



Sanitation Capacity
Building Platform

Urban Wastewater Management in Karnataka

A City Level Sanitation Study
(Belagavi, Kundapura, Vijayapura)



National Institute of Urban Affairs



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Contents

FOREWORD	v
EXECUTIVE SUMMARY	vii
SECTION I	
Urban Sanitation Management in Belagavi.....	1
SECTION II	
Urban Sanitation Management in Kundapura	21
SECTION III	
Urban Sanitation Management in Vijayapura	37
SECTION IV	
Synopsis: Learning from Informal Sector.....	59
ANNEXURES	
Annexure I: Interview with stakeholders.....	86
Annexure II: Water Quality Tests	96
Annexure III: Census Data on Sanitation in Slums.....	100

Foreword

Sanitation Capacity Building Platform (SCBP) established in 2016 is a platform anchored by NIUA and works as a collaborative initiative of experts and organisations committed to the goal of sanitation to support and build the capacity of towns/cities to plan and implement decentralized sanitation.

The Platform lends support to Ministry of Housing and Urban Affairs (MoHUA), Government of India, by focusing on urban sanitation and supports states and cities to move beyond Open Defecation Free (ODF) status by addressing safe disposal and treatment of human faeces.

The Platform partners include Center for Water and Sanitation (C-WAS) at CEPT University, CDD Society and BORDA, ECOSAN Services Foundation (ESF), Administrative Staff College of India (ASCI), UMC, Centre for Policy Research (CPR), iDeck and WASHi. The Platform also engages and supports Nodal AMRUT accredited training institutions, universities, research organisations and NGOs. SCBPs work on faecal Sludge and Septage Management (FSSM) is a Bill and Melinda Gates Foundation (BMGF) supported urban sanitation programme initiative. It is a knowledge platform on decentralised urban sanitation. It is a resource centre for Learning and Advocacy Material, important Government Orders and Reports, Training Modules, Workshop Reports and other publications produced under SCBP and partner organisations.

ABOUT NIUA

National Institute of Urban Affairs (NIUA) is premier institute for research, capacity building and dissemination of knowledge for the urban sector in India. It is registered as an autonomous body under the Ministry of Urban Development, Government of India. NIUA conducts research in emerging themes such as urbanization, urban policy and planning, municipal finance and governance, land economics, transit oriented development, urban livelihoods, environment and climate change and smart cities. NIUA supports innovations in the urban sector through informed dialogues, knowledge exchanges, training and capacity building. In its mission to promote evidence-based policy-making and urban scholarship, NIUA is currently engaged in inter-disciplinary research

and proactive engagements with change agents, which involve projects that create & maintain digital interface solutions.

ABOUT THE STUDY

In order to understand the urban sanitation challenges in the Indian states, a field based research on septage and wastewater management was commissioned by NIUA. The states of Odisha, Madhya Pradesh, Karnataka and Telangana were selected for the study. Under this project 3 towns were also selected per state by the researchers for qualitative and quantitative assessment of current sanitation, septage and wastewater management. The ULB's institutional landscape and the major issues and challenges in these towns were analysed. Using the town wise findings, a state level perspective and understanding of urban sanitation management was obtained. The deliverable of the research will be used as inputs into the training material for the Sanitation Capacity Building Platform (SCBP).

The key research areas for the study were:

1. Status of septage containment, conveyance, disposal and treatment systems in each town.
2. Analysis of the sustainability and equitability of the existing and proposed sanitation services in the context of municipal finances and institutional structure of the ULBs.
3. The business and operational model for private sector operators with a special focus on profitability and their relationship with ULB.
4. Impact of unsafe disposal and lack of treatment of wastewater and faecal sludge on ground water and surface water bodies.
5. Possible improvements that can be brought about in septage and wastewater disposal in terms of provisioning and governance in urban areas of the state and towns.

This document provides a synopsis of different informal sector businesses in the three towns and their relationship to the municipality. Further it illustrates (through the case of the Vijayapura Town) how the application of the Sanitation Safety planning process can forge a response of a municipality to this sector with the eventual aim of achieving universal sanitation services, resource recovery reuse and public & environment health management. In the process livelihoods are also generated and strengthened. The research is based on primary data collected from these three towns and its contextualization and assessment at the state level. Municipal and ULB norms, actual operations of ULBs and government departments were studied along with an analysis of the budgets and expenditures of ULBs related to sanitation and water supply.

Executive Summary

Learnings from the informal sector in Urban WATSAN of Karnataka

In Karnataka, Belagavi, Kundapura and Vijayapura were selected for studying existing sanitation situation with a focus on the role of informal sector in this space. Given inadequacies and gaps in municipal service provision, there is a market response to these gaps. A very significant part of this market response are small informal enterprises that fill these gaps. These informal enterprises are found both in the water and sanitation spaces – common examples are water tankers, “honey suckers” or vacuum trucks that evacuate onsite sanitation systems and farmers using fecal sludge as fertilizer in different ways. Less commonly acknowledged examples, though equally prevalent are ring makers for pit toilets, wastewater irrigation service provision enterprises and vegetable fresh-water based washing enterprises. These enterprises not only fulfill service provision needs, they achieve resource recovery and reuse. Furthermore, they represent livelihoods, often for many poor people. The question usually raised is are the practices of these enterprises safe? The key research questions are (a) What are the useful lessons to be learnt from the solutions of the informal sector and (b) given such a wide spread prevalence informal sector can municipal policy achieve service provision, public health, resource recovery/reuse and livelihood all of them together.

This report from the observations of these towns reflects on the above questions and possible practical ways Municipalities can respond. The report can be summarized as:

- a. In all three towns, there is very significant dependence on groundwater for drinking and non-drinking purposes. Therefore, groundwater contamination is an important route for health risks to realize. Thus maintaining groundwater quality should be an important objective of sanitation systems. In Vijayapura risks are low due to the low groundwater table. However both in Belagavi and Kundapur risks need to be monitored carefully as water tables are high.
- b. There is significant existing and high potential of reuse of wastewater in irrigation in and around Vijayapura and Belagavi. Instances of reuse of wastewater by farmers in these towns have been documented. What is

also seen is a conscious choice of lower risk crops by farmers, hygiene practices by farmers to ensure their own safety and in some cases conscious irrigation practices to ensure safe use of wastewater. What is also observed in Vijayapura is the washing of produce with freshwater before it is sent to the market thus reducing the health risks for consumers greatly. Further most of this produce has further risk barriers built-in such as peeling, washing and cooking at the consumption end before it is actually ingested by humans.

