax papers can get a temporary "ID bond" water connection paper to apply for a BPL tap connection if the land on which they reside is not disputed.

While general households pay a one-time fee of INR 6,000 for setting up a connection, BPL households pay INR 1,200 (with an option to pay through 12 monthly installments) (Table 8). Monthly charges are also subsidized to INR 60 as opposed to INR 120 for general tap connections. Payments are to be made on a semiannual basis. One must produce his or her BPL card and appropriate property tax papers, which indicate a dwelling of less than 100 square yards, at the time of application.

TABLE 8 GVMC Tap Connection Charges for General and BPL Categories

Category	Initial costs	Monthly charges
General	INR 6,000 + civil works	INR 120
BPL	INR 1,200 (inclusive of civil works)	INR 60

Since October 2014, GVMC has set up 13 water kiosks that provide potable water at INR 2 per 20L can under the NTR Sujala Pathakam scheme. These kiosks have been set up in slums only with the urban poor being targeted as the beneficiaries. Section 4 of the report covers these kiosks in detail.

3.3 Future Plans

GVMC has projects in the pipeline to facilitate capacity augmentation and reduce transmission losses. The projects whose detailed project report (DPR) is submitted/under preparation are as follows:

– *Yeleru Canal Project*
Extending to 153 kilometers (KMs), the Yeleru open canal is currently witnessing around 47 percent of water loss (277 MLD/590 MLD) owing to transmission and evaporation. To increase effective utilization of the water, a pipeline network is proposed. A DPR for this project has been submitted for review.

– *Raiwada Canal Project*
The Raiwada Canal Project (58.3 KMs) is similar to that of the Yeleru Canal Project, proposing to lay a pipeline network replacing the open canal to decrease the 46 MLD water loss (out of 77 MLD drawn). A DPR for this project has been prepared and submitted for review.

– *Anakapalle Water Supply Improvement*
To augment the present water supply of 4.55 MLD from Sarada River through infiltration wells at Anakapalle, this project proposes to tap 23 MLD of water from the Yeleru Canal. A DPR is under preparation.

– *Desalination Plant*
A 10 MLD desalination plant is proposed, on a pilot basis, to be set up near Atchutapuram Mandal. Consent is awaited for the project proposal.

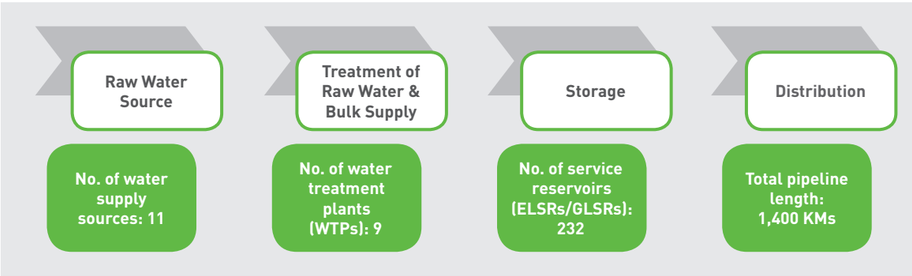
– *Summer Storage Tanks*
A storage tank of 796 MLD capacity with water drawn from the Yeleru Canal is proposed. The tanks are planned to be set up along Yeleru Canal.

- *Refurbishment of Old Lines*
There is a plan to replace old pipelines that cause frequent leakages.

3.4 Transmission Process

Vizag's piped water supply, which serves 54.9 percent of the population, originates from 11 sources; it is then transmitted to nine water treatment plants (WTPs) and industries as raw bulk water, stored in 232 reservoirs, and distributed along a 1,400 KM piped network.

Figure 6. Transmission Process of Piped Water Supply by GVMC

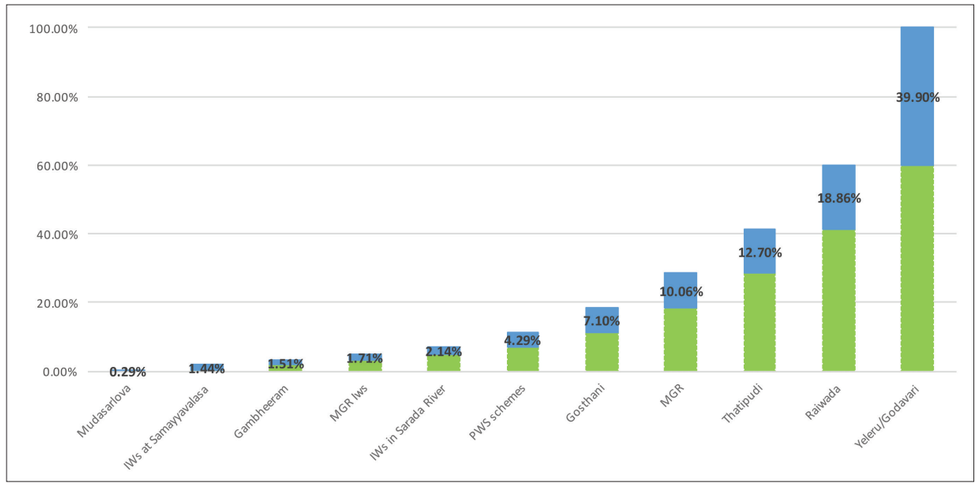


3.4.1 Raw Water Sources

Vizag's piped water supply relies to a major extent on surface water. GVMC draws water from 11 sources, some situated as far as 200 KMs away (Godavari), for piped water supply that includes reservoirs, infiltration wells, etc. The contribution of the water sources can be seen in Figure 7. Four of these sources—Yeleru/Godavari, Raiwada, Thatipudi, and Meghadri Gedda (MGR)—contribute more than 80 percent of the total supply of treated water.

Vizag piped water draws from 11 sources; 81 percent of the total supply of treated water comes from just 4 of these sources.

Figure 7. Contribution of Water Sources IW = Infiltration wells



3.4.2 Treatment and Storage

A part of the water extracted from various sources is transmitted to industries as raw bulk water, while the rest is directed to the nine water treatment plants (WTPs) (Table 9). The treated water from WTPs is directed to various reservoirs, including elevated-level service reservoirs (ELSRs) and ground-level service reservoirs (GLSRs). There are a total of 232 reservoirs distributed around the city.

Not all WTPs are functioning at full capacity. For instance, Godavari WTP at Narava (150 MLD capacity) is running at 100 MLD due to the raw water shortage. Weak quality assurance processes seen at the WTPs, along with limited scientific knowledge of GVMC's operating personnel for water treatment, can be detrimental to the WTPs' operation.

Vizag inherently has good-quality water sources, which reflects in the quality of the municipal water supply within BIS 10500 limits. Our water quality results and household surveys confirmed this. There is occasional supply of muddy or foul-smelling water due to lack of upkeep or cross-contamination in underground pipes, but these complaints are generally handled promptly by GVMC personnel. Quality testing of the 499 piped water samples by a contracted NABL-accredited laboratory and 401 by the internal GVMC testing department were done on three accounts: residual chlorine, turbidity, and pH. Moreover, the samples are spread across the network, taken from raw water sources, like Godavari; WTPs, like Mindi; and reservoirs, like those at Padmanabhapuram and Sheelanagar. All 900 water samples show 100 percent compliance on all three sections tested, showing that GVMC is doing a commendable job in terms of quality of water supplied.

TABLE 9 Raw Water Treatment Plants in Vizag

S. no	Existing water treatment plant location	Installed capacity (MLD)	Water treated at present capacity (MLD)	Name of the source
1	Krishnapuram	46	40	Thatipudi
2	Godavari Treatment Plant at Narava	150	100	Yeleru/Godavari
3	Raiwada Treatment Plant at Narava	68	60	Raiwada
4	Sundarayya colony	46	18	Yeleru
5	Sundarayya colony	9	5	Yeleru
6	Sidhartha Nagar	9	5	Yeleru
7	Minidi	25	25	MGR
8	Mudasarlova	2	1	Mudasarlova
9	Gambheeram	5	5	Gambheeram

3.4.3 Distribution

The distribution network constitutes piping structure from the ELSRs/GLSRs to households through the intricate city network, including last-mile connections (made up of pipes of various diameters ranging from 15mm to 700mm). The total network, including transmission and distribution, covers a length of about 1,400 KMs. Though the layover of the system is quite extensive, the infrastructure needs an upgrade.

There is very limited understanding of transmission losses at various stages (e.g., due to the open canal system), and the actual water supplied to the distribution system is unknown. Timeworn pumps are reducing the efficiency of transmission, which stands at 80 percent, increasing non-revenue water (NRW) and also operation and management (O&M) costs, thereby affecting the water supply service. Moreover, there is a lack of preventive management.

The treated water is distributed through three types of connections:

- *Domestic Connection:*
  A total of 201,817 domestic tap connections are present in GVMC's area of jurisdiction. This includes 34,967 connections under the Extra Revenue (ER) category. These connections were metered right from the time of setup and their billing was supposed to be as per the meter readings. However, they have served just as other general connections have, with a fixed monthly tariff of INR 120 per month.

  Table 10 shows the zone-wise coverage of domestic connections. The share of piped connections for the general category seems low but is explained by the presence of about 300,000 domestic bore well connections as estimated by GVMC officials. (Anakapalle and Bheemili rely on local infiltration wells and the associated distribution network (household and community level taps).) They also rely quite significantly on hand pumps.

TABLE 10 Zone-Wise Coverage of Domestic Connections

Zone no.	No. of BPL connections	No. of general connections	BPL HHs	General HHs	Coverage (%)	
					BPL	General
1	9,264	16,305	39,969	44,852	24	36
2	7,253	30,111	18,167	71,082	28	42
3	7,623	20,438	20,460	58,271	32	35
4	19,704	26,644	55,454	115,962	31	23
5	14,605	22,781	41,540	97,074	35	23
6	7,476	9,996	20,080	52,094	34	19
Anakapalle	2,771	2,649	5,025	19,007	39	14
Bheemili	1,981	2,216	6,691	7,602	41	29
Total	**70,677**	**131,140**	**207,386**	**465,944**	-	-

BPL HH is from UCD List; # APL HH = Total HH (Census 2011)—BPL HH (UCD List)

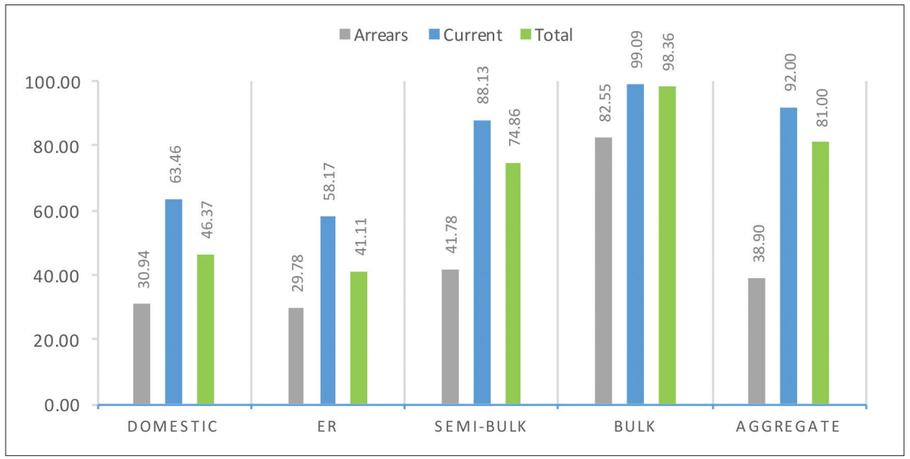
- *Semi-Bulk Connection:*
  The number of semi-bulk connections stands at 3,652. This includes residential, semi-residential, commercial, and semi-commercial apartments.

- *Bulk Connection:*
  With 66 connections, this category caters to the industrial raw and clean water needs. Contributing 76.45 percent of GVMC's demand collection (2014–15) with 99.09 percent collection efficiency, the revenue contributed by bulk connections amounts to almost 82 percent of accounts received.

3.5 Water Supply Collections

The overall collection efficiency of piped water supply in Vizag is 81 percent. As can be seen from Figure 8, the collection of water charges is most efficient in the bulk category for both arrears and current demand. The low collection efficiency of arrears in all four categories underscores the need for immediate action to retrieve the pending water charges.

Figure 8. Collection Efficiency of GVMC



Only 2.16 percent (3,718/1,72,031) of the piped water connections are currently metered, translating to approximately 41.4 percent of water consumption in terms of volume. The stark difference between the benchmark and the current extent of metering arises because 79.23 percent of the domestic connections are not metered while all of the bulk and semi-bulk are. Without having all connections metered, the water supply system lacks accurate information to identify and rectify transmission and distribution losses.

With metered bulk and semi-bulk connections contributing a major share (83.68 percent) of the total revenue, the cost recovery in water supply for GVMC stands at approximately 153.2 percent (FY14–15).[20] The MoUD defines the total operating revenues as a percentage of the total operating expenses incurred in the corresponding time period. Only income and expenditure of the revenue account must be considered, and income and expenditure from the capital account should be excluded. Though the figure reflects the economic stability of GVMC's water supply system, there is room for improvement.

With an average of 35 complaints lodged regarding pipe leakages per day (all of them having been addressed on the same day in 2014), Vizag receives a 100 percent score for efficiency in addressing customer complaints.

With nominal water charges being collected from domestic consumers, GVMC is unable to tap the surplus through quantity-based volumetric water charges. Implementing this would ensure increased revenues and lower NRW, resulting in a better cost recovery. With contribution of almost 34 percent of total O&M costs (Rs. 4,000 lakhs out of Rs. 11,762 lakhs; budget FY14–15), electricity is an expense that requires attention to reduce overall costs.

[20] http://www.wsp.org/sites/wsp.org/files/publications/service_benchmarking_india.pdf

In the last quarter of the recently concluded FY2014–15, the GVMC commissioner stressed higher bill collection and urged GVMC personnel to facilitate it. The following table indicates that while the city average for bill collection from domestic consumers was 63 percent for FY2014–15, BPL consumers paid 72 percent of their current bills.

TABLE 11 **Tap Water Bill Payment by Various Consumer Category for FY2014–15**

Intended consumer category	Category	No. of connections[21]	Monthly tariff (INR)	Annual demand (in INR lakhs)	Balance (in INR lakhs)	Collection (in INR lakhs)	% collection
Urban poor	Various[22]	52,735	60	380	105	275	72%
Urban poor	ID bond	2,478	60	18	16	1	8%
General	Others	78,133	120	1,125	424	701	62%
General	ER	34,967	120	490	205	285	58%
Total		168,313		2,013	750	1,262	63%

According to GVMC, the extent of NRW was approximately 30 percent. But cities like Jaipur and Goa deployed measures to contain the losses in the distribution network that reduced NRW to approximately 25 percent. With metered bulk and semi-bulk connections consuming only around 30 percent of total water, this presents a window of opportunity for loss reduction in domestic distribution, thereby increasing water supply service coverage and revenues. As can be seen from Table 12, however, the extent of NRW is calculated to be 46.5 percent in Vizag against a benchmark of 20 percent. In addition to transmission and distribution losses, unbilled water supply stand posts (approximately 9,500 in number) and water charges on a flat tariff base contribute significantly to the extent of NRW (not taken into account in calculation in Table 12). With increasing urbanization, GVMC needs to bring down the quantity of NRW to guarantee water service to a larger section of the city on the lines of cities like Jamshedpur (NRW was brought down to 8 percent from 33 percent, resulting in an increase in water service coverage from 67 percent to 88 percent during 2012, as reported by JUSCO).

TABLE 12 **NRW Calculation for GVMC Water Supply**

Type	Quantity (MLD)
Bulk	68
Semi-Bulk	9
Domestic	109
Total billed water	187
Total water supply	291
% NRW	46.5%

[21] Data collected from GVMC Revenue department. Their data accounts for ~84 percent of the BPL tap connections that GVMC WSM team has.
[22] Includes Amrutham, APIIC, BPL, Gajuwaka, Jeevandhara, and NSDP schemes.

3.5.1 Recommendations

WATER SUPPLY

Short Term

- Facilitate more BPL household tap connections to increase revenue from domestic consumer segment.
- In arrears INR 3.6 crore is to be collected from urban poor and INR 13 crore from the general consumer category.
  - Reduce NRW being supplied through community taps and tankers.
  - Reduce urban poor's reliance on groundwater for any form of consumption in the absence of supply from community tap water or a GVMC tanker.
- Leverage IEC activities for
  - Better water management, as there is a lack of awareness among the city's urban poor about the city's water supply deficit.
  - Creating awareness about various water sources' quality, their suitability for specific end use, and the implications on health, especially in areas where there is limited municipal water supply and people tend to rely on groundwater.

Medium Term

- Assess the condition of the old transmission, feeder, and distribution mains for revamp in a phased manner. Similarly, identify and repair all leakages in the system.
- Develop a plan for de-silting the balancing reservoir (MGR, Mudasarlova, and Raiwada) to create additional water in the supply system.
- Install bulk electromagnetic and ultrasonic flow meters at transmission mains, WTPs, balancing reservoirs, and ELSR and GLSR inlets.
- Issue tenders to map the city's complete water supply piping infrastructure (storm drains, sewage, drinking water, and cross connections).
- Implement energy audit findings in a phased manner to reduce power consumption, hence the supply cost.

Long Term

- The design for capacity augmentation of reservoirs should inculcate splitting the reservoir into two to three compartments. As drinking water reservoirs cannot be de-silted since they require continuous water storage, this design will ensure water storage from the drinking water reservoirs, thus enabling de-silting.
- Assess the condition, location, and calibration status of all energy meters at all WTPs and pump stations and replace if not found within acceptable norms. Also, conduct an energy audit by an independent third party for all WTPs and pump stations to develop an action plan for energy reduction.
- Implement 1S, 2S[23] principles and visual management[24] in all WTPs and pump houses.
- Cultivate predictive management techniques by developing a city-level hydraulic model and calibrating it based on comprehensive HH and topological survey.

[23] 1S—Sort: Remove what is not needed and keep what is needed; 2S—Set in order: Arrange essential items in order for easy access. These principals and visual management go hand in hand at water treatment plants, pump stations, water distribution centers, etc.

[24] Visual management systems "enable anyone to immediately assess the current status of an operation or process at a glance, regardless of their knowledge of the process. Visual displays relate information and data to employees in an area through the use of charts, graphs, and process documentation."

- Develop a feasibility report and plan for the recycling/reusing of treated sewage for tertiary use. Implement the same based on a public-private partnership (PPP) model, as in Tata Steel at Jamshedpur.
- Implement in a phased manner total productive maintenance in all WTPs and pump houses to achieve zero accidents, breakdowns, complaints, and defects.

COLLECTIONS

Short Term

- Conduct a detailed assessment for a bulk metering program.
- Procure basic leak detection equipment and portable flow measuring devices.
- Institutionalize an NRW reduction system for active leakage management.
- For sustained bill collection, set up community-level billing franchises by involving self-help groups (SHGs). Hyderabad Metropolitan Water Supply and Sewerage Board has implemented this.

Medium Term

- Deploy domestic metering programs to ensure metering is done for increased revenues.
- Establish demo-zone DMAs at Malkapuram (as 24/7 is implemented) or Gajuwaka (as infrastructure is in place with last-mile and consumer metering to be done). Ensure constant monitoring of these DMAs and a stepwise approach toward NRW reduction.
- Develop and implement a volumetric tariff and metering policy for domestic consumers with a special emphasis on urban poor.

Long Term

- Develop strategy and action planning for a city-level geographic information system (GIS) to link it with NRW reporting. This will enable proactive customer relations in terms of revenue, complaint, and asset management. An existing geo-referenced city base map developed by GVMC can be used to develop this facility and also communicate the benefits for consumers if they pay for water consumption.