- c. Treated faecal sludge is used as fertilizer for agricultural by farmers in Vijayapura and potentially in Belagavi towns. Here again farmers have developed practices of use of fecal sludge in a way that significant hazards are reduced when actually applied to crops. Fecal sludge is usually composted and used or spread across fields during sowing time and given adequate time to dry.
- d. Kundapur, a coastal town has a culture of open wells and pit toilets in dwellings. It is a place with abundant rainfall and very high water table. It also has a history of investment in piped water supply system which has gained limited acceptance by its people. Therefore investments in centralized “piped” infrastructure thinking may be of limited value and has to be accompanied with management of onsite systems. Wastewaters and sludge are currently being discharged through informal small scale piped sewers into the estuary without treatment – however the tidal cycles just draw the wastewater into the sea without causing local environmental or health issues.
- e. Other important informal sector players are ring-makers preparing concrete circular rings for pits and septic tanks. They could be useful players in the supply chain to help enforce better onsite sanitation systems.

Key recommendations for the towns would be

- a. Adequate drinking water quality monitoring to check if wastewater is contaminating drinking water sources – very importantly including public and private sources of water from groundwater. As a practice this is broadly missing in all towns.
- b. Regular coorelation between health data (eg: cases of water borne diseases) and water quality to be done – this is a missing practice.
- c. In Vijayapura solid-waste chokes open drains where wastewater flows. So solid waste management should be given importance to clear up the open drains which the UGD opens out into. It should also ensure its water supply pipes do not contaminated in the open-drains where solid waste chokes wastewater flows. Vijayapura can engage with its farmers, evolve and communicate a “safe and best practices for irrigation with wastewater & reuse of fecal sludge” culture locally. Experts from agriculture can be consulted to help evolve these best practice protocols. This can be monitored

by the town municipality periodically. Private honeysuckers can be asked to register with the municipality and discharge their trucks with specified farmers known to follow good irrigation and fecal sludge practices. These set of recommendations for Vijayapura are detailed out as a part of this report.

- d. Belagavi needs to address discharge of untreated industrial effluent on a high priority basis. This would address its highest risk.
- e. Kundapura has to monitor its groundwater quality across the town regularly and engage with its citizen through public messaging about where groundwater quality is good and where it is not. In this way it will leverage its existing investment in piped water supply for best health benefits.
- f. All towns will greatly benefit with better enforcement through building bye-laws for better designed onsite sanitation systems.
- g. Most importantly all these towns could adopt the Sanitation Safety Planning Methodology as a tool to plan and improve its sanitation systems incrementally and continuously. This methodology allows towns to recognize where the maximum health and environment risks are in their existing systems and prioritise interventions and investments in sanitation so that adequate risk barriers are created thus protecting public health and environment. This also ensures maximum return on sanitation investment. Further it helps integrate and recognize informal sector contributions when the risk they represent is not high, but will point towards corrective actions should they begin to represent higher risks.

Section I

Urban Sanitation Management in Belagavi

Brief Introduction

Belgaum/Belagavi a City Municipal Corporation in North Karnataka is one of the oldest cities in the state. It is situated at the border of Karnataka, Maharashtra and Goa. It is Located at the foothills of Western Ghats, rivers such as Ghataprabha and Markhandeya flow close to the city from which most of the water is supplied. Belagavi was selected as a “Smart City” under the Smart City Mission in 2016.

Map 1: Location of Belagavi in the state of Karnataka



Perhaps the “smartness” of this city lies significantly in the revival of its ancient open wells. Historically, nearly half of Belagavi’s water supply was met through water from the fabled “Congress Well”. After the introduction of piped water, most of Belagavi’s open wells fell into disuse. Interestingly, since 2004, 21 high-yielding wells, and 41 smaller wells have been revived by the local government in a participatory manner. Today, water from these wells constitutes 15% (20,600 KLD) of municipal water supply and significantly contribute to the water resilience of the city. The private/informal sector in the city also significantly contributes to both water supply services and sanitation. It is estimated that nearly 25% of the water demand is met from informal sources of water. About 97% of the households have toilets while 3% of the households

do not have toilets. Nearly 48% of the total households in the city are connected to the underground drainage (UGD) system which is connected to the “Bellary nala” — a stream that eventually joins the Ghataprabha River. The rest of the household with toilets (i.e. 48% of the households), have on-site sanitation systems. The municipal and private honey-suckers, which empty the on-site sanitation systems, dispose of the sludge into the Bellary nala. Wastewater from the nala is currently used by farmers to fertigate agricultural lands.

1. About the Town

Belagavi is governed by a City Municipal Corporation which has 60 wards. It is the District Headquarters of Belagavi District. This city town is spread over 99.61 sq. km (9961 hectares). It is located at 15.8497° N, 74.4977° E.

2. Demography

As per the population Census 2011, there are total 1,11,874 families residing in the Belgaum City and the total population is 490,045. The average sex ratio is 988 females for 1000 males.

The population of Children of age 0-6 years in Belagavi City is 52,649 which is 11% of the total population. The Child Sex Ratio of Belgaum is 935 which is less than Average Sex Ratio (988). The literacy rate of Belgaum is 89.8%, which is higher compared to national literacy rate of 85% (DCO, 2014)¹.

According to the estimates given by the CMC, the current population is 5,65,000 and there are 1,15,883 households.

Table 1: Demography of Belagavi

Population						No of households		Literacy			Workers			
Total	F	M	SC	ST	Slum	Total	Total (%)	F (%)	M (%)	Total (%)	F (%)	M (%)		
4,90,045	5,65,000 *	2,43,5084	2,46,537	38,404 (7.8%)	15,997 (3.3%)	57,902	1,11,874	1,15,883 *	89.25	84.97	93.46	34.95	14.2	55.5

Source: Census 2011

*Current Estimate: Source: Ministry of Urban Development. 2015 “India Smart City Profile: Belgaum)

3. Climate

Belgaum is situated at an altitude of 758 meters and witnesses an average rainfall of 1,250 mm a year. The maximum rainfall recorded is 2,017 mm and minimum of 770 mm. Belgaum has a tropical climate with temperature in summers rising up to about 34°C and in winters the temperature drops to about

¹ Directorate of Census Operations. (2014). District Census Handbook: Belgaum.

12°C. The region lies in the Northern Dry Zone and has black clayey and sandy loamy soil².