3.6 24/7 Pilots

Since 2005, GVMC has thrice tried to pilot 24/7 piped water supply projects with in-house expertise and capabilities; however, these efforts have not been successful primarily due to the lack of requisite technical knowhow. Critical activities such as detection, measurement, and prevention of leakage; creation of hydraulically discrete DMAs; consumer consultation; and others were not carried out, which are essential to convert any existing distribution network to a 24/7 network. Since 2005, GVMC has made attempts to evaluate the feasibility of 24/7 piped water supply in Vizag through pilot projects and test DMAs. After the city was selected for development under the Smart City program, the assessment for a continuous water supply gained attraction.

The first pilot project for an uninterrupted water supply was at Muralinagar (Ward 39). Though all the water connections in those wards were fitted with metering devices, frequent power cuts and insufficient water supply resulted in the failure of the test DMA with intermittent supply. With two consecutive harsh summers, the second pilot project at Sagarnagar also had to be discontinued. The recently launched third pilot project at Malkapuram is almost 50 percent complete, per GVMC officials, with 30-odd DMAs set up. With slow progress at metering the 6,895 HH (Census 2011) and exhaustion of funds due to uncertainty surrounding the recently revamped central government scheme JNNURM

(now referred to as AMRUT), the project is marginally better planned than were the previous ones but is being executed without any significant and much-needed external technical expertise. The pilot project at Malkapuram is still underway with no tangible results.

With no prior experience in 24/7 water supply, the pilots deployed by GVMC did not yield desired results; however, there are other 24/7 supply pilot cases in India (such as Hubli-Dharwad, Belgaum, Gulbarga in Karnataka, Nagpur in Maharashtra, etc.) functioning exceedingly well. The reason behind their success is a PPP approach that resulted in a water loss reduction (10 percent from around 50 percent), better customer care, and a more efficient system to address grievances. PPP models have ensured better planning, appropriate process flow, and adherence to target benchmarks through contractual agreements.

The PPP model for implementing a 24/7 pilot project ensures that stringent key target benchmarks are set through contractual agreements. In addition, leveraging performance-based payment leads to reliable and sustainable outcomes. Furthermore, experienced private players bring in new technologies, sophisticated processes, and training modules that GVMC currently lacks.

The recommendations, categorized by the time required for execution, are listed below.

The partial success of the 24/7 water supply pilots can be attributed to the inexperience of GVMC in 24/7 water supply, which led to the unsuccessful establishment of test DMAs. This, coupled with inadequate raw water supply and limited detection and removal of leakages, resulted in poor performance. The existing infrastructure of water supply in Vizag, without any hydraulic modeling, cannot be used for a 24/7 water supply system. The basic components—like pipes, for example—have different requirements. Furthermore, without bulk meters, domestic connection metering, and active leakage management in place, implementing a 24/7 water supply system will not achieve fruitful results.

3.6.1 Recommendations

PLANNING

- Develop a comprehensive plan through phased implementation and the PPP model by leveraging the learnings from demo zones and the hydraulic model for converting Vizag into a 24/7 water supply with 100 percent consumer metering (long term).

CAPACITY BUILDING

Short Term

- Revenue collection
  - Review customer data to add new sites into the billing system for increased revenues.
  - Introduce incentive-based collection agency contracts for both soft- and hard-bucket collection to enhance collection efficiency.
- Debt recovery
  - Set up a dedicated team for arrear analysis, debt recovery, and the disconnection process.
- Customer Relationship Management
  - Set service levels based on the consumer satisfaction/expectation survey.
  - Define lines of responsibility for front-end and back-end services.
- Set SLBs for meter reading to match the workload required by the billing system.
- Introduce a cascaded performance scorecard mechanism at all levels aligned to GVMC's vision to strive for better performance in the areas of processes, customer, financials, community, etc.
  - Conduct weekly management meetings for performance review.

Medium Term

- Training should be given on
  - Basics of information technology (usage of tablets, mobiles, and internet safety) for all levels of management;
  - Preventive maintenance for deputy executive engineers, assistant engineers, WTP operators, and maintenance teams;
  - NRW reduction and DMA management for chief engineers, superintendent engineers, executive engineers, DyEEs, AEs, and joint engineers;
  - Treatment and quality assurance compliance for engineers/operators/linemen at WTP;
  - Customer service training for assistant engineers and joint engineers;
  - Data, metering, and billing network for revenue/accounts team and metering team; and
  - Waste management education for the public about problems in throwing refuse into storm drains instead of throwing it into the sewage system.

CITY OF VISAKHAPATNAM WATER SUPPLY | 3. WATER SUPPLY

NTR Sujala plant operators at Bapuji Nagar (ward no. 37). Plant operators are local self-help group members.

4. SMALL WATER ENTERPRISES

4.1 NTR Sujala Pathakam

2014 was a critical year for Vizag regarding SWEs' sector development. Chief Minister Mr. Chandrababu Naidu promised during election to provide affordable, safe drinking water through water kiosks at INR 2 per 20L to the citizens of Andhra Pradesh to reduce the incidence of waterborne diseases. Thus, after his victory in June 2014, the NTR Sujala Pathakam safe, affordable water scheme was initiated.

TABLE 13 **Proposed Action Plan for Setting Up NTR Sujala Kiosks in Rural Andhra Pradesh**

Year	No. of habitations proposed
2014-15	5,000
2015-16	10,000
2016-17	15,000
2017-18	15,000

Though the scheme focused on quality-affected rural habitations between October 2014 and March 2015, GVMC had set up 13 such kiosks in its area of jurisdiction, and there are 12 additional kiosks in different stages of development currently. Unfortunately, in October, the same year Vizag was hit by Cyclone Hudhud, the civil society came forward to rebuild and improve the lives of the urban poor, especially the most vulnerable, to set up such kiosks for water treatment. For example, the Vizag chapter of Rotary India set up 16 water treatment facilities for dispensing free treated water in schools, hospitals, and other public places.

In September 2014, urban local bodies (ULBs) in Andhra Pradesh cumulatively set a minimum target of launching 186 kiosks each for this and the next financial year[25] by the Municipal Administration and Urban Development (MAUD) department of Andhra Pradesh, setting the following the minimum targets[26] for installation of these kiosks:

TABLE 14 **MA&UD Targets for Setting Up NTR Sujala Kiosks for ULBs in Andhra Pradesh**

		# of target kiosks	
S. no.	Grade of ULB	2014–15	2015–16
1	Nagarpanchayats	2	2
2	Grade III municipalities	3	3
3	Grade II municipalities	4	4
4	Grade I municipalities	5	5
5	Special grade municipalities	10	10
6	Selection grade municipalities	12	12
7	Other corporations	25	25
8	Vijaywada Municipal Corporation	50	50
9	GVMC	75	75
	Total	**186**	**186**

[25] Andhra Pradesh G.O. Ms.No.189.
[26] G.O. Ms.No.189, MA&UD Department, Dt. 16.09.2014.

These kiosks were to be set up for the following three categories of slums in urban areas:

- Slums where no drinking water distribution system exists
- Slums where the quality of drinking water is not fit for human consumption
- Slums where a water distribution system is available but no drinking water is supplied

A critical part of this plan was CSR[27] funding, which district collectors were to secure by engaging with companies operating in their respective districts. But due to these companies' lukewarm response, these targets did not materialize.

GVMC set a minimum target of launching 75 kiosks in the year 2014–15, but due to lack of CSR funds, GVMC had to reduce this target as well as fund these kiosks. In consultation with elected Members of Legislative Assembly (MLAs), GVMC launched eight pilot kiosks on the statewide launch of the scheme (October 2), one each in every legislative ward. Consequently, a target was set to establish 25 such pilots by the end of FY2014–15; 13 had been set up by mid-March.

For each constituency, zonal GVMC teams were asked to shortlist three to four sites that had a GVMC community hall with an electricity connection and where raw water supply could be guaranteed either in the form of municipal supply (tap or tanker) or groundwater (bore well). The final selection of site and operator (individual or SHG members) was done in consultation with the constituency's MLA. GVMC received a formal government order in mid-September informing it that October 2 was the desired date of the scheme's statewide launch. Tenders were invited and awarded for water treatment equipment and bore well drilling in three days' time. Thus eight kiosks were quickly launched on October 2, 2014.

4.2 Consumer

An important issue that affects the economic success of an SWE is activating consumer demand. Activating demand is dependent on factors such as community awareness of water quality and its relationship to health and thus a willingness to pay for water.

4.2.1 Willingness to Pay

Consumer research surveys found that INR 3 per 20L can is an almost universally acceptable price point, in slums with kiosks and without kiosks, while INR 8 per 20L can was reported to have lower acceptability in the "willingness to pay" assessment question. It is worth noting that 55 percent of respondents are willing to change to a clean, pure water source, even if it requires paying for water, while another 40 percent are willing to try it, as indicated in Tables 15 and 16. This has significant implications for the sustainability of these systems.

TABLE 15 **Consumer Research—Willingness to Pay**

Willingness to pay (20L can)	INR 3	INR 5	INR 8
Strongly willing to pay	71%	10%	8%
Slightly willing to pay	10%	42%	14%
May or may not pay	0%	32%	22%
Slightly unwilling to pay	0%	7%	18%
Strongly unwilling to pay	0%	1%	37%

[27] As per the Corporate Social Responsibility (CSR) rules under Companies Act 2013, every company, private limited or public limited, which either has a net worth of INR 500 crore or a turnover of INR 1,000 crore or net profit of INR 5 crore, needs to spend at least 2 percent of its average net profit after taxes for the immediately preceding three financial years on CSR activities.

TABLE 16 **Consumer Research—Willingness to Change to Paid Source of Clean and Pure Water**

Response	% Respondents
Will stop my current sources completely and switch to the new source	55%
Will try the new source	40%
Will not try the new source	3%
Don't know/can't say	2%

4.2.2 Awareness

Since NTR Sujala Pathakam is a statewide program borne out of the state government's publicized commitment to the provision of safe drinking water, there is awareness about it among the urban poor. There is, however, lack of awareness about the correlation between health and water, thereby limiting demand even in slums with inadequate quality and insufficient quantity of municipal water. Based on the three case studies conducted (see Section 5), it is clear that there is potential for SWEs to address the need for water in communities while providing livelihoods and improving health.

4.2.3 Usage

The consumer research indicated that 14 percent of respondents had tried NTR Sujala kiosk water and 79 percent of them use it regularly. When we only consider slums with NTR Sujala kiosks, ~19 percent (Figure 9) of respondents claimed to be regular users of this treated water, 26 percent of respondents had tried this source of water, and 75 percent of them have it available. There is no other paid potable water source that has such a high trial-to-regular-use ratio. One has to consider that this low consumption from kiosks is due to these kiosks being relatively new and people have had exposure to them during winter and spring months only, which are typically low-demand months.

For all end use, urban poor prefer municipal supply through household-level taps over community taps or municipal water tankers. Since supply through taps is limited, however, hand pumps and private bore wells (extracting groundwater) are used widely across the city. Our consumer research has also confirmed a strong preference for municipal tap water supply when it is available

Figure 9. Consumer Research:
Urban Poor's Preference for Various Water Sources (in Slums with NTR Sujala Kiosks)

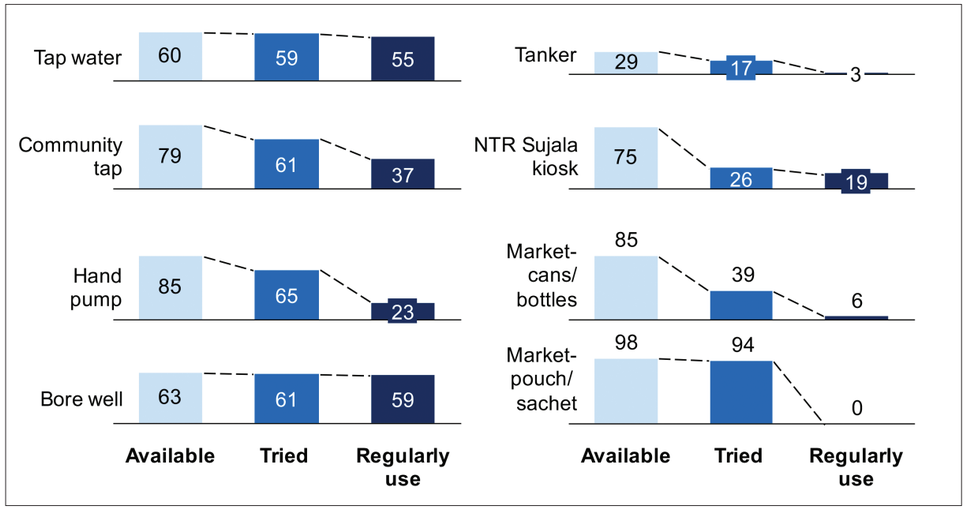
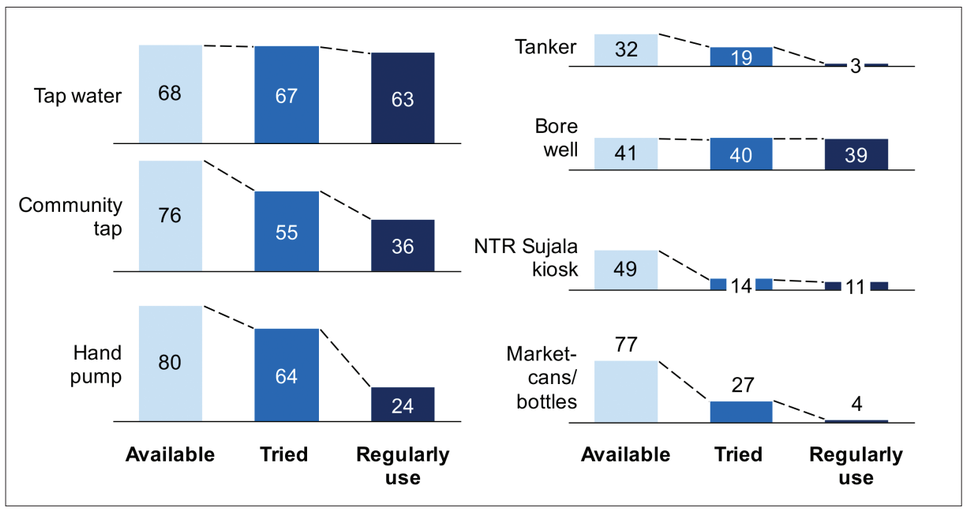


Figure 10. Consumer Research:
Urban Poor's Preference for Various Water Sources



As per Table 17, in slums with NTR Sujala kiosks, ~19 percent of drinking water needs are met from these kiosks, second only to 29 percent each from household-level taps and bore well water.

TABLE 17 **Consumer Research—Type of Activity by Water Source (Slums with NTR Sujala Kiosks)**

Water sources	Drinking	Cooking	Washing/cleaning food items	Other uses like washing, bathing
Tap water available at home	29%	35%	35%	39%
Community tap water	11%	17%	19%	18%
Bore well/boring water	29%	33%	35%	34%
Tanker water	1%	1%	1%	1%
Hand pump	7%	7%	9%	7%
NTR Sujala kiosk	19%	7%	0%	0%
Market—bottles/cans	5%	1%	1%	0%
TOTAL	**100%**	**100%**	**100%**	**100%**

4.2.4 Challenges

There are various challenges in terms of consumers. First, a lack of awareness about the importance of safe drinking water and the tendency to consume water freely available through community taps, tankers, and hand pumps. Thus there is limited demand. Second, the prevailing payment model leads to petty cash handling and credit. Third, water treatment is leading to extremely low total dissvoled solids (TDS) (as low as 5 and 20 in some cases) in treated water, which affects the taste and could lead to lower demand. Fourth, the number of pilot kiosks is still far from adequate for this mechanism to become a feasible option for all. Finally, regular users are not using this water for cooking purposes, which partially defeats the purpose of the scheme.

4.2.5 Recommendations

SUPPLY

- Facilitate setting up of distribution channels to increase reach to neighboring slums with minimal increase in prices.

  Commission more NTR Sujala kiosks in areas that rely heavily on tanker water but have sufficient groundwater of adequate quality for ablutionary purposes. Parts of Zone 5—wards 50, 55, 56, and 57—and Zone 6—wards 69, 70, 71, and 72—should be targeted for commissioning of more NTR Sujala kiosks. The commissioning of these kiosks must be complemented with IEC activities to create awareness about the health benefits of safe water in preventing waterborne disease, educating on water quality difference in the quality of NTR Sujala kiosk water and groundwater (being extracted through bore wells/hand pumps) and thus their different end uses.

AWARENESS/DEMAND

- Invest in building awareness by explaining the health hazards associated with different contaminants found in water and typical end use for each kind of water source.
- Get UCD zonal divisions to
  - focus promotions on sampling and trials to help win initial customer base.

– train operators in effective consumer engagement.

– identify key opinion leaders in the community and use their influence to mobilize communities to adopt safe water.

COLLECTIONS

• Promote subscription models for consumers to increase frequency and allow for a better payment model

– through an NTR Sujala kiosk.

– in areas where people consume or are likely to consume contaminated groundwater in the absence of municipal supply. Our water quality testing results have confirmed above-permissible-limit presence of fluoride in groundwater samples collected in Zone 4 and nitrates in Anakapalle and Bheemili (refer to Annexure 6).

Figure 11. Comparison of Cost of Serving through Tankers and NTR Sujala Kiosks

Key Assumptions	Tanker		NTR Sujala kiosk	Key assumptions
• 1 tanker for 20 HHs • Driver daily charges: 315 • Tanker hourly rental: 256 • Hours of operation:8 • Average distance per trip: 10km • No. of trips per tanker daily: 3-4	50	Liters per capita per day (lpcd)	4	• Daily can sales: 200 • Remuneration to SHG: INR 5000 (included in operating costs) • Monthly maintenance charges: INR 2000 • Monthly repair and spares: INR 2000
	0.12	Operating cost (INR/liter)	0.12	
	7,400	Daily operating cost (INR)	475	
	1,000	People served	1,000	
	~25,00,000	Annual operating cost (INR)	~1,75,000	
	Free	Price for consumer (INR/liter)	0.10	

- **Consumers**
  - Shall have to use groundwater sources for regular purposes
  - INR 2 per 20L of potable water versus free water
- **GVMC**
  - Capital cost of INR 7-8 lakhs for setting up a NTR Sujala kiosk

Tankers can be selectively replaced with NTR Sujala kiosks in areas where groundwater is fit for regular purposes

4.3 Financial

The state government of Andhra Pradesh had envisaged companies with their CSR funds to be their bulk sponsors at the time of launch of this scheme. But due to a lukewarm response from companies for funding this statewide scheme, GVMC has had to finance all the kiosks, making them "ULB-funded, locally managed" systems.

4.3.1 Pricing and Sales

There is uniform pricing of INR 2 per 20L can. State government had set this price assuming a sale of 400 cans per day, which would provide the plant operator with the requisite financial buffer for kiosk maintenance. Figure 11 shows GVMC's UCD team sales record for these kiosks as of March 2, 2015 since the launch date, October 2, 2014.

Figure 12. NTR Sujala Kiosks' Details as Shared with GVMC UCD Wing

S. No.	Name of constituency	Ward no.	Name of area	Households	Total can sales	Average daily can sales[1]
1	East	2	Mustapha Colony (Arilova)	252	5,500	41
2	South	30	Nerella Koneru	299	500	4
3	West	48	Burma Colony	176	6,500	48
4	North	37	Bapuji Nagar	280	2,785	21
5	Gajuwaka	58	Fakertekya	565	3,000	22
6	Pendurthy	70	Chemalpalle	220	5,000	37
7	Anakapalle	-	Velapula Veedhi	330	4,500	33
8	Bheemili	-	Reeliveedhi	65	1,850	14

[1] By dividing total can sales by 135 days (30 days x 4.5 months)

The can sales shown above are for about 4.5 months (excluding 15 days to account for Cyclone Hudhud's impact). While the above indicates a range of 4–48 cans, with 27 cans sold on an average per day per kiosk, there is a significant amount of underreporting to GVMC officials, as admitted by operators to the Safe Water Network team. Due to lack of a proper sales recording mechanism, there is also a recall bias when sharing these numbers for several months at a time. These kiosks, inaugurated almost at the onset of winter, witnessed 10–40 can sales per day initially. In the month of March, daily can sales were reported to be varying from 15 to 200 to even 300 across stations. The relative increase is typical of the seasonality, primarily based on lesser potable water consumption in winters and higher availability of municipal supply in winters associated with this sector.

4.3.2 Capital Expense

GVMC has had to invest in raw water supply as well as installation and commissioning of these kiosks. Plants have been set up in existing GVMC community halls with electricity connections, which has allowed for quick commissioning as well as lower civil costs. Table 18 shows a typical cost breakdown.

TABLE 18 **NTR Sujala Kiosks: Typical Capital Costs**

Cost head	Cost[28] (in INR lakhs)
Bore well drilling, fixing submersible motor with pump	1.7–2.9
Equipment cost	4.4 (1,000 LPH)
Kiosk storage tank	1.1
Total	**7.2–8.4**

4.3.3 Operating Expense

Operating costs vary across kiosks (Table 19). This is primarily due to electricity costs, maintenance, and repairs. Raw water is being supplied free of cost through a combination of sources—tankers, municipal piped water, and bore wells. GVMC covers the cost of electricity at several of these kiosks, while at other kiosks operators pay for it from the revenue collected. There is a lack of clarity on the regulatory provision around this. Electricity bills vary between INR 500–1,100 per month based on hours of operation, which is driven by the demand of water from these kiosks.

TABLE 19 **NTR Sujala Kiosks: Typical Operating Costs—Monthly**

Cost category	Cost/month[29] (in INR)
Operator salary/SHG savings	3,000–4,000
Electricity	500–1,100
Consumables, such as chemicals	1,000
Security/cleaning personnel	1,000
Repairs, electrician visits	1,000
Total	**3,500–4,600**

Although equipment suppliers are supposed to cover plant maintenance and repair costs for up to two years after plant installation, there are cases of operators paying for filter change, etc. Since these plants are relatively new, cases of breakdown have not been experienced except for some small mechanical or electrical problems. Average savings for operators are around INR 3,000–4,000.

Operators were initially provided with only 20–30 bubble-top cans of 20L capacity at the time of the kiosk's launch, so some have invested in 20L bubble-top cans as per demand from consumers. The typical cost incurred for such a can is INR 130, and it is sold further to end users at INR 150.

[28] From GVMC WSM data.
[29] From GVMC WSM data.

4.3.4 Challenges

Water initiatives are largely overlooked by companies in their CSR strategy to allow for higher alignment with sanitation goals, which have been personally mobilized by the prime minister through his flagship Swachh Bharat (Clean India) mission. Up to 10 percent of GVMC water supply capital expenditure could be spent on these kiosks if they are to achieve a target of setting up 75 such kiosks in 2015–16, in the absence of CSR funds and central government support. This financial burden could limit the actual number of kiosks that are set up. In addition, inappropriate site selection (areas with fewer households nearby and with above-average municipal piped supply) has inherently affected some kiosks' sales, and they face the risk of not recovering even monthly operating costs.

4.3.5 Recommendations

CAPITAL

- The district collector, Vizag, and GVMC would have to engage with companies operating in Vizag to raise CSR funds with the assurance of providing them with land, electricity, and raw water to set up NTR Sujala kiosks.
- Facilitate distribution channels, as several of these kiosks are located in slums with 200–500 HHs only.

FINANCIAL SUSTAINABILITY

- Improve site selection by assessing the likely impact of prevailing water availability, quality, and population density on water demand from these kiosks.
- INR 2 per 20L can is unviable pricing, even with electricity costs covered by GVMC, and could drive operators away from this scheme.

4.4 Operational

4.4.1 Technology

A technical experts' committee was set up by the Panchayati Raj and Rural Development (PR&RD) ministry to advise on the technological and water quality aspect of this statewide scheme. Appropriate technology selection occurred in a multi-stakeholder consultation with experts from the state government's engineering department, health department, National Environmental Engineering Research Institute (NEERI), and UNICEF. A workshop was conducted to select suitable water treatment technologies for the implementation of this NTR Sujala Pathakam scheme with committee members, equipment manufacturers, and NGOs.

The key final recommendations are:

- Potable water quality should be in adherence to BIS 10500:2012.
- Treatment technology selection as indicated in Table 20[30]

[30] From GVMC WSM data.

TABLE 20 **Technology Selection Criteria for NTR Sujala Kiosks**

Technology	Criteria	
Reverse osmosis (RO)	1) TDS is more than 1000 mg/L in the water and all other parameters are within IS standards. 2) Combination of TDS is more than 500 mg/L, fluoride more than 1 mg/L, nitrate more than 45 mg/L, and iron more than 0.3 mg/L	Disinfection shall be integral to all treatment. technologies
Electrolytic de-fluoridation	Fluoride is more than 1 mg/L in the water and all other parameters are within IS standards.	
Terafil technology	Iron is more than 0.3 mg/L and all other parameters are within IS standards.	
Ultra filtration with ultraviolet technology	Turbidity is more than 2 NTU in the water identified and all other parameters are within IS standards.	

- Disinfection shall be an integral part of all the above identified treatment units.
- The superintendent engineers shall examine the quality parameters of water source to finalize the treatment technology.
- RO plants' reject water will be around 40–60 percent. RO plants' reject water shall be treated before disposal; however, the treatment of this water shall be studied in detail and finalized based on the findings.
- Purified water shall be supplied in two sizes of 10L or 20L cans.

The raw water source for these plants is a mix of bore well, municipal piped water, and municipal tanker supply. Only the groundwater from bore wells might need RO treatment in some parts of the city. Groundwater used as raw water for kiosks in Anakapalle and Nerella Koneru had nitrates above acceptable limits, whereas TDS was between 300 and 750 across four such kiosks.

In GVMC's area of jurisdiction, the 13[31] operational kiosks have RO plants with a mix of 1,000 and 1,500 LPH plants. The remaining 12 are also RO based. In all, there are thirteen 1,500 LPH plants and twelve 1,000 LPH plants. Incidentally, all the plants set up by the Rotary Club are also RO based while they use municipal piped water supply as their raw water, which has less than 200 TDS and no chemical contamination. Hence, at a city level, there seems to be overreliance on RO systems. These plants are not equipped with a remote monitoring system to inform about plant health, treated water produced, and water quality.

4.4.2 Water Quality

Treated water complies with BIS 10500 (2012) criteria, but there are no daily or periodic water quality testing protocols in place. Due to redundant treatment at some of these kiosks, where raw water has low TDS, in the treated water TDS was found to be below 10. Although this does not have any health implications, it does alter the taste to some extent and implies that the plant is being operated at inappropriate settings.

Vizag inherently has good quality of water sources, which reflects in the quality of municipal water supply within BIS 10500 limits, and consumers are generally satisfied with this water. Our water quality results and household surveys confirmed this. There is occasional supply of muddy or foul-smelling water due to lack of upkeep or cross-contamination in underground pipes, but these complaints are generally handled promptly by GVMC personnel.

[31] As of mid-March 2015.

Of 179 water quality samples, 62 were found to have TDS above acceptable limits[32] of 500, and 30 were above 1,000. These samples were predominantly from groundwater sources, such as hand pumps/bore wells/public wells, or from households that had collected water from these sources. In Zones 3 and 4, TDS was found to be in the 1,800–2,000 range at several groundwater sources. The same water was reportedly found in surrounding households' drinking water vessels. These samples had above-acceptable limits of both nitrates and fluoride based on a detailed quality analysis. In Zone 2 and Anakapalle, the high TDS samples were found to have nitrates above acceptable limits. Refer to Annexure 6 for more details.

4.4.3 Operations and Maintenance

Sustainable operations and maintenance of SWEs can only be ensured if operators have sufficient skills to understand plant O&M and manage the overall plant activities. Appropriate training is required at each level for technical sustainability. This training is critical to ensure optimal operations. A lack of trained operators and managers could result in unreliable and unsafe water supply as well as higher operational costs. The kiosks are managed by women SHGs, entrepreneurs who lack training and skills and thus rely on assistant engineers (AEs) of the GVMC WSM team or the equipment manufacturer for any technical assistance or to resolve any malfunctioning. GVMC engineers check and fix generic mechanical and electrical issues and not water treatment technology/equipment-specific issues, as they are not technically equipped to handle RO treatment plants. They are unable to advise operators on preventive maintenance of the plant, which is rather critical to protect high-value items, such as pumps and membranes, as well as keep the downtime of the kiosk to a minimum.

At a policy level, there are no clear guidelines for management of these kiosks. Active self-help groups (SHGs)/local women as identified collectively by elected MLAs and GVMC zonal offices are entrusted with these kiosks' O&M. These women operators run the kiosks with some oversight from GVMC engineers and UCD personnel.

The equipment manufacturers are contractually obliged to ensure repair and maintenance of these plants during the defect liability period of two years; however, operators provided mixed feedback on the timely and cost-effective resolution of problems by equipment manufacturers' representatives. Since these plants are relatively new (one to five months old), no major breakdowns have taken place, hence the issue of appropriate technical assistance is currently disregarded.

4.4.4 Monitoring and Evaluation

There are no guidelines for monitoring and evaluating these kiosks at a city level on a frequent basis. In Vizag, UCD personnel are supposed to monitor the operations of these kiosks. They visit them on a fortnightly/monthly basis but without any scientific approach. They seek basic details about can sales, plant operations, and challenges.

4.4.5 Challenges

Predominantly RO technology is being used in these kiosks, but the raw water supplied to most of these kiosks could be treated using simpler purification processes to make it potable. This would not only make the scheme more cost-effective but also save significant amounts of reject water from being generated in the process. There is also no mechanism in place for preventive maintenance of electrical or water purification systems, especially the high-value items like motor, filter membrane, etc. Failure of these key components and untimely or no repair thereof has been one of the biggest impediments for such kiosks all over the country.

In addition, there is no standardization of equipment across these kiosks; for the same quality of raw water, there are varying purification features/processes installed across kiosks. There is no NABL-certified lab in the entire city to test water.

[32] As defined by Bureau of Indian Standards IS 10500:2012 (second revision).

4.4.6 Recommendations

TECHNOLOGY

- Establish clear technical specifications for the RO treatment plant, preferably with a remote monitoring system to ease monitoring.
- Select treatment technology based on site-specific raw water quality.
- Set up distribution channels for NTR Sujala kiosks to serve slums in hilly areas and remote locations. Mini distribution vehicles could be deployed for home delivery with an additional cost for convenience (INR 2–3 per can higher than the kiosk price).

WATER QUALITY

- Conduct detailed quality tests on raw water for deciding treatment technology to be used and further ensure strict adherence to treatment technology selection guidelines; also explore technologies requiring low energy (ultrafiltration/ultraviolet/disinfection/slow sand filters) where the contamination is predominantly microbial.
- Facilitate setup of an NABL-certified lab in the city. In the interim, tie in with Andhra University for water quality testing.

O&M

- Deploy remote monitoring systems in kiosks for preventive maintenance and better plant health.
- Create and institutionalize a local technical services entity for repair and maintenance of the NTR Sujala kiosks as well as other kiosks set up by the equipment supplier or philanthropic institutions, such as Rotary Club. This is critical to ensure operational sustainability of these kiosks and cost-effective O&M. A team of five electrical and water treatment personnel, with an annual expenditure of up to INR 15 lakhs, can manage up to 100 kiosks.

4.5 Capacity

The O&M of these kiosks has been entrusted to active SHGs or local entrepreneurs selected by MLA and GVMC zonal officials. There are no fixed selection criteria (educational or technical qualifications). GVMC engineers also do not have the technical knowhow for running these systems and effectively training kiosk operators. Additionally, the effectiveness of GVMC oversight is limited. GVMC UCD wing personnel have not been trained to add any specific value to the functioning of these kiosks. While they play a critical role in site selection, they are underutilized in the implementation phase.

At a policy level, there are no standard guidelines for operator training in running these kiosks. The equipment manufacturer provides the initial operator training at the time of plant installation. Lack of operator training in conjunction with inadequate technical oversight is leading to undesirable characteristics in treated water, affecting the safety of treated water (thereby need) and taste (thereby demand) (e.g., less than 10 TDS of treated water, no or excess chlorine in treated water, and no pH balancing).

4.5.1 Recommendations

CAPACITY BUILDING

- Facilitate capacity-building programs for GVMC personnel
  - Technical (for ensuring technical and operational sustainability)
    - Water treatment technology for AEs
    - Preventive maintenance
  - Managerial (for consumer and livelihood sustainability)
    - Consumer awareness and handling
    - Financial and operational discipline
- Train operators using simpler and shorter formats of aforementioned capacity-building programs. Conduct refresher programs/workshops annually.
- Introduce water purification as a vocational course in ITIs.
- UCD personnel to instill financial discipline in operators (e.g., maintain daily registers) and standardize the objective and process of their kiosk visits.

4.6 Environmental Sustainability

Environmental sustainability is about making responsible decisions and incorporating practices to help prevent negative effects on the environment. Measures that may help SWEs address issues of environmental sustainability include protecting the water source and reducing the impact of any discharge.

- ***Supply security:*** Although operators are using a mix of municipal piped water, tanker water, and bore well water, it is the bore well that secures continuous supply of raw water for these kiosks.
- ***Discharge:*** The technical expert committee studied the RO reject water before fixing any guidelines for it. In the absence of any guidelines, operators are draining the reject water into sewer pipes.

4.6.1 Recommendations

ENVIRONMENTAL SUSTAINABILITY

- Introduce environmental criteria in site-selection process (e.g., check water table for local area).
- Implement rainwater recharge systems to augment the aquifer and dilute the impact of reject water.
- Train operators in basic water resource management.

A water kiosk, set up at Sheila Nagar in Gajuwaka area, was brough under Greater Visakhapatnam Municipal Corporation ambit in 2005.

5. SMALL WATER ENTERPRISES CASE STUDIES

5.1 NTR Sujala Kiosk at Burma Colony

Operator Lavanya had volunteered to run this kiosk when a local MLA had sought an operator at a constituency meeting. Her parents stay in this colony, while she lives with her husband and family about 15 KMs away. She travels daily to and from this kiosk and operates it for 12 hours at a stretch. At the time of this study, her kiosk was selling about 150–200 cans a day, but she was incurring significant costs every alternate day on filter change due to a process design fault. After she learned that this was unusual, she managed to get the representative from the equipment supplier to correct it, and now she hopes to earn a decent livelihood. She fondly says that the most satisfying aspect of running a treated water kiosk is her neighbors and customers telling her that their kids are staying healthy now.

5.2 NTR Sujala Kiosk at Mustapha Colony (Arilova)

Rekha Jyoti was selected by Mother Teresa SHG and the slum federation leader to operate this NTR Sujala kiosk. Close to 60 years of age, she stays in the kiosk enclosure with her husband and runs the kiosk passionately. She had been feeling uneasy about some locals buying cans from her and selling them to people in more affluent colonies at a much higher price. So she was working with the slum-level federation to try and confirm this. When asked what kept her going at this age, she said she's doing "social service" by providing safe drinking water.

5.3 SVS Sewa Samiti

SVS Sewa Samiti, an NGO, commissioned a safe drinking water kiosk in Sheila Nagar in Gajuwaka area in October 2014. This area is not well connected with the city water supply network, as it was brought under GVMC's ambit in 2005 and thus many people rely on GVMC-hired tankers and groundwater. In about four months of operation, post-Cyclone Hudhud, they have sold about 1.5 million L of water at INR 2 per 20L can (INR 10p per L). At the time of study, their daily sales were between 600–700 cans, with more expected as the temperatures rise. The kiosk is run professionally, with the utmost focus on cleanliness and operational discipline. Two shifts of two operators each manage this kiosk for 12 hours daily. One can find a water quality test certificate from Andhra University, plant maintenance schedule, and total sales to date record posted on their glass wall for everyone to see.

Sticker on NTR Sujala scheme 20 liter water cans.

Safe Water Network field assessment team with NTR Sujala plant operators and Mission for Elimination of Poverty in Municipal personnel (second from right) at Mustapha Colony, Arilova (ward no. 2).

6. DIGITAL TOOLS

Digital tools in this context are web-based applications with modules to improve the management and operations of water service delivery. They are in use in the global drinking water sector and in certain locations in India. Akvo FLOW is the best example of this, as it is a valued component of service monitoring in locations in India, Ethiopia, Kenya, Ghana, Bolivia, Colombia, Peru, Nepal, Indonesia, and Uganda.

Safe Water Network conducted a broad-reaching landscape review, or "discovery," to establish what relevant work around digital tools exists, where project tools would be best positioned within the sector, and the lessons others had learned that would guide tool development. The work was completed through discussions with anticipated users, such as municipal officials and kiosk operators, to determine whether they already used digital tools, and the challenges, issues, and needs around them. Desktop review of similar tools, and discussions with the creators of other tools and global specialists in the drinking water sector, validated the need for additional digital tools and identified lessons learned. Interviews with GVMC were conducted to determine the current overall needs that various digital tools might address, current usage of any digital tools to support their governance and management needs, and demand for and response to proposed digital tools related to SWEs.

GVMC uses three digital tools to improve communications and operations:

- *WhatsApp Messenger*
  The internet-based WhatsApp Messenger is used for internal communication along the management hierarchy of project status and critical maintenance work.
- *Water Supply Intranet and Supervisory Control and Data Acquisition (SCADA)*
  The intranet-based software is used for daily water supply status that includes water consumption details, information about tankers plying around the city, etc. Also, the SCADA system has been implemented for bulk water supply. GVMC introduced the SCADA system for metering its bulk and semi-bulk water connections. By getting into a PPP on a build-operate-transfer (BOT) basis, GVMC has managed to increase its revenue by INR 1 crore per month and has avoided all NRW in bulk supplies without any capital investment, as the private operator worked on a revenue-sharing basis for two years. In 2013, the entire software and hardware setup has been transferred to GVMC.
- *Citizen Charter and Online Customer Grievance Portal*
  As the name suggests, an online citizen charter and customer grievance portal is functional and accessible through GVMC's official website.

Today, there are no existing digital tools to address NTR Sujala kiosks or other SWEs, despite a need to address:

- Inappropriate technology selection: All current WTPs are RO based, but other cost-effective options, such as ultrafiltration/ultraviolet, etc., could be considered depending on raw water quality.
- Lack of technical oversight, which increases risks of breakdowns as plants age.
- Limited understanding of SWE economics, a potential threat to the financial sustainability of kiosks.

Safe Water Network identified a significant demand for information on the most cost-effective and appropriate water treatment technology selection, operational effectiveness, and necessary finances to support SWEs complementary to government piped water operations.

6.1 Findings

Safe Water Network has identified demand for each of the digital tools based on direct interviews with likely users in Vizag and through specialist discussions held outside of India. A clear but careful demand was identified among the groups in that there is space for each tool, and a majority of those interviewed in Vizag had positive impressions of the tools' utility. But tool development and rollout must be careful and align with the positions held by those who responded positively.