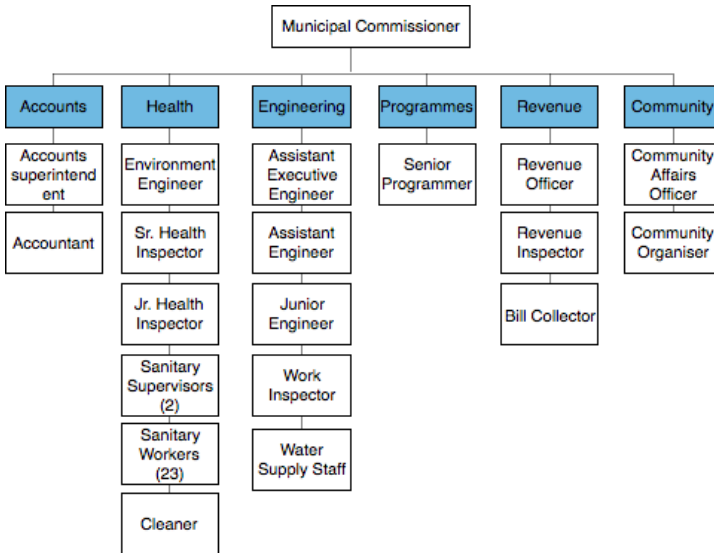
4. Economy

Maize, jowar, rice, bajra and wheat are the major cereal crops of the city, groundnut, sugarcane, cotton, soyabean and tobacco are the main cash crops. Major industries here include chemicals, drugs and pharmaceuticals, ink, paints, varnishes, insecticides and fertilisers. An important commodity manufactured here is groundnut oil.

5. CMC Institutional Structure

Belagavi CMC has an elected governing body consisting of 60 ward representatives (Councillors) and the council is headed by an elected Mayor. The administrative structure is headed by an appointed KAS cadre commissioner. The structure includes Environmental Engineer, Engineers, Health Inspectors, Community Organisers and Revenue Officers. The Karnataka Urban Water Supply and Drainage Board (KUWSDB) is in charge of the infrastructure and water supply. KUWSDB, Belagavi is headed by Executive Engineer.

Figure 1: CMC Institutional Structure



² Karnataka State Department of Agriculture. 2017. "Agro Climatic Zones of Karnataka." Accessed August 17. www.raitamitra.kar.nic.in/stat/kacz.htm.

6. Water

The region around Belagavi City is forested. Hence the groundwater table in Belagavi City is high. Shallow aquifer is prevalent and can range from from 5 — 20 ft deep. Historically, this city was dependent on groundwater through open wells for its needs. As the city started growing, during the British rule many open wells were dug to meet the additional demand. After independence, the city got access to piped water by accessing the water of Rakaskop Dam of Markandeya River in the year 1960. Interestingly, at that time the citizens were not interested in using piped water. To promote piped water supply, the then administration closed many wells. In the year 1995, the Rakaskop reservoir dried. Dr. M. Vishveshwarayya who designed the Rakaskop reservoir had mentioned in the preamble to his report that Belagavi water supply can be maintained by a chain of wells. During the crisis of 1995, the city administration started looking for alternate sources of water supply and started reopening the closed wells. Since 2004, 24 high-yielding wells, and 55 smaller wells have been revived by the local government in a participatory manner. Today, water from these wells constitutes 20% (20,600 KLD) of municipal water supply and significantly contribute to the water resilience of the city.

6.1 Water Sources

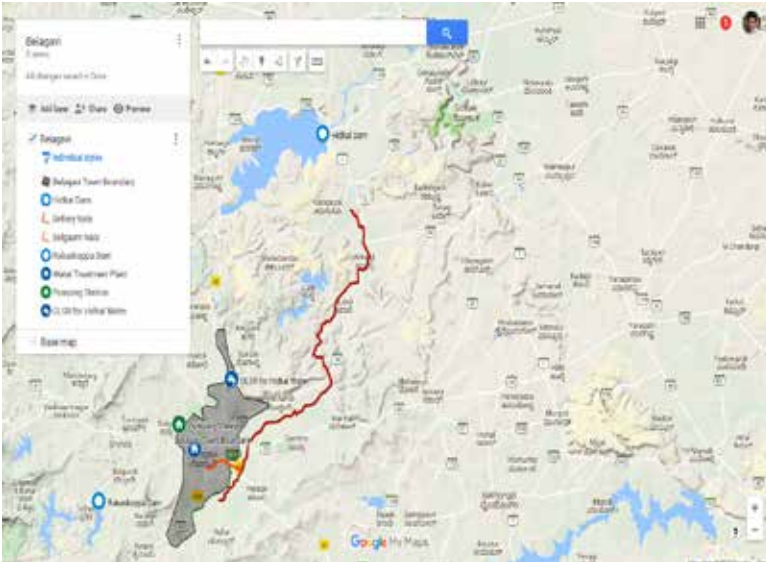
A. Surface Water

Reservoirs of the Rakaskop Dam on the Markandeya River and Hidkal Dam constructed over Ghataprabha River are the largest source of the water supply to Belagavi. Together, a total of 81,829 KLD (81.82 MLD) of water is supplied from these dams, which constitutes 78% of the total supply. Apart from this, 27,276 KLD (27 MLD) is also supplied to the beneficiaries like Hindalco, TATA Power, Air Force Office (Sambra), MES and Grama Panchayats residing on the supply line.

Figure 2: Rakaskop Dam on Markandeya River is a major source of municipal water



Map 2: Surface Water Structures in Belagavi



B. Groundwater

i. Municipal Open Wells

The uniqueness of Belagavi lies in the fact that the CMC revived ancient open wells from which 20,600 KLD (~20 MLD) of the water is supplied. The open wells contribute to 20% of the water supply. The CMC has revived 79 big and small size old wells.

Figure 3: Congress well built in 1924 for a Congress Convention chaired by Mahatma Gandhi. It has been reviewed and is now being used for municipal water supply.



ii. Municipal Borewells

Around 2,024 KLD (2 MLD) or 2% of total water consumption is met from 852 borewells fitted with power pumps.

iii. Private Open Wells

With an assumption that there is nearly one well for 500 HHs, a total of 200 wells each supplying 20 KLD³, it is estimated that 4,000 KLD (4 MLD) of the water needs are met by private open wells.

iv. Private Borewells

Assuming there are around 10,000 private borewells – i.e. one borewell for every 10 houses - supplying 3 KLD⁴ each, the total supply is estimated to be 30,000 KLD (30 MLD). This accounts for 23% of the city's water supply.

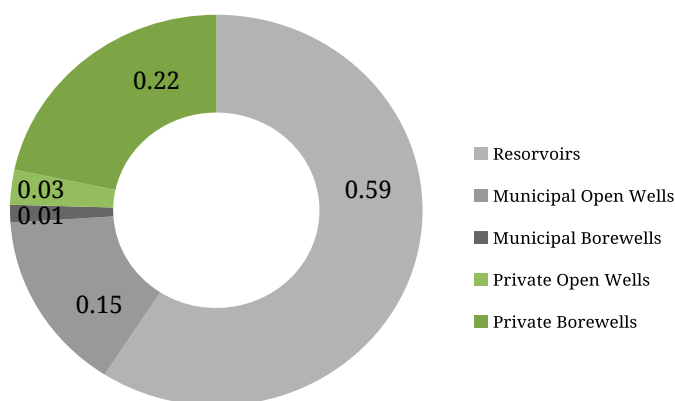
Thus, the private or the informal sector contributes to 25% of Belagavi's water supply.

6.2 Water Supply

A. Municipal Piped Water

Belagavi City Municipal Corporation currently supplies 81,829 KLD of water from the Rakaskop and Hidkal dams. Additional 22,624 KLD, i.e., 22% of the total municipal supply and 16% of the city's total water supply is sourced by the KUWSDB from the city's open wells and borewells. However

Figure 4: Water Sources in Belagavi



³ Since data is not easily available for the informal sector / private sector contribution to water supply, for the current estimate it is assumed each well is contributing 20 KLD. This can be refined based on sampling of different wells and their per day yields.

⁴ Similarly it is assumed each bore-well is contributing around 3KLD.

transmission and distribution losses in Belagavi’s piped water supply is estimated to be 28%⁵. The city claims to have achieved 24*7 water supply in 10 wards and supply of water once in 4 days in 46 wards.

B. Municipal Tankers

The Municipal Corporation has only 3 tankers. One is used for cleaning public toilets and 2 as stand byes to supply drinking water if need arises in the city.

C. R.O. Plants

Belagavi CMC has installed around 40 R.O. plants throughout the city. They provide 780 KLD of treated drinking water.

D. Private Tankers

There are around 120—150 private water tankers in the city who source water from private open wells and bore wells.

The water supply therefore can be summarised as below:

Table 2: Water Supply Summary

Water Supply (in Kilo Litres per day)			
Source	Municipal	Private	Total
Surface Water	81,829		81,829
Open wells	20,600	4,000	24,600
Borewells	2,024	30,000	32,024
Total	104,453	34,000	1,38,453
Distribution losses at 28% (Unaccounted for Water)	29,247	-	-
Actual supply achieved	75,206	34,000	1,09,206
Actual LPCD	133	60	193

While the LPCD calculated above as per the supply numbers is arriving at 133 LPCD, Belagavi has declared that it supplies at 110 LPCD with 28% unaccounted for water in its submission of application to the Smart City.

6.3 Water Demand

Since Belagavi has underground drainage supply, water demand for the city should be at 135 lpcd. In addition to the domestic demand for water in Belagavi there is a significant economic/industrial demand for water in and around the city. Broadly the following table summarises this demand.

⁵ The figure of 28% Transmission and Distribution losses is used from the Smart City Self-assessment scenarios.

Table 3: Water Demand

Type of demand	Demand in LPCD	Total in MLD
City demand - Domestic	135 LPCD	76.27 MLD
City demand - Non-domestic	65 LPCD	36.72 MLD
Industrial demand	--	27 MLD
Grand Total	200 LPCD	140 MLD

6.4 Water Quality

At the overall level, water quality monitoring seems to be conducted at the supply level and at the distribution level. There is no evidence of the town making pro-active connections of health data and diseases data with water quality monitoring. The following about water quality monitoring are observed:

1. The pumping station at Hindalga has a water treatment plant at Laxmi Tekadi. Data needs to be gathered on the water quality and the parameters that are tested here.
2. Each municipal well is fitted with a mini water filtration plant. The treated water is supplied through regular pipe network. However, the presence of such a water treatment system for surface water needs to be ascertained.
3. Many homes in Belgaum that have open wells also have onsite sanitation systems. Most of the households have septic tank models, even though due to the shallow aquifer, there is a risk of these open wells being contaminated. Such areas need to be identified to see if the water quality is compromised.
4. Point of use treatment is happening in commercial establishments and most of the households.


Figure 4: Each open well has been installed with mini water filtration plants which consists of sand filter, alum and chlorine dozer



Figure 5: Regular tests are conducted to monitor the water quality of surface and groundwater

Physical, Chemical and Bacteriological Analysis Results of Tilakwadi Congress Well Water Samples

Sl. No	Characteristics	Result of Well water sample	Result of filter water sample	Acceptable Limit	Cause for Rejection	REMARKS
		9.5.2008	9.5.2008	9.5.2008	9.5.2008	
1	Turbidity (NTU)	2.2	1.2	1.0	10.0	
2	Taste and Odour	Un-objectionable	Un-objectionable	Un-objectionable	Un-objectionable	
3	pH	6.60	6.7	7.0 to 8.5	<6.5, >8.2	
4	Total dissolved solids (mg/l)	220.00	220.00	500.00	2000.00	
5	Total hardness (as CaCO ₃) (mg/l)	118.00	118.00	200.00	600.00	
6	Chloride (as Cl) (mg/l)	46.00	46.00	200.00	1000.00	
7	Sulphates (as SO ₄) (mg/l)	17.30	17.3	200.0	400.00	
8	Alkalinity (as CaCO ₃) (mg/l)	103.00	100.00	200.00	600.00	
9	Magnesium (as Mg) (mg/l)	7.80	7.80	<30	150.00	
10	Calcium (as Ca) (mg/l)	34.5	34.5	75.0	200.00	


 Assistant Executive Engineer
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 Belgaum.

7. Sanitation

7.1 Number of Toilets

A total of 1,12,407 households, i.e., nearly 97% of the households in the city have toilets. Of the houses with toilets, around 52% of the households have onsite sanitation systems. The remaining 48% are connected to the underground drainage system.

Table 4: HHs with and without toilet in Bellary

Total Households	1,15,883.00
Households with Toilets	1,12,407.00
Households without Toilets	3,476.00

7.2 Underground Drainage

Of the household with toilets, around 48%, i.e. 53,955 households, are connected to underground drainage. Sewerage from the underground drainage is discharged into Lendi nala through gutters and sewer lines, which ultimately joins the Bellary nala. This Bellary nala is a perennial stream which originates in the hills of Yellur and Damne near Belgaum. It flows for 30 km through

industrial areas, villages and farmlands and ultimately joins Markandeya River. However, apart from domestic sewerage, industrial effluent too is released into the Bellary nala.

Figure 6: An underground drainage chamber opening into the Belgaum nala



According to a study conducted on the water quality of Bellary nala in 2015 – based on 13 water quality parameters that were tested - the stream was found to be significantly contaminated with pollutants. Parameters such as total dissolved solids (TDS), total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorides and oil and grease: their concentrations were significantly more than the desirable limits⁶.

The farmers on both sides of the Bellary nala pump this water to their fields to grow Sugarcane, Paddy, Cucumber and Coriander. One farmer confirmed the presence of solid waste including plastic, sanitary waste, syringes, etc.

7.3 On-site Sanitation

Around 58,451 i.e., 52% of the households with toilets are not connected to the underground drainage. The CMC has 2 honey-suckers, and 1 jetting machine. There's only one private honey-sucker, which operates outside the city limits. The residents apply to the municipality for cleaning their septic tanks. The CMC charges ₹1,500 within the city limits and ₹2,500 outside the city.