Of the 21 professionals interviewed in Vizag, 15 expressed positive impressions of the technology selection tool (TST); 11 saw positive value in the plant audit tool (PAT); but only 8 had positive impressions of the financial viability tool (FVT) (Table 21). These findings are not surprising, as the value of each tool to users becomes increasingly specific. The breakdown of positive respondents by category is presented below.

TABLE 21 **Positive Responses to Digital Tools by Respondent Category**

	Positive response to indicated digital tool		
Respondent category	**TST**	**PAT**	**FVT**
High-level decision makers	Yes	No	Yes
Local government officials	No	Yes	No
Government engineers	No	Yes	No
Technical specialists	Yes	No	No
Investors/donors	Yes	No	Yes
Academics	Yes	No	Yes
Private sector providers	Yes	Yes	Yes
Highest IT functionality	Yes	Yes	No

These summarized findings indicate both the clear need across the respondent category for individual tools and the importance of carefully rolling out each tool with a focus on the most likely positive user.

These findings are consistent with less formal responses obtained during discussions and trends identified during document discovery and online research. A large amount of interest and information was identified related to the TST. Any attempts at the creation of digital tools were identified in this region, and comprehensive review documents were available. In addition, the pairing of treatment technologies with contaminants had a long and technically reviewed history in the drinking water sector. Basic principles of the relationship are established best practices that were supported by specialist review in multiple references.

It would be expected that the PAT would appeal to a smaller audience. It is specific in its application to just audits of RO plants, and the content of the tool is—at this time—only applicable to India. It is not surprising that private-sector service providers (those expected to conduct audits) and government functionaries (those expected to directly require audits) show the most positive response to the tool.

Similarly, it is expected that the FVT would appeal to an audience of high-level decision makers, investors/donors, and private-sector actors. These users are expected to be more focused on the financial operations of the business of drinking water supply than would engineers or technical specialists.

In addition, document review uncovered another important point not directly addressed in questions about tool usage. The landscape review from Pacific Institute concluded, "It is vital that an effective decision-making support tool be available in both electronic and hard-copy formats—the latter for users without computers or internet access." This need for multiple formats was also identified during the user interviews in Vizag, as many of the interviewees had very limited, if any, daily interaction with web-based sources of information or productivity support. This multiplicity of need will be addressed through the scope of work being prepared by Safe Water Network to guide the work of the tool developer.

The conclusions that Safe Water Network draws from investigations and discussions align closely with those offered by Pacific Institute in their global review of mobile phone for WASH activities. Therefore, Safe Water Network will adapt the summary table (Table 22) they provided with the specificity of the findings' implication on the development of the three tools.

TABLE 22 **Lessons from mWASH Review**

Lesson from mWASH review	Adapted description	Relevance to digital tool creation
Considerations for user participation and experience		
Understand the sociocultural context	Prepare for issues such as differences in IT access and familiarity; rigid attitudes and expectations of governmental capacity; preferred modes of communication; and prohibitive fears and concerns.	During the Vizag interview, a surprisingly low usage of IT for work support was identified, with most people using only WhatsApp for formal and informal communication. The socialization of each tool across a wide range of capacities and needs will be important.
Build the user base through well-planned outreach to achieve uptake	Outreach is important to user uptake of the system, both during project development and implementation.	Safe Water Network has built into tool development multiple opportunities for user engagement and input.
Ensure the system is easy to use	The success of a system and user participation depends heavily on technical accessibility. This is particularly true at the first point of user interface with the system. It is equally true for the set of relevant output formats	The accessibility of the user interface has proven to be critical in the digital tools Safe Water Network has developed. Because most users of the proposed tools have limited IT experience, the user interface and outputs must be simple, direct, and related to the user's responsibilities and tasks.
Fulfill a key need	Uptake is facilitated when a user receives a direct benefit from tool use.	Initial interviews have identified key users and needs for each tool. Tool beta testing and rollout will align with these findings.
Use of the data		
Implement and promote user access to data	Users must have access to the same data as do the agencies they are trying to hold accountable	Data will only be collected using the PAT. The TST and FVT will have the option of data collection, but this will primarily relate to users and uses. The data collected using the PAT will be collected for the government, and all data collected will be available to the government authorities requesting plant audits.

Lesson from mWASH review	Adapted description	Relevance to digital tool creation
Plans for success and sustainability		
Identify and measure indicators of short- and long-term success; use this information to refine system design	Too many IT products do not develop and track metrics of effectiveness that would clarify how different social, technical, and program design factors affect success. Simple metrics must apply to serve as factual proof of the need for and relevance of the system.	Safe Water Network has included in the scope of work for the tool developer the back-end ability for the organization to monitor downloading of each tool, data input to the PAT, and—with user identification—scenario options carried out on the TST and the FVT.
Secure a future for the system through a plan for long-term sustainability, including on-call technical support, long-term user support, and financing long-term user support, and financing	Implementers risk failing their beneficiaries when they can't keep a system running	The three digital tools will fortunately be useful both externally and internally to Safe Water Network. This presents two groups with incentive to support the systems over time. Tool development is supported through the current grant, but tool maintenance and upkeep will be part of Safe Water Network/India's standard operations. Safe Water Network will direct the tool developer to provide (1) written guidance on data archiving, backup policies and practices, and processes for updating databases; (2) training on tool usage to staff from Safe Water Network/India; and (3) technical documentation and manuals in electronic format for Safe Water Network's approval.

Finally, investigations and discussions held during the discovery phase clearly show that effective user interfaces are generally missing from sector support resources. A key lesson from the efforts and analyses is the equal importance of the technical functionality of the tool and its user interface.

Overall, the lessons from discovery can be summarized as follows:

1. The user interface is critical.
2. The tools must be directly relevant to and used by those "working on the ground" to reduce waterborne diseases and improve community health.
3. The tools must guide practitioners through a process that helps them make the decisions they must make.
4. Key change agents must be empowered with the information they need to address the specific challenges they face.
5. Each tool must be user-friendly, regularly updated, and available in multiple languages.
6. Effective dissemination is key to the success of these decision-making tools.
7. Dissemination must be supplemented with in-country education and workshops to inform potential users about where to find each tool and how to use it.

6.2 Recommendations

The following tools are recommended for successful implementation of NTR Sujala and other kiosks:

- **Technology Selection Tool (TST):** Identifying appropriate water treatment technology (for Water Projects/ Works team).
- **Plant Audit Tool (PAT):** Auditing decentralized water systems for i) instilling best practices (for UCD zonal staff) and ii) protecting investment.
- **Financial Viability Tool (FVT):** Understanding economics for viability, significance of maintenance, and need for a sustainability fund for high value.

With the current IT infrastructure at GVMC, there is also a need for better processes and surveillance. Incorporating digital tools into GVMC and SWE processes will allow for better monitoring of water availability to different parts of the city to help understand demand management and monitoring leakages throughout the city to ensure a reduction in NRW. The need for a central tool to monitor the metered supply lines became evident as well.

The implementation of information and communication technology will bring in faster, more efficient, and transparent service delivery under the Smart Cities initiative. In addition to creating new digital tools, GVMC can upgrade existing tools:

- **WhatsApp:** Develop applications for data entry and aggregation until the city becomes "smart."
- **Water Supply Intranet:** Develop applications for data entry and aggregation until Vizag attains Smart Cities goals.
- **Citizen Charter and Online Customer Grievances Portal:** Improve customer relationship management with analytics capabilities for 1) complaint registration, 2) consumer grievance handling, 3) monitoring and tracking complaints, 4) raising alerts, and 5) complaint closure.

To supplement the metering at WTPs, reservoirs, etc., sensor equipment installed to measure accurately and monitor the city's supply will aid in constant surveillance. Also, to complement the same on the demand side, a SCADA network implementation for the entire city is beneficial for an overall effective water supply system. Furthermore, for streamlined supervision and administration, a statistics, data quality, and analytics cell must be established.

Local politician's tanker typically used to serve the urban poor.

7. CONCLUSION

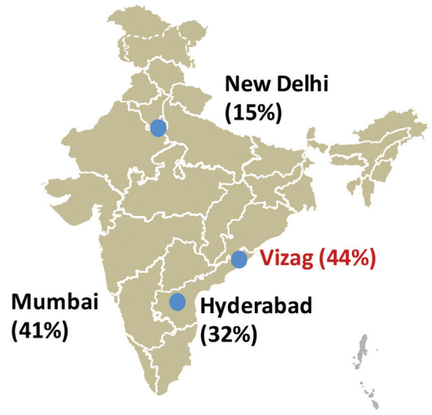
GVMC has done a commendable job in striving to provide clean, reliable water to its citizens. Various delivery mechanisms exist for the 200,000 households in slums within GVMC limits, including small water kiosks under the NTR Sujala Pathakam scheme; however, the city is underperforming against many standard benchmarks. Increased attention to improving Vizag's water supply under the Smart Cities initiative provides an opportunity to implement measures to improve piped water supply, supplemented by additional kiosks. In addition, the GVMC and water kiosk entrepreneurs could improve water provision efficiency and effectiveness through the use of digital tools.

8. ANNEXURES

8.1 Scope of Work

USAID Urban WASH Alliance
Scope of work

- Structured interviews with key Stakeholders to conduct need assessment and feasibility of safe water provision to slums.
- Determine role of Urban Safe Water Enterprises (USWEs) in the slums in expanding access of safe water provision.
- Assess existing digital tools, if any, while gather inputs on proposed digital tools from stakeholders.



The detailed ToR of the assignment enclosed

The ToR of the assignment needs to be communicated to the Municipal Commissioner (MC), Vizag to facilitate assessment

8.2 Questions for Interviewing Urban Local Bodies (ULBs)

I. CITY WATER OVERVIEW

This section is for acquiring basic information about the city and the ULB as well as seeking qualitative comments on the overall water landscape.

1. Name of city: _____
2. Name of urban local body (ULB): _____
3. Name of interviewee: _____
4. Designation: _____
5. Mobile/contact no.: _____
6. What is the ULB's role in oversight and governance of water supply in the city?
7. How would you describe the overall water condition of the city? How about safe drinking water supply?
8. What is the water supply to planned colonies, resettled colonies, notified and non-notified slums (in LPCD)?
9. How many hours per day and how many times a week do these various categories of housing get access to water from a municipal delivery mechanism?
10. How would you describe the water situation in the city's slums?
11. What are the ULB's initiatives toward provision of water in slums, specifically? Any initiatives especially for potable water?
12. On average, how much distance must a slum dweller cover to get to various water delivery mechanisms?
13. What are the major challenges to providing water in the slums in a sustainable manner?
14. Please mention activities carried out by the ULB as per the following categories, **at a city and slum level separately:**
    1) Increasing access through various delivery mechanisms
    2) Improving reliability of delivery mechanisms
    3) Enhancing water quality
    4) IEC programs
    5) Others
15. With respect to tanker water supply, please indicate the following by zone:
    i. Municipal (ULB owned)
        a) No. of tankers _____
        b) Typical capacity of tankers _____
    ii. Other tankers (hired/private)
        a) No. of tankers _____
        b) Typical capacity of tankers _____
16. Please provide details of expenditure on tanker water supply, split by capital/initial (1) and monthly operating cost (2) in INR crores:

Source:										
Source information date (mm/yyyy):										
Financial year	**FY'15**		**FY'14**		**FY'13**		**FY'12**		**FY'11**	
Municipal tankers										
Other tankers										

II. POTABLE WATER MARKET in SLUMS

17. Is drinking water being sold in slums? Yes ☐ No ☐
    If yes, then fill in the table below:

Source:			
Source information date (mm/yyyy):			
S. No.	**Form in which drinking water is being sold**	**Raw water source**	**Treatment methodology**
1	Pouch		
2	Can (jerry/bubble-top/others)		
3	Bottled water		
4	Treated water kiosks/ATMs		
5	<Other 1> _____		
6	<Other 2> _____		

18. For the same source, indicate the following:

Source:			
Source information date (mm/yyyy):			
S. No.	**Form in which drinking water is being sold**	**Common quantity denominations (in liters)**	**Typical price per liter**
1	Pouch		
2	Can (jerry/bubble-top/others)		
3	Bottled water		
4	Treated water kiosks/ATMs		
5	<Other 1> _____		
6	<Other 2> _____		

19. What is the quality monitoring mechanism for the water being sold in slums?
    i. Private or government laboratory _____
    ii. Name of laboratory _____
    iii. Any other details _____

20. Is there any water quality monitoring provision in place for water supply in slums? If yes, indicate process, check points, and frequency.
    i. Any separate authority concerned _____
    ii. Private or government laboratory _____
    iii. Name of laboratory _____
    iv. Any other details _____ _____

III. URBAN SMALL WATER ENTERPRISES (USWEs)

This section will collect information about USWEs from a ULB perspective. This shall cover the regulatory environment in which USWEs are set up and operated as well as the prevailing role that USWEs play in these cities, the potential that ULBs see in them, and recommendations on how this sector should advance and expand.

1. What types of USWEs operate in the slums of the city?

2. How do USWEs fit in with the overall plans of the city?

3. What is this ULB's role in oversight and governance of USWEs?

4. Is this ULB in charge of monitoring and regulating their operation? Yes ☐ No ☐

5. Does this ULB release tenders for inviting organizations to set up USWEs as PPPs? If yes, then indicate price (in INR paise/liter) and the number of systems set up for pickup, home delivery, and water ATMs with the year of tender. If more than one tender has been released, then please indicate above for all occasions. Also please share the tender documents.

Year of tender	At kiosk		Home delivered		Water ATMs (near kiosk)		Water ATMs (away from kiosk)	
	No. of units	Price	No. of units	Price	No. of units	Price	No. of units	Price

6. What is your process and frequency for tariff revision, in the case of PPPs?

7. How are these PPP projects funded?

8. Please enlist the approvals that USWEs must gain to set up operations (e.g., land, water, electricity)?

Type of approval	Purpose	Time taken for approval	Authority concerned	Charges, if any (INR)

9. If yes, then what are the relevant regulations governing USWE operations under the following categories? If the ULB plans to set up USWEs in the near future, then what are the regulations they are considering under the following categories?

Categories	Details of regulation	Methodology for monitoring	Penalty, if any
Service reliability (if PPP)			
Pricing (if PPP)			
Social inclusion (if PPP)			
Budgetary compliance (if PPP)			
Safety			
Water quality			
Labor protection			
Wastewater			
IEC programs			
Others			

10. What are the key challenges to regulating and overseeing USWEs?

11. Do you see potential in USWEs to help augment ULB's potable water provision in city's slums?

12. In your opinion, what share of slums in your city can be provided access to safe water using USWEs in an economically viable manner?
    - i) Less than 10 percent
    - ii) About 25 percent
    - iii) About 50 percent
    - iv) About 75 percent
    - v) 100 percent

13. What would be the major benefits of expansion?

14. What are the key challenges in USWE expansion?

15. While developing PPPs to establish USWEs, what do you think are the challenges from a ULB's perspective and how can USWEs overcome them?

IV. DIGITAL TOOLS TO SUPPORT OVERSIGHT AND OPERATION OF USWEs

We are developing mobile applications to improve development, establishment, and oversight of USWEs. For the same, we intend to understand what digital tools are currently available and being used by the ULB as well as seek your feedback on the following three envisioned tools:

A. *Technology Selection tool:* To recommend effective treatment technologies based on local water quality challenges
B. *Audit tool:* To assess a USWE for its institutional mechanisms—operating capacity, funding support, technological, and quality
C. *Financial Viability tool:* To improve understanding of economics and trade-offs of various USWE models to support project planning and investment

1. Are there any existing digital tools (mobile application, desktop software, etc.) or online applications being used by the ULB for any water provision-related work? If yes, please list the tools below with their objective, intended end user, benefits, challenges, and desired improvements.

Existing Digital Tools with ULB					
Name of Tool	**Objective**	**End user**	**Benefits**	**Challenges**	**What features or capabilities would make the tool more useful to you?**

2. Please share your views on the three envisioned tools.

Tool 1: Technology Selection: To recommend effective treatment technologies based on local water quality challenges		
Type of user	**Challenges faced by ULB that the tool could address**	**What features or capabilities would make the tool more useful to you?**

Tool 2: Audit: To assess a USWE for its institutional mechanisms—operating capacity, funding support, technological, and quality		
Type of user	**Challenges faced by ULB that the tool could address**	**What features or capabilities would make the tool more useful to you?**

Tool 3: Financial Viability: To improve understanding of economics and trade-offs of various USWE models to support project planning and investment		
Type of user	**Challenges faced by ULB that the tool could address**	**What features or capabilities would make the tool more useful to you?**

3. What is the best way to introduce each tool in the city and to users of the tools?

4. What do you think would be the major challenges to the introduction and uptake of these tools?

5. Do you think these tools would be helpful in assessing benefits of USWEs while they augment municipal water supply?

V. OTHER WATER SUPPLY-RELATED INFORMATION

1. Is bore well digging allowed in the city? Yes ☐ No ☐

2. Is bore well digging allowed in slums? Yes ☐ No ☐

3. Is it allowed in all zones? Indicate if otherwise: _____

4. Are there any examples of CSR funding for water supply in slums? Give details.

5. Do you conduct any capacity-building programs for personnel responsible for operating and maintaining water systems, including USWEs? If yes, then share details of the program's scale, including budget and frequency. Any tie-in with ITIs, etc.? If not, would you be interested in organizing such programs?

6. What is the funding structure of water supply projects under the ULB? Share of funding by state government, central government, banks, multilateral organizations, etc.?

8.3 Consumer Research Questionnaire

USAID FROM THE AMERICAN PEOPLE

Safe WATER NETWORK

RESPONDENT ID | | | | | | | | | | | 110 1-110

CENTER:	Vizag										1	**111**											
Respondent's name:																							114–134
Household head's name:																							135–155
Address/landmark:																							156–180
							Telephone no.																181–190
Name of supervisor:																							211–232
Interviewer's name:																							233–253
Interviewer's code:					254–255			**Date of interview:**									2	0	1	5			256–259

Accompanied			**Back Checked**				**Scrutinized**			
				P	T					
TL	1		**TL**	1	5		**TL**	1		
EIC	2		**EIC**	2	6		**EIC**	2		
OFE	3		**OFE**	3	7		**OFE**	3		
FM	4	260–263	**FM**	4	8	264–267	**FM**	4		268–271
Signature: TL/EIC/OFE/FM			**Signature:** TL/EIC/OFE/FM				**Signature:** TL/EIC/OFE/FM			

GENDER			**Starting point no.**		274–275
Male	1	272			
Female	2		**House no. from starting point (1–10)**		276–277
LIFE STAGE					
Kids	1	273	**Starting address (Tick if this is the starting address)**	1	278
Adults	2		**Ending address (Tick if this is ending address)**	2	

Good _____ or Namaste or Namaskaram! I am _____ **(MENTION YOUR NAME)**. I am conducting a market survey in your area currently. **Before starting this interview, I wish to confirm that this interview complies with the Market Research Society of India (MRSI) and International code of ethics for market research.** Please be assured that all information given by you will be kept strictly confidential and not revealed to our client with your name/contact details without your prior permission. The response collected will be added together with the responses of others before presenting the findings. Under no circumstance will this information be used for sales or any commercial purpose.

Do you have any queries before I start the interview? For further clarification, you may also contact my senior at my office at any point during this interview.

INTERVIEWER TO CLARIFY AND PROVIDE ASSURANCE.

TIME OF START: _____ **TIME OF END:** _____ **TIME OF DURATION:** _____

SECTION 1: Recruitment—ASK ALL

. **INTRODUCTION: Thank you for giving me the permission to carry out this interview with you. Today, I am here to understand your water usage habits and your views on the necessity and importance of water. But before that, please answer the following questions.**

RQ1. **RECORD GENDER SINGLE CODING ONLY.**

Male	1	**TERMINATE**	
Female	2	**CONTINUE**	311

RQ2. Please tell me your age as completed on your last birthday? **RECORD VERBATIM WITH LEADING ZEROES.**

AGE:				312-313

POST CODE RESPONSE MENTIONED ABOVE IN THE GRID GIVEN BELOW.