⁶ Koppad, R., Purandara, B. K., & R, S. (2014). Water Quality Assessment of Bellary nala, Belgaum. In All India Conference on Waste Management & Pollution Control. <http://doi.org/10.13140/2.1.1055.0088>

The work of clearing blocked UGD chambers is the high priority. The honey-suckers discharge the collected waste into the UGD lines. Outside the city it is discharged directly into Bellary nala. The faecal sludge is very rarely deposited on the farms.

Figure 7: A Honeysucker Discharging Faecal Sludge Into The UGD



7.4 Water & Sanitation in slums

Belagavi has a total of 51 slums, of which 19 are undeclared. A total of 57,902 people i.e., around 10% of the people live in slums. There are 12,082 households. All slums occupy a total of 2.337 sq. km of the city area⁷. Water is supplied through public taps and water tankers. Nearly 60% of the slum households have individual septic tanks and 4% have individual pits. A small population of 5% has access to shared septic tanks. Another 5% use public septic tanks while 1% use public pits. Open defecation is practiced by 20% of the slum population⁸. Data and information about the use of public and shared toilet facilities is still in progress – challenges around these are emerging. Some undeclared slums or squatter colonies are identified as having no access to toilet facilities.

A Brief Profile of Solid Waste

The city generates around 200 tonnes of solid waste every day. The CMC processes the waste at the 66 acres Turmuri plant, which is around 15 km from

⁷ Belgaum City Corporation. (2015). Public Disclosure Document.

⁸ Administrative Staff College of India. (n.d.). City Sanitation Plan — Belgaum.

the city. This plant has a capacity to manage 210 MT wet waste. The plant has a leachate collection tank and a treatment plant of 30 KL capacity. The CMC has outsourced collection and transportation of solid waste to 47 out of 58 wards to private vendors. Remaining 11 wards are handled by the CMC itself. The private vendors and CMC put together have 54 tippers and 6 compactors. Almost 90% of the waste is collected door to door. Segregation at source is happening in pockets.

Figure 8: A Typical Solid Waste Collection Drive



8. Smart City: Proposals for Water and Sanitation

An STP of 75 MLD capacity at a cost of 156 crores is being proposed to treat the sewerage flowing into the Lendi nala. The CMC has identified a place in Halaga village. There is resistance to this among the villagers who are demanding that the STP be shifted to Alarwad village.

Under the Smart City projects self-assessments, Belagavi has used the example of its engagement with citizens for the revival of old-wells as a way citizens have participated in the city's governance. Overall on the water and sanitation front, Belagavi has expressed the ambition under the Smart City scheme, to become a 24*7 fully water-metered water supply city. It has also expressed that it will undertake management of storm-water for flood management, local water body conservation and groundwater recharge. Further it aims to have 100% sanitation coverage with all sewerage treated by an STP and atleast some reuse of waste-water. It also aims to become a city which is capable of foreseeing any potential disease outbreaks to take mitigating and preventive measures. What does all this really mean in the Belagavi context is a critical question.

A total of 69 projects were proposed for the Smart City Mission. The ones related to water and sanitation are listed below as per the listing in the document given in the Smart City website. It is unclear why 24x7 water supply and “smart metering” have been given under two heads with different budgets. A total

of 782.5 crores have been earmarked for projects under water supply and sanitation.

Table 5: Smart City Project Cost

Sl. No.	Project	Cost (Rs. in Crores)
1	Solid Waste Management	46
	- SWM including RDF plant	8
	- Integrated SWM	38
2	Ground water management	11
	- Improvements of lakes	10
	- Rain water harvesting in parks and gardens	1
3	Water Supply	498
	- 24 x 7 water supply and smart metering	9
	- Smart metering Water Supply	53
	- 24 x 7 Water Supply - Phase I	427
	- Road side drinking water kiosks	9
4	Sanitation	227.5
	- Public urinals and toilets	1.5
	- Construction of STP, Uncovered UGD, Improvements / Rehabilitation of sewer lines	156
	- Primary and secondary storm water drains	70
	Grand Total	782.5

9. The Informal Sector and their Business Models

9.1 Well Owners

In Belagavi City, the water table is as shallow as 5 ft at some places. The shallow aquifer is accessible generally, at a depth of about 20 feet. Several well owners in Belagavi supply an estimated 4,000 KLD of water to tankers (see section on water sources and supply). One of the well owners who was interviewed employs a manager whose job is to meticulously maintain records of the number of loads filled up while supplying water to the tankers. Many private well owners sell water to private tankers at ₹50—100 per load which can range from 2000 — 6000 L. This is typically supplementary source of income for the well owners. These well owners report that owing to regular pumping of water from the wells, the quality of water from the wells is very high. Further studies are required to estimate the number of private well owners.

9.2 Private Water Suppliers

There are around 120—150 private water tankers in the city. They source water

from private wells. The charges are between ₹180—500 for each tanker, with capacities ranging from 2000 — 6000 L capacity. They supply water to commercial establishments, swimming pools, hostels, industries and individual households. The water demand of floating population, students from outside town/state, healthcare services and the hospitality industry is met by these private water suppliers. These water tankers provide livelihoods to around 300—350 people.

Figure 9: Private Water Tanker



9.3 Private Honey-Sucker Operators

Belagavi city has one only private honey-sucker operator, who employs three people in his business. For a manager, driver and a cleaner, the total monthly payout is around ₹20,000. This lone machine operates largely in Kakati area in the outskirts of Belagavi. Sometimes he gets orders from city or from the CMC (as he has the lengthiest pipe). He charges in the range of ₹1,800 — 2,200 per operation. He has been in this business for nine years. Faecal sludge is deposited in open areas or on private farmlands.

9.4 Farmers

Farmers along the Bellary nala use the water for fertigating their lands. Interviews with a few farmers revealed that this water has great “power” but it is not suitable for all crops. Farmers using wastewater for farming have learnt a lesson on choice of crops over the years. They grow sugarcane, paddy, coriander and cucumber.

Farmers also claim that washing animals with this water helps in killing the skin parasites. However, the effect of this water on the animal itself is not observed by them. They also encounter a lot of solid waste, which they

separate by attaching a plastic mesh to the foot valve, which collects the solid waste. The biggest concern they expressed was encountering medical waste such as syringes.

A study on the impacts of this on the quality of soil and crops showed that the heavy metal concentrations of Fe, Zn, Cr, Ni, Pb were well within the limits in water. However, in the soil, iron and zinc were slightly above permissible limits. This study also studied effects on two crops — carrots and chilli and found that the quantity of Nickel was above the permissible limits.⁹

Some entrepreneurial farmers pump this water to other farmers as far as 10—15 km and charge them ₹40—50 per hour.

These farmers play a crucial role in sanitising wastewater flowing from the Bellary nala to the river.

Figure 10



Barma Halagekar, one of the farmers who used wastewater for irrigation

Figure 11



Basavaraj Onrotti not only used wastewater to irrigate his land but also pumps this water as far as 10-15 km and charges the farmers ₹ per hour

10. Risks & Challenges

Belagavi, is blessed with both surface and groundwater. It also has a heritage of public open wells. Belagavi has come a full circle by switching from open wells for water to infrastructure-centric surface water supply, and now back to a slow but steady revival of wells. Consumption metering and increasing block tariff is yet to take place. There is an informal sector that supplies and supplements the city's water supply – this is driven by groundwater. As the city grows, demand management will be critical. History has taught Belagavi that its wells may be its source of resilience in times of drought – therefore, trying to maximise local groundwater use along with demand management is a good pathway for Belagavi. Under the aegis of the Smart City Mission, water and sanitation projects to the tune of 782 crores have been proposed which could address these issues.

⁹Kampli, S., Singa, P. M., & S.Virupakshi, A. (2015). Characterization of Bellary nala and its Impacts on Soil and Crops. International Research Journal of Engineering and Technology, 2(5), 1085–1088.

The other big challenge is the treatment of sewerage generated by the city. Fortunately, the downstream river is more than 30 km away from the city. The sewerage flowing towards the river cleanses itself in the due course of the flow and the informal contribution of farmers utilising sewerage for farming contributes to the sanitisation process. However, monitoring and good practice inculcation amongst the farmers and the crops they grow will help ensure that potential risks from the waste-water do not have undesirable outcomes. It is important to note that this water in the Bellary nala is also polluted by industrial effluents.

More specifically the risks that faces Belagavi are as follows:

10.1 Health and Environmental Risks and potential mitigants

- i. The current Belagavi's waste-water system poses potential health risk from one perspective. There is no evidence that this risk has realised — therefore it is about monitoring and being careful in the future. This is use of waste-water flowing in the Bellary nala for agriculture. The most important mitigating measure is to check the flow of industrial pollutants in this nala. While the Smart City is addressing this with a proposal for a city sewerage treatment plant, will this STP address industrial wastewater flows in the nala. Can the city, working along with KSPCB, help industrial wastewaters to be treated and reused by industry?
- ii. There is also a risk of ground water contamination as the water table is high and the soil is black and clayey. Potential leakages from piped sewerage and seepage from leach pits could also lead to groundwater contamination. The move to full coverage through piped sewerage across the city (under smart city) may help in this effort. However, sewerage pipes have to be maintained well.
- iii. Designing and enforcing appropriate leach pit and septic tank designs for different properties that are also practicable and enforceable will help managing onsite sanitation better. Informing citizen's practices of pit design with appropriate science (for example as per CPHEEO guidelines) and driving training exercises for the informal sector that actually designs and implements these in practice is an appropriate response.
- iv. The town's solid waste management system is not happening as per expected standards. Improving the situation, sustaining best practices on this front and management of solid waste generation will add to public health objectives significantly. This is especially true given its high rainfall regime and the potential health risks of unmanaged solid waste in the town limits can cause during heavy rains.

The critical challenges that Belagavi faces are:

10.2 Sustainability Challenges

- i. The city is blessed with very high water table. Usage of shallow aquifers for its water needs reduces the load on surface water being pumped from reservoirs which are 30-50 km away. With growth, the city can have problems of scarcity, especially in drought years as history has shown. This needs demand management – to try and get its citizenry to use water efficiently. Metering the consumption of water, appropriate increasing block tariffs to send the right economic signals about frugal water use is important. The CMC's challenge is in monitoring the quantity and quality of shallow aquifer water and ensuring the sustainability of this water source as “water source of resilience”. Since water metering is already proposed in the Smart City Project, the CMC needs to work towards demand-management to ensure long term sustainability.
- ii. As the scale and speed of solid waste and liquid waste quantity is growing, the CMC needs to speed up and take initiatives to manage the scale effectively. Once the STP is set up, good wastewater management and potential reuse of wastewater for industrial use can be considered. It is also important to ensure that industrial growth happens in closed loop systems without polluting freshwater. Among different strategies of reuse of wastewater direct reuse by industry can potentially be an important strategy for Belagavi.
- iii. The role and importance of lake conservation for the city should be taken seriously. The linkages between lakes and groundwater need to be understood well. Do lakes and wetlands also have a role to play in wastewater management – can they also be a route to ensure wastewater becomes part of the shallow aquifer after wastewater treatment, by recharge through water bodies? This option must be examined as it can serve the dual purpose of ground water recharge and wastewater management.
- iv. Rainwater harvesting for direct storage and use as well as for groundwater recharge and revival of private wells must be encouraged. Engagement with citizens is necessary for this.
- v. The existing informal groundwater-based water-supply must be understood and harnessed to add resilience to the city.

10.3 Equity Challenges

- i. Clearly there is differential water supply – especially in quantity – in different parts of the city. This is true geographically and socio-economically. In the move towards 24*7 water supply with smart metering, the lower socio-economic segments must be kept in mind and revenue considerations

should not make basic lifeline water unaffordable.

- ii. Universal access to sanitation remains incomplete in the town and this must be given enough priority within Smart city projects. This will also involve convergence with the Smart City “housing for the poor”.

10.4 The Staffing and Capacity Challenge

- i. Institutionally, the KUWSDB with the support CMC works in Belagavi for water supply and sanitation. Under Smart City project a new institution Smart City Limited will look after overall management of Smart City projects, DPR creation and quality checking. Care to be taken inter-departmental coordination and responsibilities for planning and implementation.
- ii. Water quality monitoring should be envisioned in a end-to-end manner (across source, supply, distribution and point of use). This should tie into health monitoring of the city.
- iii. Given the importance of groundwater, the KUWSDB/CMC will do well in developing capacity to understand groundwater and local groundwater movements, replenishment with the rain and susceptibility to contamination.
- iv. The CMC should build capacity from a “communications” perspective – to reach out to citizenry and use communication tools to reinforce messages for demand management, rainwater harvesting, lake conservation and groundwater management. This will also help the CMC to engage with private well owners and leverage their data and knowledge of local groundwater and make them add resilience to the city.
- v. The CMC should also engage with agriculture departments, agriculturists and farmers to develop best practices and de-risking strategies for farmers who use waste-water irrigation.
- vi. The health care delivery department (PHCs, govt hospitals and private hospitals) and the CMC’s own health department needs to coordinate and exchange more information and data to keep track of how health risks are realising within the town. Making health outcomes a critical focus for sanitation is still missing.

The Sanitation Safety Plan developed by the WHO can be simplified and used as a tool to address some of the above challenges. This, however needs for it to be institutionalised as a tool for such CMCs at the state level. The SSP is an ideal tool to allow groundwater scientists, health workers, marine ecosystem experts and the WATSAN department of the TMC to converge and work together to take on these challenges.