Below 18 years	1	**TERMINATE**
18–22 years	2	**CONTINUE**
23–29 years	3	
30–35 years	4	
36–50 years	5	
Above 50 years	6	
		314

TERMINATE IF RESPONDENT IS BELOW 18 YEARS. OTHERWISE, CONTINUE.

RQ3. I would like to know something about the chief wage earner in your household.

IF RESPONDENT IS CHIEF WAGE EARNER, SAY:

i.) Please tell me, up to what level have you studied? **CODE EDUCATION IN GRID. AND SINGLE CODING ONLY.**

ii.) In areas such as yours, there are three types of houses. These are:

- **Type A:** Houses that have brick and cement walls and concrete-casted ceilings.
- **Type B:** Houses that have brick and cement walls, but the ceiling is made of anything apart from concrete (e.g., tiles, asbestos, corrugated sheet).
- **Type C:** Houses that have walls also made of anything apart from brick and cement (e.g., mud, hay, *darma*, bamboo, stone).

Please tell me your house belongs to which of these types? **SINGLE CODING ONLY.**
IF RESPONDENT SAYS TYPE A, INTERVIEWER TO TREAT IT AS PUCCA HOUSE WHILE CODING IN THE SEC GRID.
IF RESPONDENT SAYS TYPE B, INTERVIEWER TO TREAT IT AS SEMI-PUCCA HOUSE WHILE CODING IN SEC GRID.
IF RESPONDENT SAYS TYPE C, INTERVIEWER TO TREAT IT AS KUTCHA HOUSE WHILE CODING IN THE SEC GRID.

RQ3. **IF RESPONDENT IS NOT CWE, SAY:**

i.) Please tell me, up to what level have you studied? **(CODE EDUCATION IN GRID AND THEN CODE SEC BELOW THE GRID.) SINGLE CODING ONLY.**

ii.) In areas such as yours, there are three types of houses. These are:

- **Type A:** Houses that have brick and cement walls and concrete-casted ceilings.
- **Type B:** Houses that have brick and cement walls, but the ceiling is made of anything apart from concrete (e.g., tiles, asbestos, corrugated sheet).
- **Type C**: Houses that have walls also made of anything apart from brick and cement (e.g., mud, hay, *darma*, bamboo, stone).
- Please tell me your house belongs to which of these types? **SINGLE CODING ONLY.**
- **IF RESPONDENT SAYS TYPE A, INTERVIEWER TO TREAT IT AS PUCCA HOUSE WHILE CODING IN THE SEC GRID.**
- **IF RESPONDENT SAYS TYPE B, INTERVIEWER TO TREAT IT AS SEMI-PUCCA HOUSE WHILE CODING IN SEC GRID.**
- **IF RESPONDENT SAYS TYPE C, INTERVIEWER TO TREAT IT AS KUTCHA HOUSE WHILE CODING IN THE SEC GRID.**

CWE Education (Refer to definition of codes given below)	Type of Accommodation (617)		
	1 (Pucca)	2 (Semi-Pucca)	3 (Kuchha)
1	R4	R4	R4
2	R3	R4	R4
3, 4	R3	R3	R4
5	R2	R3	R3
6, 7, 8, 9, 10	R1	R2	R3
315–316	317–318		

Where education codes are:

Education Codes	
1	Illiterate
2	Literate, but no formal schooling
3	School—up to 4 years
4	School—5 to 9 years
5	SSC/HSC
6	Some college (incl. diploma), but not graduate
7	Graduate—general
8	Graduate—professional
9	Postgraduate—general
10	Postgraduate—professional

R4. **SHOW CARD R4.**
Please tell me, what is your marital status? **SINGLE CODING ONLY.**

Single	1	
Married	2	
Divorced/widow	3	**319**

SECTION 2: Water Sources and Usage

INTERVIEWER TO SAY: I will now start with questions on your daily usage of water and the sources from which you collect water.

There can be several places from which we can collect water for usage. We call them "sources of water."

K1a. **SHOW CARD K1a/b/c.**
Please tell me, from these water sources, which sources of water are available in/around your house?
MULTIPLE CODING POSSIBLE.

K1b. Now, please tell me, from these water sources, which sources of water have you ever tried collecting water from?
MULTIPLE CODING POSSIBLE.

K1c. And which of these sources do you use regularly to collect water used in your household? It may be for drinking or any other activity like bathing, washing clothes, utensils, etc. **MULTIPLE CODING POSSIBLE.**

	Available (K1a)	Ever Tried (K1b)	Regularly Use (K1c)
Tap water available at home	01	01	01
Community tap water	02	02	02
Bore well/boring water	03	03	03
Tanker water	04	04	04
Hand pump	05	05	05
Well	06	06	06
RO water solutions/water kiosk	07	07	07
Water purchased from market—bottles/cans	08	08	08
Water purchased from market—plastic pouches/sachets	09	09	09
	344–352	**353–361**	**362–370**

K1d. **ASK FOR ONLY THOSE SOURCES CODED IN K1c.**
SHOW CARD K1d.
And how far is _____ from your home? **SINGLE CODING PER SOURCE.**

Less than 5 minutes away	1
5–10 minutes away	2
15–30 minutes away	3
More than 30 minutes away	4

K1e. **ASK FOR ONLY THOSE SOURCES CODED IN K1c. SHOW CARD K1e.**
And for how long is the supply of water available to you from _____ this source in a day?
SINGLE CODING PER SOURCE

Less than 1 hour a day	1
1–2 hours a day	2
3–5 hours a day	3
5–10 hours	4
More than 10 hours	5
Throughout the day	6

	Regularly Using	Distance (K1d)	Time (K1e)	
Tap water available at home				
Community tap water	1			**373–375**
Bore well/boring water	2			**376–378**
Tanker water	3			**379–381**
Hand pump	4			**382–384**
Well	5			**385–387**
RO water solutions/water kiosk	6			**388–390**
Water purchased from market—bottles/cans	7			**391–393**
Water purchased from market—plastic pouches/sachets	8			**394–396**

K2ai. **ASK K2ai–K2aiii ONLY FOR THE SOURCES OF WATER CODED IN K1c (I.E., REGULARLY USED SOURCES, ACROSS VARIOUS ACTIVITIES MENTIONED IN THE GRID).**

SHOW CARD K2a.
And for _____ **(READ THE ACTIVITY CODED IN K2ai)**, which one do you use most often?
SINGLE CODING ONLY.

	K2ai									
Activities from water	**Tap water at home**	**Community tap water**	**Bore well/ boring water**	**Tanker water**	**Hand pump**	**Well**	**RO water solutions/ water kiosk**	**Water purchased from market—bottles/cans**	**Water purchased from market—plastic pouches/ sachets**	
Drinking—in-home consumption	01	02	03	04	05	06	07	08	09	**411–412**
Drinking water—carried along outside home to work, school, etc.	01	02	03	04	05	06	07	08	09	**413–414**
Cooking	01	02	03	04	05	06	07	08	09	**415–416**
Other kitchen usage, like washing/cleaning vegetables and fruits, etc.	01	02	03	04	05	06	07	08	09	**417–418**
Other uses, including washing, bathing, etc.	01	02	03	04	05	06	07	08	09	**419–420**

SECTION 3: Water Collection Behavior

ASK FOR THE SOURCE CODED MOST OFTEN (K2a i), EXCEPT TAP WATER AT HOME FOR ACTIVITY 01 (I.E., DRINKING IN-HOME CONSUMPTION).

K3. **SHOW CARD K3.**
Please tell me who usually goes to collect water from the given source _____ (specify the water sources from well/river/tube well/bore hole (whichever is mentioned above)). **SINGLE CODING ONLY.**

Girl child of the family	1
Boy child of the family	2
Male adults of the family	3
Female adults of the family	4
Household help/maid	5
Others	6
	431

K4. **SHOW CARD K4.**
And, on an average, how many times do you/someone from your home go to get water? Please tell me all the sources that you use for drinking water. **SINGLE CODING ONLY.**

Twice or more than twice a day	1
Once a day	2
Once in two days	3
2–3 times a week	4
Once a week	5
Less than once a week	6
	432

K5. **SHOW CARD K5.**
And, on an average, how many buckets do you/someone from your home collect during every visit?
SINGLE CODING ONLY.

1–2	1
3–5	2
More than 5	3
	433

K6a. You have said that your main source of drinking water is _____.
(PLEASE READ OUT THE MAIN SOURCE OF WATER FROM K2aii.)

Please tell me if you have paid any one-time money or setup costs for getting a regular supply of water from this source.

K6b. And from this source, on an average, how much money do you spend every month?.

K6c. And is this money that you spend every month paid at the end of the month or every time that you go to collect water?

RECORD IN INR. IN THE CASE THAT NO INITIAL MONEY WAS PAID, RECORD 000.

Amount Paid (INR)							
K6a.: INITIAL SETUP COSTS			**K6b.: MONTHLY SETUP COSTS**			**Water Payment Basis**	
Rs.			**Rs.**			**Monthly**	**Every time used**
						1	**2**
451–453			**454–456**			**457**	

SECTION 4: Quality and Satisfaction

K7a. Talking about water from this source, please tell me, is the quality of water consistent whenever you get water from this source? **SINGLE CODING ONLY.**

Yes	1
No	2
	486

K7b. **ASK K7b IF 2 IS CODED IN K7a.**
You said you feel that quality of water is not consistent. Please tell me, are there particular seasons, days, or times when do you think the quality of water drops down? Please tell me which season, days, or times.
RECORD VERBATIM. PROBE FULLY.

511-225

K7c. **ASK FOR OPTION CODED IN K2a i. SHOW CARD K7c.**
There are various attributes that can relate to a water source, such as water quality, availability, etc. As I read out the list of attributes, please see this card and tell me how satisfied/dissatisfied you are with water that you get from __________ **(READ OUT OPTION CODED IN K2a ii)** on each of them. **SINGLE CODING PER ATTRIBUTE.**

	Highly Dissatisfied	Slightly Dissatisfied	Neither Satisfied nor Dissatisfied	Slightly Satisfied	Highly Satisfied	DK/CS	
Cleanliness	1	2	3	4	5	6	541
Purity	1	2	3	4	5	6	542
Taste	1	2	3	4	5	6	543
Smell	1	2	3	4	5	6	544
Quality	1	2	3	4	5	6	545
Availability throughout the year	1	2	3	4	5	6	546
Convenience of collecting water	1	2	3	4	5	6	547
Sufficiency of water available	1	2	3	4	5	6	548

K7d. **SHOW CARD K7c**
And now please tell me OVERALL how satisfied you are with this source of water. Please answer taking in mind everything (i.e., cleanliness, availability). You can use this card for help. **SINGLE CODING ONLY.**

Highly Dissatisfied	Slightly Dissatisfied	Neither Satisfied nor Dissatisfied	Slightly Satisfied	Highly Satisfied
1	2	3	4	5
				5 51

K7d. **ASK K7d FOR ALL OPTIONS CODED IN K1a.**
SHOW CARD K7d
Now, as I read out the list, please tell me for each source of water if you face any such problems with the water that you use. ROTATE THE STATEMENTS. **MULTIPLE CODING PER SOURCE POSSIBLE.**

	Tap water at home	Community tap water	Bore well/boring water	Tanker water	Hand pump	Well	RO water solutions/ water kiosk	Water purchased from market—bottles/cans	Water purchased from market—plastic pouches/ sachets	
Water is not clean/is dirty/is polluted	1	2	3	4	5	6	7	8	9	**611–619**
There is a smell in the water we collect	1	2	3	4	5	6	7	8	9	**620–629**
Mosquitoes breed in the water source	1	2	3	4	5	6	7	8	9	**630–639**
The source of collecting water is not covered	1	2	3	4	5	6	7	8	9	**640–649**
The water is toxic/has several chemicals mixed in	1	2	3	4	5	6	7	8	9	**650–659**
It is not healthy to consume the water	1	2	3	4	5	6	7	8	9	**660–669**
Several diseases are caused due to the water	1	2	3	4	5	6	7	8	9	**670–679**
The water needs to be treated before consumption	1	2	3	4	5	6	7	8	9	**680–679**
The source of water is far away from our home	1	2	3	4	5	6	7	8	9	**680–689**
Supply of water is irregular/ highly dependent on rains	1	2	3	4	5	6	7	8	9	**690–699**
It is difficult to store water collected from this source	1	2	3	4	5	6	7	8	9	**700–709**
Any other (please specify)_______________	99	99	99	99	99	99	99	99	99	**710–719**

SECTION 5: Family Health Status

Now I would like to ask you about the kind of problems that you and your family suffer from.

H1a. **SHOW CARD H1a.**
Please see this card and tell me if any of your family members have fallen ill/suffered from these problems **(AS MENTIONED IN THE CARD)** in the past three months. These problems are mainly those that remain for a short period of time, say, a few days. You can see this list and tell me the problems. It could be anything apart from this, also. **MULTIPLE CODING POSSIBLE.**

H1b. **SHOW CARD H1b.**
Also, please tell me the member(s) who faced _____ **(READ THIS PROBLEM)** belonged to which age group. Was he/she a child, adult, or an elder person?

Children (0–6 years)	Children (7–12 years)	Children (13–18 years)	Adults (19–55 years)	Elderly (56 and above)
1	2	3	4	5

	H1a	H1b				
Short-term problems	**Problems suffered**	**Children (0–5 years)**	**Children (6–12 years)**	**Children (13–18 years)**	**Adults (19–55 years)**	**Elderly (56 and above)**
Dizziness/nausea	01	**1**	**2**	**3**	**4**	**5**
Headaches	02	**1**	**2**	**3**	**4**	**5**
Vomiting	03	**1**	**2**	**3**	**4**	**5**
Skin irritation/rashes	04	**1**	**2**	**3**	**4**	**5**
Jaundice	05	**1**	**2**	**3**	**4**	**5**
Cholera	06	**1**	**2**	**3**	**4**	**5**
Typhoid	07	**1**	**2**	**3**	**4**	**5**
Dehydration	08	**1**	**2**	**3**	**4**	**5**
Blood in stools/dark-colored stools	09	**1**	**2**	**3**	**4**	**5**
Loose motions/watery stools	10	**1**	**2**	**3**	**4**	**5**
Cold/cough	11	**1**	**2**	**3**	**4**	**5**
Fever	12	**1**	**2**	**3**	**4**	**5**
	730-754	**775-835**				

H2a. **SHOW CARD H2a.**
Please see this card and tell me if any of your family members are suffering from any of these problems **(AS MENTIONED IN THE CARD).** These problems affect a person over a longer period of time and may take years to heal. You can see this list and tell the problems. It could be anything apart from this, also. **MULTIPLE CODING POSSIBLE.**

H2b. **SHOW CARD H1b.**
Also, please tell me whether the member(s) who faced _____ **(READ THIS PROBLEM)** belonged to which age group. Was he/she a child, adult, or an elder person?

Children (0–6 years)	**Children (7–12 years)**	**Children (13–18 years)**	**Adults (19–55 years)**	**Elderly (56 and above)**
1	2	3	4	5

	H2a	H2b				
Long-term problems	Problems suffered	Children (0–5 years)	Children (6–12 years)	Children (13–18 years)	Adults (19–55 years)	Elderly (56 and above)
Severe joint pain	**1**	**1**	**2**	**3**	**4**	**5**
Bent/humped back	**2**	**1**	**2**	**3**	**4**	**5**
Disfiguration/swollen body parts	**3**	**1**	**2**	**3**	**4**	**5**
Brown spots on tooth	**4**	**1**	**2**	**3**	**4**	**5**
Tooth decay	**5**	**1**	**2**	**3**	**4**	**5**
	850	**851-875**				

SECTION 6: Willingness to Shift and Pay for Clean Drinking Water

P1. How likely are you to change your water source if a clean, pure source of water is available? **SINGLE CODING.**

Will stop using my current sources completely and switch to the new source	1
Will try the new source	2
Will not try the new source	3
DK/CS	9
	900

P2. How likely are you to change your water source if water from the new source is available some distance away and you have to collect the water? **SINGLE CODING.**

Will stop using my current sources completely and switch to the new source	1
Will try the new source	2
Will not try the new source	3
DK/CS	9
	901

P3. How likely are you to change your water source if you have to pay for the clear, pure water? **SINGLE CODING.**

Will stop using my current sources completely and switch to the new source	1
Will try the new source	2
Will not try the new source	3
DK/CS	9
	902

P4. **ASK ALL THOSE WHO CODED 1 OR 2 IN P1.**
SHOW CARD P4.
How strongly are you willing to pay and purchase clear, pure water in the future at **Rs. 8** per L?
SINGLE CODING, CODE IN THE GRID BELOW.

P5. **ASK P5 ONLY IF 1/2/3/4 IS CODED IN P4.**
And how willing are you to pay **Rs. 5** per L? **SINGLE CODING, CODE IN THE GRID BELOW.**

P6. **ASK P6 ONLY IF 1/2/3/4 IS CODED IN P5.**
And how willing are you to pay **Rs. 3** per L? **SINGLE CODING, CODE IN THE GRID BELOW**

	Rs. 8/L (P4)	**Rs. 5/L (P5)**	**Rs. 3/L (P6)**
Strongly unwilling to pay	1	1	1
Slightly unwilling to pay	2	2	2
May or may not pay	3	3	3
Slightly willing to pay	4	4	4
Strongly willing to pay	5	5	5
	903	**904**	**905**

SECTION 7: Household Profile

D1a. **SAY:** Now I would like to know about your family in general.

RECORD THE DETAILS IN THE GRID AFTER D1c.
How many members are there in your family? Please tell me the name, gender, and age of all the members in your family. Please tell me their details, starting from the youngest member to the eldest in the house. Also, please tell me how all of them earn/bring money for family. **RECORD AGES AS OF LAST BIRTHDAY FOR EACH FAMILY MEMBER. RECORD AS PER ACTUALS.**

Male	1
Female	2

D1b. **SHOW CARD D1b.**
Please tell me the educational qualification of all your family members one by one.
ASK FOR ALL THE MEMBERS. SINGLE CODING PER PERSON.

Illiterate	01
Literate without formal education	02
Literate with formal education	03
Below primary	04
Primary (5th passed)	05
Middle (8th passed)	06
Secondary/matric/class X	07
Hr. secondary/Sr. secondary/Pre-university/class XII	08
Graduate/B.Tech/B.B.A./MBBS/equivalent	09
Postgraduate/M.Tech//M.B.A./M.D./equivalent or higher	10
Non-technical/technical diploma or certificate not equivalent to degree	11
Vocational courses	12

D1b.

D1a **No. of family members**			921-922

S. no	Name	Gender	Age	Earning		Education profile		
1				Yes	No			
2				Yes	No			
3				Yes	No			
4				Yes	No			
5				Yes	No			
6				Yes	No			
7				Yes	No			
8				Yes	No			
9				Yes	No			
10				Yes	No			
11				Yes	No			
12				Yes	No			
13				Yes	No			
14				Yes	No			
15				Yes	No		**923-1390**	

D1c. **SHOW CARD D1c.**
IF THE RESPONDENT IS FEMALE AND MARRIED, ASK:
And what is the occupation of your husband? **MULTIPLE CODING PER PERSON POSSIBLE.**

D1c. **IF THE RESPONDENT IS UNMARRIED, ASK:**
And what is the occupation of your father? **MULTIPLE CODING PER PERSON POSSIBLE.**
IF THE RESPONDENT IS THE CWE HIMSELF, ASK AND CODE HIS OCCUPATION.

SHOW CARD D1c. CODE YOUR RESPONSE HERE.		
Cultivator—owns land and cultivates by himself		01
Agricultural unskilled wage laborer		02
Non-agricultural unskilled wage laborer		03
Salaried employee in a private enterprise		04
Shop owner		05
Animal-rearing farm owner, such as dairy, poultry, etc.		06
Skilled laborer—non-agricultural		07
Govt. worker		08
Self-employed		09
Business owner		10
Currently unemployed		11
Rentier, pensioner, other remittance recipient		12
Not able to work due to disability		13
Too old to work		14
Others (please specify)		15
		1400

THANK AND TERMINATE INTERVIEW.

8.4 SWE Entrepreneur/Operator Questionnaire

USAID FROM THE AMERICAN PEOPLE

Safe WATER NETWORK

RESPONDENT ID | | | | | | | | | | | 110 1-110

CENTER:	Vizag	1	**111**

Respondent's name:		114–134
MARK ANY ONE (REFER RQ1)	**OPERATOR** 1 **ENTREPRENEUR** 2	
Slum name and location:		135–135
Address/landmark:		156–180
[redacted] **Telephone no.**		181–190
Name of supervisor:		211–232
Interviewer's name:		233–253
Interviewer's code:	[redacted] 254–255 **Date of interview:** 2 0 1 3	256–259

Accompanied			**Back Checked**	P	T		**Scrutinized**		
TL	1		**TL**	1	5		**TL**	1	
EIC	2		**EIC**	2	6		**EIC**	2	
OFE	3		**OFE**	3	7		**OFE**	3	
FM	4	260–263	**FM**	4	8	264–267	**FM**	4	268–271
Signature: TL/EIC/OFE/FM			**Signature:** TL/EIC/OFE/FM				**Signature:** TL/EIC/OFE/FM		

Good _____ or Namaste or Namaskaram! I am _____ **(MENTION YOUR NAME).** I am conducting a market survey in your area currently. **Before starting this interview, I wish to confirm that this interview complies with the Market Research Society of India (MRSI) and International code of ethics for market research.** Please be assured that all information given by you will be kept strictly confidential and not revealed to our client with your name/contact details without your prior permission. The response collected will be added together with the responses of others before presenting the findings. Under no circumstance will this information be used for sales or any commercial purpose.

Do you have any queries before I start the interview? For further clarification, you may also contact my senior at my office at any point during this interview.

INTERVIEWER TO CLARIFY AND PROVIDE ASSURANCE.

TIME OF START: _____ **TIME OF END:** _____ **TIME OF DURATION:** _____

SECTION 1: Initial Details—ASK ALL

I**NTRODUCTION:** Thank you for giving me the permission to carry out this interview with you. Today, I am here to understand about your business of supplying clean and pure water in this area. Are you the right person who can answer this survey about this water supplying center?

CONTINUE ONLY IF THE RESPONDENT SAYS YES.

RQ1. **ASK AND CODE BELOW, SINGLE CODING ONLY.**
Are you the...

Owner	1	311
Operator/manager	2	

RQ2. **SAY IF 1 CODED IN RQ1 (i.e., OWNER):** Please tell me your name, address, and contact number.
RECORD IN THE GRID BELOW.

SAY IF 2 CODED IN RQ1 (i.e., OPERATOR/MANAGER): Please tell me your owner's name, address, and contact number.
RECORD IN THE GRID BELOW.

Owner's name:																			
Address:																			
								P	**I**	**N**	**C**	**O**	**D**	**E**					
Landmark:																			
							Telephone no.												

RQ1. Do you/your owner **(READ APPROPRIATE)** have any other clean and pure water supplying center in this city?
If yes, how many?

No. of operating centers elsewhere **(RECORD NUMBER)**			**411-412**
No. other operating centers	99		

SECTION 2: Setup

S1a. How did you **(READ APPROPRIATE)** choose this slum for setting up this clean and pure water supplying business?
RECORD VERBATIM. PROBE FULLY. POST CODE IN THE GRID BELOW.

S1ai. **SHOW CARD S1ai.**
Please have a look at this card. People like you have given reasons why they have chosen a particular slum area for setting up clean and pure water supplying centers.

Now please tell me which was the most important reason for you to set up the center at this slum? **CODE AS RANK 1.**

Which was the next most important reason for you to set up the center at this slum? **CODE AS RANK 2.**

Which was the next most important reason for you to set up the center at this slum? **CODE AS RANK 3.**

Reason for Choosing Location	**RANK 1**	**RANK 2**	**RANK 3**
Received a grant/loan to set up a station at this place	1	1	1
Good source of water	2	2	2
Many people were ready to buy/subscribe	3	3	3
Large number of households who can afford to buy water exists here	4	4	4
Water deficiency: Water is available in this slum, but not enough	5	5	5
Land to set up water station is easily available	6	6	6
This is an add-on product to another business	7	7	7
	451	**452**	**453**

S1b. What are the sources of the water that you use? **MULTIPLE CODING POSSIBLE.**

S1c. What source you mostly use? **SINGLE CODING ONLY.**

SOURCES	**S1b**	**S1c**
Tap water/municipality supply	1	1
Bore well/boring Water	2	2
Tanker water	3	3
Hand pump	4	4
Any other (please specify)	5	5
	454	**455**

S1d. What is the total installed capacity of this center? By installed capacity, I mean how much water this plant can treat and generate in one day. **RECORD IN LITERS.**

		,				**456–460**

S1e. When was this center started? **RECORD IN MM/YYYY FORMAT.**

M	M	Y	Y	Y	Y	461-465

S1f. What was the total amount that was spent to install the water filter station? **RECORD IN INR.**

		,			,				466-472

S1g. Who provided the land for this center? **SINGLE CODING ONLY.**

LAND SOURCE	S1g
Municipality/government	1
Community common space	2
Private individual/landlord	3
Private individual/SWE center owner	4
Any other (please specify)	5
	473

S1h. Can you please tell us what are the regulations that you need follow to set up this water station and operate it? By regulations, I mean licenses that you have to adhere to, forms that you need to fill in, etc.
RECORD VERBATIM. PROBE FULLY.

S1i. Now, can you please tell us what type of help you received or continue to receive from either the government/civic body or the community or the welfare association for this center? **RECORD VERBATIM. PROBE FULLY.**

SECTION 3: Operating Model

S2a. What is the maximum output of this center? By maximum output, I mean the maximum of how much of water this plant can treat in one day. **RECORD IN LITERS.**

		,				551–555

S2bi. In a week, how many days do you keep this center open for people to collect clean and pure water?
RECORD NUMBER OF DAYS.

		556–557

S2bii. In a day, how many hours do you keep this center open for people to collect clean and pure water?
RECORD IN HOURS.

		558–559

S2c. On an average, how much do you/ does your owner **(READ APPROPRIATE)** spend in a month for maintenance and upkeep of this center? **RECORD IN INR.**

		,			,			560–567

S2d. On an average, how much do you/ does your owner **(READ APPROPRIATE)** earn in a month from this center?
RECORD IN INR.

		,			,			568–574

S2e. Does the sale vary between seasons? **SINGLE CODING ONLY.**

Yes	1
No	2
	575

S2f. Who manages the daily operations of this center? **RECORD AS APPROPRIATE.**

Owner	1
Operation/manager	2
	576

S2g. Now, can you please tell me what are the challenges/issues/problems you face in operating this center?
RECORD VERBATIM. PROBE FULLY. POST CODE IN THE GRID BELOW.

S2h. **SHOW CARD S2h.**
Please have a look at this card. People like you have told us some challenges/issues/problems they face in operating clean and pure water supplying centers.

Now, please tell me, out of these, which one is the biggest challenge/issue/problem for you in operating this center? **CODE AS RANK 1.**

Which is the next biggest challenge/issue/problem for you? **CODE AS RANK 2.**

Which is the next biggest challenge/issue/problem for you? **CODE AS RANK 3.**

Challenges/Issues/Problems	RANK 1	RANK 2	RANK 3
Water supply from source is not uniform (erratic supply)	1	1	1
Quality of source water is not good, needs more time for treatment	2	2	2
Frequent breakdown of the unit	3	3	3
Low treated water output	4	4	4
No/little help from the company who installed the machine	5	5	5
Not many people take water from here	6	6	6
Electricity availability	7	7	7
Customers do not pay regularly	8	8	8
Number of customers who buy water are not regular	9	9	9
Local challenges, like interferences from influential people	10	10	10
	601	**602**	**603**

S2i. Are there any other centers like this in this particular locality? **SINGLE CODING ONLY.**

Yes	1
No	2
	604

S2j. Do you/ does your owner **(READ APPROPRIATE)** have plans to set up more centers like this in future? **SINGLE CODING ONLY.**

Yes	1
No	2
	605

S2k. **ASK THOSE WHO SAID YES IN S2j (i.e., CODED 1). SHOW CARD S2k.**
Please have a look at this card and tell me where where do you/ does your owner **(READ APPROPRIATE)** plan to set up new centers like this in the future?
MULTIPLE CODING POSSIBLE.

POSSIBLE CENTERS	S2k
More centers in this slum	1
Centers in other slums of Vizag	2
Centers in other towns	3
Any other (please specify)	4
	606

S2l. **SHOW CARD S2l.**
Please have a look at this card and tell me, where do you do water quality testing?
MULTIPLE CODING POSSIBLE.

POSSIBLE CENTERS	S2l
In our own center/lab	1
In an outside center/lab	2
Any other (please specify)	3
Don't do water quality testing	4
	607

SECTION 4: Sales and Pricing

S3a. Do you provide clean and pure water from here only to those people who have taken a weekly/ monthly card? Or do you also provide water to anybody as and when they come and ask? **CODE OPTION 1 (SUBSCRIPTION BASED) IF WATER IS ONLY PROVIDED TO CARD HOLDERS; CODE OPTION 2 (AD HOC BASED) IF WATER IS PROVIDED TO ANYONE. IF BOTH SUBSCRIBERS AND AD HOC CUSTOMERS ARE PROVIDED WATER, CODE OPTION 3 (BOTH). SINGLE CODING ONLY.**

Subscription based	1
Ad hoc based	2
Both	3
	651

S3b. **ASK THOSE WHO HAVE EITHER A SUBSCRIPTION OR BOTH TYPE OF CUSTOMERS (I.E., CODED 1 OR 3 IN S3a):**
You said that you provide water to people who have taken a weekly/monthly card. How many such cardholders are there for this center? **RECORD ACTUAL NUMBERS**

									652-658

S3c. Do you charge money to people who take clean and pure water from this center? **SINGLE CODING ONLY.**

Yes	1
No	2
	659

S3b. **ASK THOSE WHO CHARGE (I.E., CODED 1 IN S3b):**
How much do you charge per liter of clean and pure water for…? **(READ AS APPROPRIATE. RECORD IN INR.)**

Subscribers, those who have weekly/monthly cards			**660–661**
Others who don't have weekly/monthly cards			**662–663**

S3c. On an average, how many liters of clean and pure water do you sell in a day? **RECORD IN LITERS.**

									664-670

S3d. In what type of containers do you supply from this center? **SINGLE CODING ONLY.**

Containers supplied by us	1
Specific containers brought by the customers on a regular basis	2
Any containers brought by the customers	3
Any other	4
	671

S3e. On an average, how many people take clean and pure water daily from this center? **RECORD APPROXIMATE NUMBERS.**

						672–676

THANK AND TERMINATE INTERVIEW.

8.5 Consolidated Water Quality Report[33]

Characteristics		Taste	Odor	pH	Total Dissolved Solids	Residual Chlorine as Cl	E. Coli	Thermo-tolerent Coliform Bacteria (Fecal Coliforms)	Total Coliforms
IS 10500 Acceptable Limit		-	-	6.5 to 8.5	500mg/L max.	0.2mg/L max.	Shall not be detectable in any 100ml sample		
IS 10500 Permissible Limits in Alternative Source		-	-	-	2,000mg/L max.	1mg/L max.			
Sample Description	**Area**	**Taste**	**Odor**	**pH**	**Total Dissolved Solids**	**Residual Chlorine as Cl**	**E. Coli**	**Thermo-tolerent Coliform Bacteria (Fecal Coliforms)**	**Total Coliforms**
Top (Public)	?	Agreeable	Agreeable	7.8	824	<0.01	Absent	Absent	Absent
Treated Water, NTR WTP Plant	?	Agreeable	Agreeable	7.7	40	<0.01	Absent	Absent	Absent
Raw Water, NTR Srujana Plant	NTR AKP	Agreeable	Agreeable	8.3	464	<0.01	Absent	Absent	Absent
Shared Public Tap, AKP	AKP	Agreeable	Agreeable	7.7	844	<0.01	Absent	Absent	Absent
Consumer HH Water, AKP	AKP	Agreeable	Agreeable	7.8	800	<0.01	Absent	Absent	Absent
Public Tap	AKP	Agreeable	Agreeable	7.5	1,022	<0.01	Absent	Absent	Absent
House Tap, AKP, 6-5-43	AKP	Agreeable	Agreeable	7.5	964	<0.01	Absent	Absent	Absent
House Tap, AKP, 6-1-12	AKP	Agreeable	Agreeable	7.6	210	<0.01	Absent	Absent	Absent
House Tap, AKP, 6-5-35	AKP	Agreeable	Agreeable	8.2	166	<0.01	Absent	Absent	Absent
Public Tap, 6W/7, AKP	AKP	Agreeable	Agreeable	8	688	<0.01	Absent	Absent	Absent
Public Tap, 5W/4, AKP	AKP	Agreeable	Agreeable	8.2	732	<0.01	Absent	Absent	Absent
Hospital Drinking Water, 4-2-18, AKP	AKP	Agreeable	Agreeable	7.6	50	<0.01	Absent	Absent	Absent
Sitara Kalyana Mandapam, AKP	AKP	Agreeable	Agreeable	8.1	652	<0.01	Absent	Absent	Absent
DAV School, Bore Well Water, RW	AKP	Agreeable	Agreeable	8.1	1,986	<0.01	Absent	Absent	Absent
DAV School, RO Treated Water	AKP	Agreeable	Agreeable	7.3	348	<0.01	Absent	Absent	Absent
Government Hospital, AKP	AKP	Agreeable	Agreeable	7.1	20	<0.01	Absent	Absent	Absent
Public Tap, 7W/4, AKP	AKP	Agreeable	Agreeable	7.8	802	<0.01	Absent	Absent	Absent
Consumer House Tap, 7-6-6, AKP	AKP	Agreeable	Agreeable	7.9	1,146	<0.01	Absent	Absent	Absent
Consumer House Water, Municipal, 6-11-28	AKP	Agreeable	Agreeable	7.5	168	<0.01	Absent	Absent	Absent
Consumer House Water, Bore Well, 6-11-27	AKP	Agreeable	Agreeable	7	1,272	<0.01	Absent	Absent	Absent
Consumer House Water, 6-12-3, AKP	AKP	Agreeable	Agreeable	7.9	212	<0.01	Absent	Absent	Absent
Consumer House Water, Municipal, 6-8-5, AKP	AKP	Agreeable	Agreeable	8.3	224	<0.01	Absent	Absent	Absent
Municipal Tap, Bheemili	BML	Agreeable	Agreeable	8.3	414	<0.01	Absent	Absent	Absent
Bore Water, 12-20-163/1	BML	Agreeable	Agreeable	8.4	544	<0.01	Absent	Absent	Absent
Treated Water, NTR Srujala, Bheemili	BML	Agreeable	Agreeable	7.4	20	<0.01	Absent	Absent	Absent
Raw Water, NTR Srujala, Bheemili	BML NTR	Agreeable	Agreeable	7.8	518	<0.01	Absent	Absent	Absent
Consumer HH, Elc. Meter No. SC/532. Bheemili	BML	Agreeable	Agreeable	8.1	448	<0.01	Absent	Absent	Absent
Hand Pump, Bheemili, 17.895396,83.441998	BML	Agreeable	Agreeable	7.7	486	<0.01	Absent	Absent	Absent
Hand Pump, Bheemili, 17.895756,83.441863	BML	Agreeable	Agreeable	8.4	490	<0.01	Absent	Absent	Absent
HH, 12-20-59, Bheemili	BML	Agreeable	Agreeable	8	452	<0.01	Absent	Absent	Absent
HH, 12-20-63, Bheemili	BML	Agreeable	Agreeable	7.6	406	<0.01	Absent	Absent	Absent

[33]Samples with values above acceptable limits, as defined by IS 10500 (2012), have been highlighted.

Characteristics		Taste	Odor	pH	Total Dissolved Solids	Residual Chlorine as Cl	E. Coli	Thermo-tolerent Coliform Bacteria (Fecal Coliforms)	Total Coliforms
IS 10500 Acceptable Limit		-	-	6.5 to 8.5	500mg/L max.	0.2mg/L max.	Shall not be detectable in any 100ml sample		
IS 10500 Permissible Limits in Alternative Source		-	-	-	2,000mg/L max.	1mg/L max.			
Sample Description	**Area**	**Taste**	**Odor**	**pH**	**Total Dissolved Solids**	**Residual Chlorine as Cl**	**E. Coli**	**Thermo-tolerent Coliform Bacteria (Fecal Coliforms)**	**Total Coliforms**
HH, 12-20-59, Bheemili	BML	Agreeable	Agreeable	8.4	440	<0.01	Absent	Absent	Absent
HH, 12-20-27/11, Bheemili	BML	Agreeable	Agreeable	7.2	412	<0.01	Absent	Absent	Absent
Hand Pump, 23/12, Bheemili	BML	Agreeable	Agreeable	7.6	480	<0.01	Absent	Absent	Absent
School Source 1-ZPHS, Bheemili	BML	Agreeable	Agreeable	7.5	48	<0.01	Absent	Absent	Absent
School Source 2-ZPHS, Bheemili	BML	Agreeable	Agreeable	7.2	406	<0.01	Absent	Absent	Absent
HH, 11-1-6, Bheemili	BML	Agreeable	Agreeable	7.3	546	<0.01	Absent	Absent	Absent
HH, 11-1-4, Bheemili	BML	Agreeable	Agreeable	7.8	458	<0.01	Absent	Absent	Absent
Hand Pump, 17.894412,83.441572	BML	Agreeable	Agreeable	7.6	362	<0.01	Absent	Absent	Absent
Well (Open), 17.895070,83.491234	BML	Agreeable	Agreeable	7.7	796	<0.01	Absent	Absent	Absent
HH, 1-12-1, Bheemili	BML	Agreeable	Agreeable	7.2	964	<0.01	Absent	Absent	Absent
HH, 12-20-1, Bheemili	BML	Agreeable	Agreeable	7.9	960	<0.01	Absent	Absent	Absent
Hand Pump, Near Srujala, Bheemili	BML	Agreeable	Agreeable	7.6	834	<0.01	Absent	Absent	Absent
HH, 11-2-21/2, Bheemili	BML	Agreeable	Agreeable	7.6	1,052	<0.01	Absent	Absent	Absent
(K	BML	Agreeable	Agreeable	7.8	972	<0.01	Absent	Absent	Absent
Hand Pump, Bheemili, 17.894612,83443758	BML	Agreeable	Agreeable	8.3	992	<0.01	Absent	Absent	Absent
HH, 11-2-32, Bheemili	BML	Agreeable	Agreeable	7.2	470	<0.01	Absent	Absent	Absent
HH, 11-2-38, Bheemili	BML	Agreeable	Agreeable	7.1	536	<0.01	Absent	Absent	Absent
HH, Elec. 1324, Bheemili	BML	Agreeable	Agreeable	7.6	550	<0.01	Absent	Absent	Absent
HH, Elec. 1804, Bheemili	BML	Agreeable	Agreeable	7.4	518	<0.01	Absent	Absent	Absent
HH, Elec. 2133861, Bheemili	BML	Agreeable	Agreeable	7.7	390	<0.01	Absent	Absent	Absent
Hand Pump, 18/8, Bheemili	BML	Agreeable	Agreeable	7.1	578	<0.01	Absent	Absent	Absent
32-35-28, Kobbari Tota Tap Water (KTTW)	KOB	Agreeable	Agreeable	8.3	1,270	<0.01	Absent	Absent	Absent
32-35-143, KTTW	? KOB?	Agreeable	Agreeable	8	156	<0.01	Absent	Absent	Absent
32-28-8, KTTW	? KOB?	Agreeable	Agreeable	8	244	<0.01	Absent	Absent	Absent
32-28-7/1, Well Water 59	? KOB?	Agreeable	Agreeable	8	244	<0.01	Absent	Absent	Absent
32-32-125, KTTW	? KOB?	Agreeable	Agreeable	8.3	264	<0.01	Absent	Absent	Absent
32-34-148, KTTW	? KOB?	Agreeable	Agreeable	8	168	<0.01	Absent	Absent	Absent
32-32-113, KTTW	? KOB?	Agreeable	Agreeable	7.4	392	<0.01	Absent	Absent	Absent
32-30-155, KTTW	? KOB?	Agreeable	Agreeable	7.8	250	<0.01	Absent	Absent	Absent
32-31-207, KTTW	? KOB?	Agreeable	Agreeable	7.2	334	<0.01	Absent	Absent	Absent
32-1-88, Well Water	? KOB?	Agreeable	Agreeable	7.5	932	<0.01	Absent	Absent	Absent
32-35-74, KTTW	? KOB?	Agreeable	Agreeable	7.8	230	<0.01	Absent	Absent	Absent
32-35-77, KTTW	? KOB?	Agreeable	Agreeable	7.8	242	<0.01	Absent	Absent	Absent
Bore Well 53	? KOB?	Agreeable	Agreeable	7.6	250	<0.01	Absent	Absent	Absent
32-35-30, Tap Water	? KOB?	Agreeable	Agreeable	8	218	<0.01	Absent	Absent	Absent
32-35-101/A, KTTW	? KOB?	Agreeable	Agreeable	7.8	214	<0.01	Absent	Absent	Absent
32-9-23, KTTW	? KOB?	Agreeable	Agreeable	7.9	104	<0.01	Absent	Absent	Absent
32-9-80, KTTW	? KOB?	Agreeable	Agreeable	8.4	40	<0.01	Absent	Absent	Absent
32-9-77, KTTW	? KOB?	Agreeable	Agreeable	8.1	186	<0.01	Absent	Absent	Absent