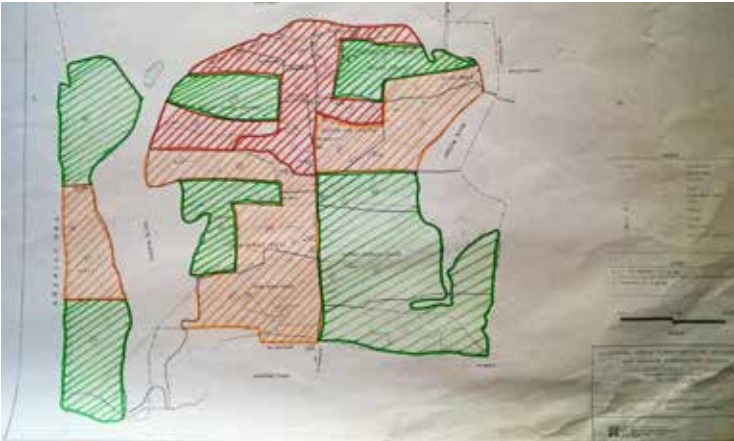
Section II

Urban Sanitation in Kundapura

Brief Introduction

Kundapura is a coastal town of 31,651 population spread over 14 sq. km. It is a Town Municipal Council (TMC) in Udupi District of Karnataka. Situated on an estuary and surrounded by water bodies on all sides — The Arabian Sea, Gangolli River and Haladi River — this town is characterised by the abundance of surface and ground water. In 2008, Karnataka Urban Infrastructure Development & Finance Corporation (KUIDFC) with financial assistance from Asian Development Bank (ADB), implemented the Karnataka Urban Development and Coastal Environment Management Plan (KUDCEMP) project to provide the town's first organised water supply system where all connections are metered. This water supply scheme has been designed to cater to the population of 75,663 population for the ultimate year of 2026.

Map 3: Map of Kundapura displayed at the TMC



Owing to high water tables, abundance of water and a humid environment, per capita consumption of water is estimated to be about 200 LPCD. However, the study so far has revealed that only 32% of the total households are connected to the municipal piped water supply. Rest of the water, i.e., 4,313 KLD is entirely drawn from private wells and bore-wells.

Nearly 96% of households in Kundapura have toilets. The TMC has built community toilets in areas where households lack individual toilets. A Sewerage Treatment Plant (STP) along with the UGD is in operation. Traditional practices have been a roadblock to implement both the water supply as well as the sewerage infrastructure. Most people refuse metered connections as most of the households have access to private wells, which they have been using for generations. Most of the households also use grey water for watering their private gardens. Due to this, the amount of wastewater flowing into the drains

is not enough for the UGD to work. It is important to note that the town already has a localised system in place to reuse grey water. However, black water sucked out from onsite sanitation systems is discharged into the river.

The TMC is going ahead with the infrastructure work with the hope that people's attitudes will change.

1. About the Town

Kundapura is a Town Municipal Council and Taluk Headquarters of Kundapura Taluk in Udupi District. This coastal town is spread over 14 sq. km (3,462 acres). It is located at 13.6316° N, 74.6900° E.

2. Demography

According to the 2011 Census, the town's population is 30,444 comprising 15,604 females and 14,840 males with a sex ratio of 1,051 females per 1,000 males. The population density of this town is 2,396 persons per sq. km.

Kundapura Town Municipal Council has administration over 6,272 houses. The literacy rate of Kundapura is 90.52%, which is higher than the state average of 75.36%¹. The town has nine slums of which none are declared. Total slum population is 5,231².

According to the municipal records, there are now 8,460 households and the current population is 31,651.

Table 6: Demography of Kundapura

Population						No of households		Literacy			Workers			
Total	F	M	SC	ST	Slum	Total	Total	F	M	Total	F	M		
30,444	31,651*	15,604	14,840	1,439 (4.73%)	362 (1.2%)	5,231	6,483	8,460*	90.5%	94.3%	86.9%	38%	75%	25%

Source: Census 2011

*Current Estimate (Source Municipal Data, 2017)

3. Climate and Geography

Among the ten agro-climatic zones of Karnataka, Kundapura lies in the 'Coastal Zone'³. It receives an average rainfall of 4,297 mm per year from June to September. Most areas have red lateritic and yellow loamy soil. Areas close to the sea also have sandy soil⁴.

¹ Census 2011. (2015). Kundapura Population Census 2011. Retrieved August 16, 2017, from <http://www.census2011.co.in/data/town/803139-kundapura.html>

² Town Municipal Council Kundapur. (2015). Public Disclosure Schedule.

³ Karnataka State Department of Agriculture. 2017. "Agro Climatic Zones of Karnataka." Accessed August 17. raitamitra.kar.nic.in/stat/kacz.html

⁴ Town Municipal Council Kundapur. (2015). Public Disclosure Schedule.

4. Economy

Being a coastal town, Kundapura’s economy is based on fishing and business.

Agriculture

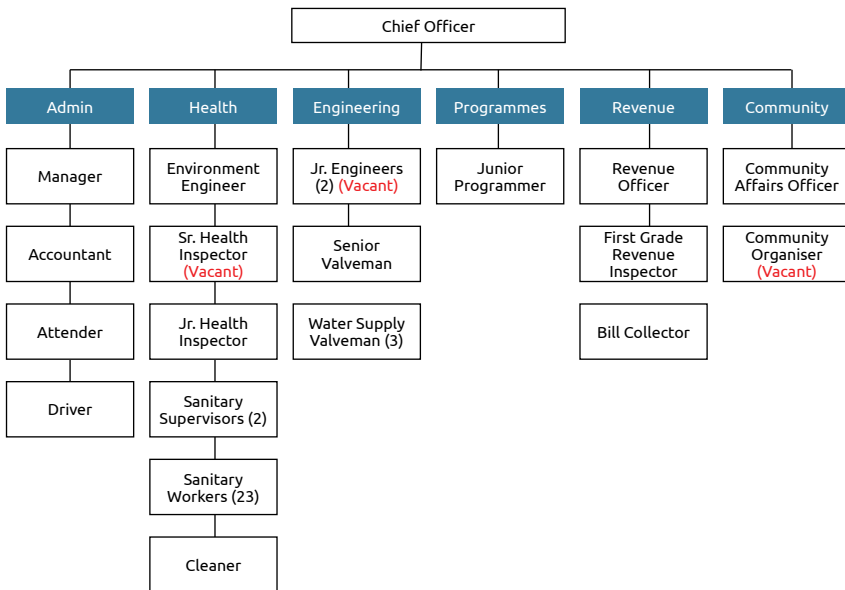
Crops grown in Kundapura include

- Cereals and Millets: Paddy
- Commercial Crops: Cashew, Flowers, Arecanut
- Plantation and Horticulture: Coconut

5. TMC Institutional Structure

There are a total of 50 posts in the TMC, of which four are vacant. Details are given in the organogram below. Infrastructure projects have historically been driven by KUIDFC and currently Karnataka Urban Water Supply and Drainage Board (KUWSDB) is driving the UGD/SDP.