Characteristics		Taste	Odor	pH	Total Dissolved Solids	Residual Chlorine as Cl	E. Coli	Thermo-tolerent Coliform Bacteria (Fecal Coliforms)	Total Coliforms
IS 10500 Acceptable Limit		-	-	6.5 to 8.5	500mg/L max.	0.2mg/L max.	Shall not be detectable in any 100ml sample		
IS 10500 Permissible Limits in Alternative Source		-	-	-	2,000mg/L max.	1mg/L max.			
Sample Description	**Area**	**Taste**	**Odor**	**pH**	**Total Dissolved Solids**	**Residual Chlorine as Cl**	**E. Coli**	**Thermo-tolerent Coliform Bacteria (Fecal Coliforms)**	**Total Coliforms**
32-9-37, KTTW	? KOB?	Agreeable	Agreeable	7.8	244	<0.01	Absent	Absent	Absent
32-9-32, KTTW	? KOB?	Agreeable	Agreeable	8	164	<0.01	Absent	Absent	Absent
32-9-70, KTTW	? KOB?	Agreeable	Agreeable	7.8	294	<0.01	Absent	Absent	Absent
32-9-16, KTTW	? KOB?	Agreeable	Agreeable	7.9	282	<0.01	Absent	Absent	Absent
32-9-18, KTTW	? KOB?	Agreeable	Agreeable	8	290	<0.01	Absent	Absent	Absent
32-9-7, Well Water	? KOB?	Agreeable	Agreeable	7.6	1,234	<0.01	Absent	Absent	Absent
32-9-8/1, Well Water	? KOB?	Agreeable	Agreeable	7.5	1,074	<0.01	Absent	Absent	Absent
32-9-90, KTTW	? KOB?	Agreeable	Agreeable	8	228	<0.01	Absent	Absent	Absent
32-9-93, KTTW	? KOB?	Agreeable	Agreeable	7	232	<0.01	Absent	Absent	Absent
32-9-94/4, KTTW	? KOB?	Agreeable	Agreeable	8	222	<0.01	Absent	Absent	Absent
32-33-126, KTTW	? KOB?	Agreeable	Agreeable	7.4	272	<0.01	Absent	Absent	Absent
32-33-124, KTTW	? KOB?	Agreeable	Agreeable	8.3	286	<0.01	Absent	Absent	Absent
32-1-88, KTTW	? KOB?	Agreeable	Agreeable	7.2	272	<0.01	Absent	Absent	Absent
32-9-83, KTTW	? KOB?	Agreeable	Agreeable	7.8	264	<0.01	Absent	Absent	Absent
NTR Sujala Raw Water	KOB NTR	Agreeable	Agreeable	7.3	152	<0.01	Absent	Absent	Absent
NTR Community Hall Bore Well	KOB NTR	Agreeable	Agreeable	7.2	716	<0.01	Absent	Absent	Absent
Allipuram Bore Well	KOB	Agreeable	Agreeable	7.6	614	<0.01	Absent	Absent	Absent
NTR Sujala Raw Water (AMC), Arilova Mustaffa Colony	MUS NTR	Agreeable	Agreeable	7.3	40	<0.01	Absent	Absent	Absent
Vivekananda Colony, AMC	MUS	Agreeable	Agreeable	7.7	330	<0.01	Absent	Absent	Absent
Priyadarshini Colony (Bore Well), AMC	MUS	Agreeable	Agreeable	7.1	770	<0.01	Absent	Absent	Absent
House Water (GVMC), AMC	MUS	Agreeable	Agreeable	7.9	280	<0.01	Absent	Absent	Absent
Balaji Nagar, House Tap, AMC	MUS	Agreeable	Agreeable	7.6	220	<0.01	Absent	Absent	Absent
Hand Pump, Balaji Nagar, AMC, 2/40	MUS	Agreeable	Agreeable	7	1,038	<0.01	Absent	Absent	Absent
House Bore Water, Balaji Nagar, AMC	MUS	Agreeable	Agreeable	7.1	950	<0.01	Absent	Absent	Absent
Community Hall, Balaji Nagar, AMC	MUS	Agreeable	Agreeable	8.1	360	<0.01	Absent	Absent	Absent
Tap Water, House, Balaji Nagar, AMC	MUS	Agreeable	Agreeable	7.7	454	<0.01	Absent	Absent	Absent
Hand Pump, Balaji Nagar, AMC, 2/42	MUS	Agreeable	Agreeable	7.1	1,202	<0.01	Absent	Absent	Absent
12-144, Tap Water House, Balaji Nagar, AMC	MUS	Agreeable	Agreeable	7.7	456	<0.01	Absent	Absent	Absent
13-1348/1, Tap Water House, MC	MUS	Agreeable	Agreeable	7.8	218	<0.01	Absent	Absent	Absent
MC Public Tank, GVMC	MUS	Agreeable	Agreeable	7.6	314	<0.01	Absent	Absent	Absent
13-1054 MC, Tap Water House	MUS	Agreeable	Agreeable	7.7	190	<0.01	Absent	Absent	Absent
2-93, Hand Pump, MC	MUS	Agreeable	Agreeable	7.7	698	<0.01	Absent	Absent	Absent
2-98, Hand Pump, MC	MUS	Agreeable	Agreeable	7	898	<0.01	Absent	Absent	Absent
Sai Chaitanya Public School, MC	MUS	Agreeable	Agreeable	7.8	310	<0.01	Absent	Absent	Absent
13-1059/1, House Tap Water, MC	MUS	Agreeable	Agreeable	7.7	322	<0.01	Absent	Absent	Absent

Characteristics		Taste	Odor	pH	Total Dissolved Solids	Residual Chlorine as Cl	E. Coli	Thermo-tolerent Coliform Bacteria (Fecal Coliforms)	Total Coliforms
IS 10500 Acceptable Limit		-	-	6.5 to 8.5	500mg/L max.	0.2mg/L max.	Shall not be detectable in any 100ml sample		
IS 10500 Permissible Limits in Alternative Source		-	-	-	2,000mg/L max.	1mg/L max.			
Sample Description	**Area**	**Taste**	**Odor**	**pH**	**Total Dissolved Solids**	**Residual Chlorine as Cl**	**E. Coli**	**Thermo-tolerent Coliform Bacteria (Fecal Coliforms)**	**Total Coliforms**
13-1042, House Tap Water, MC	MUS	Agreeable	Agreeable	7.6	286	<0.01	Absent	Absent	Absent
13-1062, House Tap Water, MC	MUS	Agreeable	Agreeable	7.6	288	<0.01	Absent	Absent	Absent
Plot No. 274, House Tap Water, MC	MUS	Agreeable	Agreeable	7.7	314	<0.01	Absent	Absent	Absent
13-1066, House Tap Water, MC	MUS	Agreeable	Agreeable	7.2	238	<0.01	Absent	Absent	Absent
13-1070, House Tap Water, MC	MUS	Agreeable	Agreeable	7.7	280	<0.01	Absent	Absent	Absent
13-1078, House Tap Water, MC	MUS	Agreeable	Agreeable	7.7	280	<0.01	Absent	Absent	Absent
13-1083, House Tap Water, MC	MUS	Agreeable	Agreeable	7.5	670	<0.01	Absent	Absent	Absent
Municipal School, Bore Water, MC	MUS	Agreeable	Agreeable	7.1	1,000	<0.01	Absent	Absent	Absent
MCV School, Tap Water, MC	MUS	Agreeable	Agreeable	7.9	264	<0.01	Absent	Absent	Absent
Arilova Community Hall, Hand Pump 235	MUS	Agreeable	Agreeable	6.9	440	<0.01	Absent	Absent	Absent
Arilova Govt. Hospital	MUS	Agreeable	Agreeable	7.8	260	<0.01	Absent	Absent	Absent
Arilova Area Water Supply Main Tank	MUS	Agreeable	Agreeable	8.2	186	<0.01	Absent	Absent	Absent
5-3-254, Jalari Pet (JP)	JPET	Agreeable	Agreeable	7.9	196	<0.01	Absent	Absent	Absent
Municipal Bore Water 1, JP	JPET	Agreeable	Agreeable	7	1,998	<0.01	Absent	Absent	Absent
Municipal Bore Water 7, JP	JPET	Agreeable	Agreeable	7.2	1,472	<0.01	Absent	Absent	Absent
5-4-7, House Water, JP	JPET	Agreeable	Agreeable	7.8	188	<0.01	Absent	Absent	Absent
5-4-11, House Water, JP	JPET	Agreeable	Agreeable	8	194	<0.01	Absent	Absent	Absent
5-4-16, House Water, JP	JPET	Agreeable	Agreeable	7.9	240	<0.01	Absent	Absent	Absent
5-3-37, House Water, JP	JPET	Agreeable	Agreeable	7.2	1,576	<0.01	Absent	Absent	Absent
5-3-155, House Water, JP	JPET	Agreeable	Agreeable	7.3	282	<0.01	Absent	Absent	Absent
Hand Pump No. 13, JP	JPET	Agreeable	Agreeable	7.1	1,846	<0.01	Absent	Absent	Absent
Hand Pump No. 17, JP	JPET	Agreeable	Agreeable	7.2	896	<0.01	Absent	Absent	Absent
5-3-128, House Water, JP	JPET	Agreeable	Agreeable	7.9	228	<0.01	Absent	Absent	Absent
5-4-71/1, House Water, JP	JPET	Agreeable	Agreeable	8	202	<0.01	Absent	Absent	Absent
5-4-75, House Water	JPET	Agreeable	Agreeable	7.7	242	<0.01	Absent	Absent	Absent
5-3-111, House Water	JPET	Agreeable	Agreeable	7.8	242	<0.01	Absent	Absent	Absent
5-3-118, House Water	JPET	Agreeable	Agreeable	8	238	<0.01	Absent	Absent	Absent
5-3-156, House Water	JPET	Agreeable	Agreeable	7.9	214	<0.01	Absent	Absent	Absent
5-3-125, House Water	JPET	Agreeable	Agreeable	7.1	202	<0.01	Absent	Absent	Absent
5-3-204, House Water	JPET	Agreeable	Agreeable	8	184	<0.01	Absent	Absent	Absent
5-3-208, House Water	JPET	Agreeable	Agreeable	7.8	186	<0.01	Absent	Absent	Absent
5-3-215, House Water	JPET	Agreeable	Agreeable	8	252	<0.01	Absent	Absent	Absent
5-3-222, House Water	JPET	Agreeable	Agreeable	8.3	234	<0.01	Absent	Absent	Absent
5-3-230, House Water	JPET	Agreeable	Agreeable	7.7	236	<0.01	Absent	Absent	Absent
5-4-25, House Water	JPET	Agreeable	Agreeable	8	234	<0.01	Absent	Absent	Absent
Hand Pump No. 20	JPET	Agreeable	Agreeable	7.2	1,224	<0.01	Absent	Absent	Absent

Characteristics		Taste	Odor	pH	Total Dissolved Solids	Residual Chlorine as Cl	E. Coli	Thermo-tolerent Coliform Bacteria (Fecal Coliforms)	Total Coliforms
IS 10500 Acceptable Limit		-	-	6.5 to 8.5	500mg/L max.	0.2mg/L max.	Shall not be detectable in any 100ml sample		
IS 10500 Permissible Limits in Alternative Source		-	-	-	2,000mg/L max.	1mg/L max.			
Sample Description	**Area**	**Taste**	**Odor**	**pH**	**Total Dissolved Solids**	**Residual Chlorine as Cl**	**E. Coli**	**Thermo-tolerent Coliform Bacteria (Fecal Coliforms)**	**Total Coliforms**
5-1-99, House Water	JPET	Agreeable	Agreeable	7.9	246	<0.01	Absent	Absent	Absent
5-1-214, House Water	JPET	Agreeable	Agreeable	7.8	218	<0.01	Absent	Absent	Absent
5-1-256, House Water	JPET	Agreeable	Agreeable	7.8	206	<0.01	Absent	Absent	Absent
5-2-20, House Water	JPET	Agreeable	Agreeable	7.9	214	<0.01	Absent	Absent	Absent
5-1-119, House Water	JPET	Agreeable	Agreeable	8	230	<0.01	Absent	Absent	Absent
5-2-29, House Water	JPET	Agreeable	Agreeable	7.7	358	<0.01	Absent	Absent	Absent
5-3-239, House Water	JPET	Agreeable	Agreeable	7.5	270	<0.01	Absent	Absent	Absent
2-31-93/1, House Water, Chukkavani Palem (CVP)	CHUK	Agreeable	Agreeable	8.5	1,996	<0.01	Absent	Absent	Absent
Well Water 1, CVP	CHUK	Agreeable	Agreeable	8.1	322	<0.01	Absent	Absent	Absent
2-31-130, House Water, CVP	CHUK	Agreeable	Agreeable	7.7	1,992	<0.01	Absent	Absent	Absent
2-31-131, House Water, CVP	CHUK	Agreeable	Agreeable	7.9	1,998	<0.01	Absent	Absent	Absent
2-31-132, House Water, CVP	CHUK	Agreeable	Agreeable	7.9	416	<0.01	Absent	Absent	Absent
Well Water 2, CVP	CHUK	Agreeable	Agreeable	8	282	<0.01	Absent	Absent	Absent
Well Water 3, CVP	CHUK	Agreeable	Agreeable	7.4	1,778	<0.01	Absent	Absent	Absent
2-31-121, CVP	CHUK	Agreeable	Agreeable	7.9	362	<0.01	Absent	Absent	Absent
Well Water, 2-31-126, CVP	CHUK	Agreeable	Agreeable	8.1	1,996	<0.01	Absent	Absent	Absent
Tiffine Center, 2-31-122, CVP	CHUK	Agreeable	Agreeable	8	1,994	<0.01	Absent	Absent	Absent
2-31-126/1, CVP	CHUK	Agreeable	Agreeable	8	374	<0.01	Absent	Absent	Absent
2-31-140, Well Water, CVP	CHUK	Agreeable	Agreeable	8.1	19,90	<0.01	Absent	Absent	Absent
2-31-141, House Water, CVP	CHUK	Agreeable	Agreeable	8.1	390	<0.01	Absent	Absent	Absent
2-31-93/4, House Water, CVP	CHUK	Agreeable	Agreeable	8.1	320	<0.01	Absent	Absent	Absent
GVMC School, Mindi	MIN	Agreeable	Agreeable	8.5	322	<0.01	Absent	Absent	Absent
Bore No. 65/1, Mindi	MIN	Agreeable	Agreeable	7.4	1,858		Absent	Absent	Absent
2-25-85, MCP School, Mindi	MIN	Agreeable	Agreeable	7.6	1,898	<0.01	Absent	Absent	Absent
Hospital, Mindi	MIN	Agreeable	Agreeable	7.4	1,720	<0.01	Absent	Absent	Absent
2-27-37, Well Water, Mindi	MIN	Agreeable	Agreeable	7.5	1,436	<0.01	Absent	Absent	Absent
Public Well, Mindi	MIN	Agreeable	Agreeable	8	1,990	<0.01	Absent	Absent	Absent
Mineral Water, Mindi School	MIN	Agreeable	Agreeable	8	198	<0.01	Absent	Absent	Absent
2-28-2, Houe Water, Mindi	MIN	Agreeable	Agreeable	8.5	790	<0.01	Absent	Absent	Absent
Community Hall, Mulagada	MIN	Agreeable	Agreeable	8.3	1,006	<0.01	Absent	Absent	Absent
Bore Well, Mulagada	MIN	Agreeable	Agreeable	8.2	1,002	<0.01	Absent	Absent	Absent
Public Well, Mulagada	MIN	Agreeable	Agreeable	8.4	1,532	<0.01	Absent	Absent	Absent
68-1-18, House Water, Mulagada	MIN	Agreeable	Agreeable	8.3	62	<0.01	Absent	Absent	Absent
68-1-120, House Water, Mulagada	MIN	Agreeable	Agreeable	8.2	186	<0.01	Absent	Absent	Absent
68-1-102/A, House Water, Mulagada	MIN	Agreeable	Agreeable	8.4	212	<0.01	Absent	Absent	Absent
68-1-99, House Water, Mulagada	MIN	Agreeable	Agreeable	8.3	210	<0.01	Absent	Absent	Absent
68-1-35, House Water, Mulagada	MIN	Agreeable	Agreeable	8.2	204	<0.01	Absent	Absent	Absent
Mineral Water, Mulagada School	MIN	Agreeable	Agreeable	8.1	78	<0.01	Absent	Absent	Absent

8.6 Water Quality Reports of 25 Parameters for Various Water Sample[34]

Characteristics		Color	Turbidity	pH	Electrical Conductivity	Total Dissolved Solids	Total Hardness as CaCO3	Non-Carbonate Hardness as CaCO3	Calcium Hardness as CaCO3	Alkalinity to Phenolphthalein as CaCO3	Total Alkalinity to Methyl Orange as CaCO3
Method		IS:3025 (pt-4)	IS:3025 (pt-10)	IS:3025 (pt-11)	SM2510-B	IS:3025 (pt-16)	IS:3025 (pt-21)	By calculation	By calculation	IS:3025 (pt-23)	IS:3025 (pt-23)
IS 10500 Acceptable Limits		5	1	6.5–8.5	-	500	200	-	-	200	200
IS 10500 Permissible Limits		15	5	6.5–8.5	-	2,000	600	-	-	600	600
Sample Codes	**Description**	Hazen	NTU	-	µs/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
3534/2	Treated Water, NTR WTP Plant	<5	<1	7.5	64	40	19.8	Nil	9.9	Nil	20.1
3534/3	Raw Water, NTR Srujana Plant	<5	<1	8.3	998	464	237.6	66.75	89.1	10.05	160.8
3534/6	Public Tap	<5	1.8	7.5	1,578	1,022	524.7	172.95	277.2	Nil	351.75
3534/17	Public Tap, 7W/4, AKP	<5	4.6	7.8	1,235	802	287.1	55.95	128.7	Nil	231.15
3534/20	Consumer House Water, Bore Well, 6-11-27	<5	6	7	1,959	1,272	732.6	340.65	504.9	Nil	391.95
3534/25	Treated Water, NTR Srujala, Bheemili	<5	<1	7.4	39	20	0	Nil	0	Nil	10.05
3534/26	Raw Water, NTR Srujala, Bheemili	<5	4	7.8	794	518	207.9	Nil	79.2	Nil	241.2
3534/41	HH, 1-12-1, Bheemili	<5	<1	7.2	1,465	964	534.6	182.85	128.7	Nil	351.75
3534/46	Hand Pump, Bheemili, 17.894612, 83443758	<5	2.6	8.3	1,526	992	405.9	Nil	69.3	40.2	381.9
3534/53	32-35-28 Kobbari Tota Tap Water (KTTW)	<5	2.3	8.3	1,954	1,270	504.9	Nil	138.6	190.95	452.25
3534/76	32-9-7, Well Water	<5	12	7.6	1,896	1,234	544.5	162.6	217.8	Nil	381.9
3534/85	NTR Sujala Raw Water	<5	1.5	7.3	232	152	0	Nil	0	Nil	50.25
3534/86	NTR Community Hall Bore Well	<5	5.1	7.2	1,103	716	465.3	113.55	198	Nil	351.75
3534/88	NTR Sujala Raw Water (AMC), Arilova Mustaffa Colony	<5	<1	7.3	62	40	0	Nil	0	Nil	20.1
3534/100	MC Public Tank, GVMC	<5	6.8	7.6	484	314	158.4	7.65	69.3	Nil	150.75
3534/113	Municipal School, Bore Water, MC	<5	3.1	7.1	1,538	1,000	554.4	222.75	207.9	Nil	331.65
3534/117	Arilova Area Water Supply Main Tank	<5	10.3	8.3	286	186	118.8	28.35	59.4	20.1	70.35
3534/126	Hand Pump No. 13, JP	<5	<1	7.1	2,840	1,846	1,108.8	636.45	564.3	Nil	472.35
3534/149	2-31-93/1, House Water, Chukkavani Palem (CVP)	<5	58	7.8	3,070	1,996	1,306.8	794.25	623.7	Nil	512.55
3534/152	2-31-131, House Water, CVP	<5	15	7.9	3,075	1,998	1,009.8	778.65	643.5	Nil	231.15
3534/160	2-31-140, Well Water, CVP	<5	18	8.1	3,063	1,990	940.5	628.95	643.5	Nil	311.55
3534/165	2-25-85, MCP School, Mindi	<5	103	7.6	2,921	1,898	1,138.5	937.5	643.5	Nil	201
3534/168	Public Well, Mindi	<5	2.1	8	3,062	1,990	1,217.7	865.95	811.8	Nil	351.75
3534/171	Community Hall, Mulagada	<5	3.8	8.3	1,548	1,006	316.8	15.3	108.9	30.15	271.35
3534/173	Public Well, Mulagada	<5	1	8.4	2,356	1,532	950.4	518.25	59.4	80.4	351.75

Excess turbidity leads to foul tastes, odors, and colors in water. It can pose a serious health concern when heavy metal ions, pesticides, or waterborne disease-causing organisms may attach to the suspended particles.

High TDS results in undesirable taste. It causes deposition of scale in valves and pipes, resulting in decreased performance of applications like boilers and cooling towers, water supply system, etc.

In the presence of calcium and magnesium, hard water can cause the formation of bladder stones. Also, it can lead to reduced lathering of soaps and buildup of scale on electric heating elements and boilers.

High alkalinity of water gives the water a soda taste while drying up the skin.

[34] Samples with values above acceptable limits, as defined by IS 10500 (2012), have been highlighted.

Characteristics		Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Chloride as Cl	Sulfates as SO4	Nitrates as NO3	Nitrites as NO2	Fluoride as F
Method		IS:3025 (pt-40)	IS:3025 (pt-46)	IS:3025 (pt-45)	IS:3025 (pt-45)	IS:3025 (pt-32)	IS:3025 (pt-24)	IS:3025 (pt-34)	IS:3025 (pt-34)	SM4500-D
BIS 10500 Acceptable Limits		75	30	-	-	250	200	45	0.02	1.0
BIS 10500 Permissible Limits		200	100	-	-	1,000	400	45	-	1.5
Sample Codes	**Description**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
3534/2	Treated Water, NTR WTP Plant	3.96792	2.40768	5.5	0.3	4.9	<1	6.0	0.01	<0.1
3534/3	Raw Water, NTR Srujana Plant	35.71128	36.1152	54.4	2.5	77.7	33.2	54.3	0.02	0.5
3534/6	Public Tap	111.10176	60.192	113	14.6	174.8	68.5	147.5	0.01	0.4
3534/17	Public Tap, 7W/4, AKP	51.58296	38.52288	141	18.4	165.1	59.2	111.0	0.01	0.3
3534/20	Consumer House Water, Bore Well, 6-11-27	202.36392	55.37664	96	30	204.0	165.5	152.3	0.04	<0.1
3534/25	Treated Water, NTR Srujala, Bheemili	0	0	8.3	1.3	4.9	1.1	1.8	0.01	<0.1
3534/26	Raw Water, NTR Srujala, Bheemili	31.74336	31.29984	79	10.1	72.8	17.5	37.2	0.22	0.6
3534/41	HH, 1-12-1, Bheemili	51.58296	98.71488	80.1	9.3	213.7	28.7	46.6	0.02	0.5
3534/46	Hand Pump, Bheemili, 17.894612,83443758	27.77544	81.86112	157	13	213.7	21.4	19.4	0.03	0.2
3534/53	32-35-28 Kobbari Tota Tap Water (KTTW)	55.55088	89.08416	194	40	199.1	14.6	47.4	0.05	1.7
3534/76	32-9-7, Well Water	87.29424	79.45344	162	40	218.5	124.7	158.4	0.03	0.2
3534/85	NTR Sujala Raw Water	0	0	48.1	8.5	24.3	1.6	34.9	0.02	<0.1
3534/86	NTR Community Hall Bore Well	79.3584	65.00736	33.6	10	72.8	35.7	70.1	0.02	0.5
3534/88	NTR Sujala Raw Water (AMC), Arilova Mustaffa Colony	0	0	13.4	1.7	4.9	0.2	0.3	0.01	<0.1
3534/100	MC Public Tank, GVMC	27.77544	21.66912	35.2	5.1	53.4	7.6	4.5	0.15	0.5
3534/113	Municipal School, Bore Water, MC	83.32632	84.2688	91.4	12.5	204.0	58.3	110.1	0.03	0.5
3534/117	Arilova Area Water Supply Main Tank	23.80752	14.44608	9.9	1.9	24.3	14.1	0.5	0.02	0.2
3534/126	Hand Pump No. 13, JP	226.17144	132.4224	138	8.6	262.3	234.9	412.2	0.03	0.3
3534/149	2-31-93/1, House Water, Chukkavani Palem (CVP)	249.97896	166.12992	95	17	276.8	534.9	86.0	0.06	1.3
3534/152	2-31-131, House Water, CVP	257.9148	89.08416	235	13	262.3	825.7	89.0	0.06	1.2
3534/160	2-31-140, Well Water, CVP	257.9148	72.2304	256	27	179.7	904.7	29.8	0.09	1.2
3534/165	2-25-85, MCP School, Mindi	257.9148	120.384	130	31	116.6	906.8	185.0	0.03	0.1
3534/168	Public Well, Mindi	325.36944	98.71488	125	32	194.3	858.1	12.7	0.02	0.1
3534/171	Community Hall, Mulagada	43.64712	50.56128	195	26.1	126.3	227.1	64.8	0.02	0.2
3534/173	Public Well, Mulagada	23.80752	216.6912	103	3	408.0	141.3	25.5	0.02	0.8

Excess calcium and magnesium in drinking water causes calcification of coronary arteries. Also, they are, to an extent, responsible for the formation of bladder stones.

Excess of chloride in drinking water causes various types of cancer, kidney and liver damage, immune system dysfunction, disorders of the nervous system, hardening of the arteries, and birth defects.

Cathartic effects (accelerated defecation) are commonly reported to be experienced by people consuming drinking water containing sulfate.

Excess of nitrate and nitrite in drinking water causes blue baby syndrome in infants, where the lack of ability by blood to carry oxygen to the body parts occurs. Nitrites and nitrates also cause cancer.

Excess fluoride causes dental fluorosis, which (when mild) includes white streaks and (when severe) can include brown stains, pits, and broken enamel.

Characteristics		Iron as Fe	Silica as SiO2	Arsenic as As	Total Coliforms per 100ml	Thermo-tolerant coliform bacteria (Fecal Coliforms)	E. Coli per 100ml
Method		SM 3125	IS:3025(pt-35)	SIM 3125	IS1622:1981	IS 1622:1981	IS 1622:1981
BIS 10500 Acceptable Limits		0.3	-	0.01	Absent		
BIS 10500 Permissible Limits		0.3	-	0.05			
Sample Codes	Description	mg/L	mg/L	mg/L	per 100ml	per 100ml	per 100ml
3534/2	Treated Water, NTR WTP Plant	<0.01	0.9	<0.01	Absent	Absent	Absent
3534/3	Raw Water, NTR Srujana Plant	<0.01	9.4	<0.01	Absent	Absent	Absent
3534/6	Public Tap	<0.01	10.4	<0.01	Absent	Absent	Absent
3534/17	Public Tap, 7W/4, AKP	<0.01	1.2	<0.01	Absent	Absent	Absent
3534/20	Consumer House Water, Bore Well, 6-11-27	<0.01	4.7	<0.01	Absent	Absent	Absent
3534/25	Treated Water, NTR Srujala, Bheemili	<0.01	0.3	<0.01	Absent	Absent	Absent
3534/26	Raw Water, NTR Srujala, Bheemili	<0.01	12.6	<0.01	Absent	Absent	Absent
3534/41	HH, 1-12-1, Bheemili	<0.01	7.9	<0.01	Absent	Absent	Absent
3534/46	Hand Pump, Bheemili, 17.894612,83443758	0.09	9.7	<0.01	Absent	Absent	Absent
3534/53	32-35-28 Kobbari Tota Tap Water (KTTW)	<0.01	3.4	<0.01	Absent	Absent	Absent
3534/76	32-9-7, Well Water	<0.01	6.1	<0.01	Absent	Absent	Absent
3534/85	NTR Sujala Raw Water	<0.01	1.2	<0.01	Absent	Absent	Absent
3534/86	NTR Community Hall Bore Well	<0.01	8.3	<0.01	Absent	Absent	Absent
3534/88	NTR Sujala Raw Water (AMC), Arilova Mustaffa Colony	<0.01	0.7	<0.01	Absent	Absent	Absent
3534/100	MC Public Tank, GVMC	<0.01	9.0	<0.01	Absent	Absent	Absent
3534/113	Municipal School, Bore Water, MC	<0.01	11.0	<0.01	Absent	Absent	Absent
3534/117	Arilova Area Water Supply Main Tank	0.04	3.0	<0.01	Absent	Absent	Absent
3534/126	Hand Pump No. 13, JP	0.16	13.1	<0.01	Absent	Absent	Absent
3534/149	2-31-93/1, House Water, Chukkavani Palem (CVP)	<0.01	5.8	<0.01	Absent	Absent	Absent
3534/152	2-31-131, House Water, CVP	<0.01	7.7	<0.01	Absent	Absent	Absent
3534/160	2-31-140, Well Water, CVP	<0.01	6.5	<0.01	Absent	Absent	Absent
3534/165	2-25-85, MCP School, Mindi	0.01	10.1	<0.01	Absent	Absent	Absent
3534/168	Public Well, Mindi	0.09	8.2	<0.01	Absent	Absent	Absent
3534/171	Community Hall, Mulagada	0.70	7.5	<0.01	Absent	Absent	Absent
3534/173	Public Well, Mulagada	<0.01	6.8	<0.01	Absent	Absent	Absent

Excess iron in drinking water leads to nausea, cramping, vomiting, and constipation.

8.7 Backup Calculations for Tanker vs. SWE Economics

Metrics	Tanker	SWE
LPCD	50	4
Operating cost (INR/L)	0.12	0.12
Daily operating cost	7,401	461
People served	1,000	1,000
Annual cost per unit	2,701,256	168,428
Price for consumer (INR/L)	Free	0.1
Water provided (in L)	50,000	4,000

Backup Calculations	
Tanker	
LPCD	50
Average tanker capacity (in L)	5,000
No. of people served in one trip	100
No. of trips per day if equivalent people have to be served	10
No. of tankers needed daily	3
Operating cost per tanker	
Driver charges daily	315
Tanker hourly rental	256
Hours of operation	8
Fuel charges per KM	11
Average distance per trip	10
Total daily cost per tanker	2,467
Total daily cost	7,401
Daily cost per L	0.12

Assumptions (from GVMC team)	
Driver charges daily	315
Tanker hourly rental	256
Hours of operation	8
Fuel charges per KM	11
Average distance per trip	10
No. of trips per tanker daily	4

Backup Calculations	
SWE	
LPCD	4
Plant capacity (liters per hour—LPH)	1,000
Hours of operation	5
People served	1,000
Daily can sales	200
Electricity tariff per unit (INR/kWh)	4
Electricity units consumed daily	34
Electricity cost daily	135
Daily contribution to AMC	67
Daily repairs expense	33
Filter expense	33
Daily expense on consumables	40
Plant operating cost daily	308
Daily operator salary	167
Daily total cost	475
Daily cost per L	0.12

Capital costs	
Plant cost	400,000
Civil works	200,000
Tanks	114,000
Purchase of distribution vehicle	100,000
Purchase of cans	45,500
Total	859,500

Assumptions (Safe Water Network)	
No. of cans carried per trip	40
Price at kiosk (INR/can)	2
Monthly contribution to annual maintenance contract (AMC)	2,000
Repairs expense	1,000
Filter expense	1,000
Consumables	1,200
Operator monthly salary	5,000
Electricity consumption (in kWh)	
Bore well motor	2
Raw water pump	1
Plant	3
Total units consumer per hour	7

8.8 List of Participants at Multi-stakeholder Discussion (March 23, 2015)

Organization	Designation	Name
Andhra University	Professor	Sampath Kumar
GVMC	AE	G.M.S. Kumar Raju
GVMC	AE	T.V. Satyanarayana
GVMC	APD, UCD	Venkat Raju
GVMC	Mobilizer, MEPMA	A.V. Ramana Rao
Rotary	Head	P.L.K. Murthy
Rotary	WASH Head	Mr. Rai
Association for Regional Tribal Development (ARTD)	Mobilizer	K. Jyothirmayi
ARTD	Mobilizer	K. Laxmi
Ion exchange	Manager—Sales	Kumar
Vizag Port Trust	Secretary	Naresh Kumar
Population Services International	Manager—Programs	G.K.V. Ravi Chandra
Sathya Sai Foundation	Mobilizer	Rajesh
King George's Hospital (KGH)	Superintendent Doctor	Dr. Sastry
GVMC	Officer, Visakhapatnam Aids Control Society (VACS)	Sasi Bhushan Rao
Ward 47	Ex-ward Councilor	Suhasini
Ward 46	Slum Level Federation (SLF) Head	n/a

8.9 List of People Interviewed

Organization	Designation	Name
GVMC	Commissioner	Pravin Kumar
GVMC	Chief Engineer	N. Durga Prasad
GVMC, Water Supply & Maintenance (WSM)	Superintendent Engineer	Moses Kumar
GVMC, WSM	Executive Engineer	Pallam Raju
GVMC, WSM	Assistant Engineer	G.M.S. Kumar Raju
GVMC, WSM	Assistant Engineer	T.V. Satynarayana
GVMC, WSM	Assistant Engineer	T. Mani Kumar
GVMC, WSM	Supervisor—Raiwada WTP Facility	Muttaiah
GVMC, WSM	Assistant Engineer	Veeraiah
GVMC, WSM	Works Inspector	Kiran
GVMC, Bulk Water Supply	Lead Contractor	Ramesh
GVMC, IT Contractor	Senior Database Administrator	Suresh
GVMC, IT Contractor	Senior Programmer	Satya
GVMC, Public Health	Chief Medical Officer	Dr. Raju
GVMC, RAY cell	Coordinator	N. Sarojini
GVMC, RAY cell	Mobilizer	Vijay Kant
GVMC, UCD	Project Director	Swaroop Rani
GVMC, UCD	Project Coordinator	Ram Babu
GVMC, UCD	Assistant Project Director III	R. Venkat Rao
GVMC, UCD	Assistant Project Director II	Naga Mani
GVMC, UCD	District Mission Coordinator, MEPMA	A.V. Ramana Rao
GVMC, Finance	Additional Commissioner	S.S. Verma
Telugu Desam Party	Assistant to MLA (East)	Siva
Telugu Desam Party	Assistant to MLA (East)	Sivaji
Andhra University	Professor	Sampath Kumar
VUDA	Chief Engineer	Jai Ram Reddy
District	Medical & Health Officer	Dr. J. Sarojini
King George Hospital	Superintendent	Dr. M. Madhusudhana
King George Hospital	Deputy Civil Surgeon	K.S.L.G. Sastry
NTR Sujala Kiosk	Operator, Burma Colony	K. Lavanya
NTR Sujala Kiosk	Operator, Mustapha Colony	Rekha Jyoti
NTR Sujala Kiosk	Operator, Nerella Koneru	Bhawani
NTR Sujala Kiosk	Operator, Bapuji Colony	GKM Lakshmi, Bagum
NTR Sujala Kiosk	Operator, Anakapalle	L. Mani
NTR Sujala Kiosk	Operator, Bheemili	K. Durga
SVS Sewa Society	Operator, SWE	Arun Kumar
Rotary International, Vizag Chapter	President (2014–15)	P.L.K. Murthy
Rotary International, District 3020	Chair, Water and Sanitation	B.K. Rai
Rotary International, District 3020	District Governor	Ch. Surya Rao
BS Chemicals—Water Quality Vendor for GVMC	Proprietor	Mr. Prasad
G.o.A.P.	Executive Engineer—CE Office in Charge	VRK Raju

ABOUT SAFE WATER NETWORK

Safe Water Network develops market-based, community-level solutions that deliver safe, affordable and reliable water to populations in need. We engage the diverse capabilities of our public- and private-sector partners to advance our model for broad replication, and document and share our insights through forums, workshops, and reports. Our operating footprint of over 150 safe water systems, providing safe water access to 600,000 people in Ghana and India, forms the basis for research and innovation to systematically address the challenges of local sustainability. Safe Water Network was co-founded in 2006 by actor and philanthropist Paul Newman, along with prominent civic and business leaders.

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