Figure 12: TMC Institutional Structure



6. Water

Surrounded by water bodies on all three sides — The Arabian Sea, Gangolli River and Haladi (also known as Varahi upstream) River — this town is characterised by the abundance of surface and ground water. The town has a river delta in the North. River Varahi/Halady comes in from the East and flows north of the town to form a common delta with Gangoli, which joins the sea to the North of Kundapura. Further, the backwaters from the sea/delta bifurcates the town

towards its West. These backwaters heave to the rhythm of the tides. Owing this natural abundance of freshwater and high groundwater levels, people of Kundapura have always relied on open wells for domestic consumption. Most households also had their own pit toilets. However, now the municipality has introduced a piped water supply system which relies on surface water from River Varahi pumped from 11 km upstream from the Japti Panchayat.

6.1 Water Sources, Demand and Supply

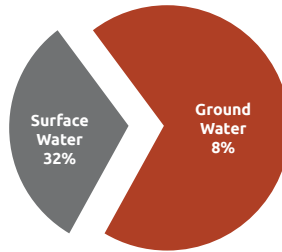
A. Demand

Owing to (i) high water tables and abundance of water (ii) a humid environment where people bathe more than once, wash clothes more regularly and drink more water, and (iii) based on conversations with local people, per capita consumption of water is estimated to be about 200 LPCD.

B. Sources and Supply

I. Municipal Supply: Surface Water

Figure 13: Water Sources and Supply in Kundapura



In 2008, Karnataka Urban Infrastructure Development & Finance Corporation (KUIDFC) with financial assistance from Asian Development Bank (ADB), implemented the Karnataka Urban Development and Coastal Environment Management Plan (KUDCEMP) to provide the town's first organised water supply system where all connections are metered. This water supply scheme has been designed to cater 7.6 MLD at 135 LPCD to the population of 75,663 population for the ultimate year of 2026⁵. This water is supplied from Varahi River, 11 km from the town. River Varahi is the only source of Municipal water and forms 100% of the municipal piped supply. It has a 100 hp jackwell pump, with a pumping capacity of 326 cubic meters/hr against a head of 54 metres. This is pumped to three overhead tanks in the city of around 500 KL each.

⁵ Karnataka Urban Infrastructure Development and Finance Corporation. (2017). Improvements for 24 x 7 Water Supply system for TMC, Kundapura-Package number 02KDP01.

Table 6: Details of Municipal Water Connections

Connection Type	Numbers
Residential	2,696
Non-domestic	33
Commercial	154
Parchayth	6
Engineering College	1
Fire Station	1
Total	2,891

Table 7: Water Tariff for Domestic Connections

Usage Limits		Cost / KL
Minimum (KL)	Maximum (KL)	
0	8	₹8
8	15	₹10
15	25	₹12
>25		₹14

This has a distribution network of 58.21 Km.

Currently, 3 MLD of water to Kundapura Town, including non-domestic and commercial connections. Details of connections are given in Table 6. It is important to note that only 2,696 households, i.e., only 32% of the total households have municipal connections. In many households with municipal connections, piped water is used for cooking and drinking only. For all other purposes, well water is used. Water supply is metered and has an increasing block tariff. The current tariff is given in Table 7. There is 80% revenue realisation in Kundapura.

An average household of 3.74 using 200 LPCD (22.44 KL/month), will have to spend ₹185 per month if they depend entirely on municipal supply.

II. Groundwater

A typical household is of about 10 cents or 4,350 sq. Ft. Each house has an open well in the front-yard and pit toilet in the backyard. Wells are usually dug upto 30-40 ft depth. Traditionally these were lined with laterite stones but increasingly concrete rings are becoming common. The water table can vary from 3-5 ft in rainy season to upto 15-20 ft during summer months.

Despite the ambitious plans of the government, most people rely on their private wells. As per the Census report, nearly 75% of the population of Kundapura Taluk depend on open wells and this holds good for Kundapura TMC. Of the 8,460 HHs, only 2,697 HHs have municipal connection which amounts to 64 LPCD. The remaining 5,763 HHs use private open wells or borewells. As mentioned earlier, the average consumption in Kundapura is 200 LPCD. Therefore the remaining 136 LPCD, i.e., 4,313 KLD of water is drawn from private open wells and borewells, which amounts to 68% of the water supply. Even

with electrical pumping, the estimated cost of water from these wells will be under Rs. 2/KL.

There is only one private water tanker which is rarely employed. There are no R.O. plants in Kundapura. There is also a reluctance among people to switch to municipal piped water as they believe that the water from their wells is safe as it has been used for generations.

Table 8: Water Supply in Kundapura

	Municipal (100% Surface Water)	Private/Informal (100% Groundwater)
Quantity (KLD)	2,017	4,313
Total (L per day)	20,17,000	43,13,000
LPCD	64	136

6.2 Water Quality

The TMC has a water treatment system in the pumping station at Japthi. The treatment system is a combination of slowsand filter, clariflocculator, aerators and chlorinators. There is also a water quality lab which measures the water quality parameters every day and monitors it. The treatment system at Japthi based on these parameters. Water quality parameters monitored include pH, turbidity, conductivity, E-coli (MPN) and residual chlorine. However, there is no distribution point sampling and testing done.

Given that significant use of open-well water for drinking purposes, it must be observed that open-wells and pit toilets co-exist in high water table areas here. Given the land-use and household pattern, there is a distance of 10–15 ft maintained between wells and pit toilets⁶. We are undertaking water quality tests to verify if the well water is contaminated.

Conversations with people indicated that people are very comfortable using

⁴ CPHEEO Norms for distance between wells and onsite sanitation is as follows:

In dry pits or unsaturated soil conditions, i.e. where the height between the bottom of the pit and the maximum ground water level throughout the year is 2 m and more:

- The pits can be located at a minimum distance of 3 m from the water sources such as tube wells and dug wells if the effective size (ES) of the soil is 0.2 mm or less, and
- For coarser soils (with ES greater than 0.2 mm) the same distance can be maintained if the bottom of the pit is sealed off by an impervious material such as puddle clay or plastic sheet and 500 mm thick envelope of fine sand of 0.2 mm effective size is provided around the pit.

In wet pit saturated soil conditions, i.e. where the distance between the bottom of the pit and the maximum ground water level during any part of the year is less than 2 m:

- The pits can be located at a minimum distance of 10 m from the water sources such as tube wells and dug wells if the ES of the soil is 0.2 mm or less, and
- For coarser soils (with ES more than 0.2 mm), minimum distance of 10 m can be maintained if the pit is sealed off by an impervious material such as puddle clay or plastic sheet with 500 mm thick envelope of fine sand of 0.2 mm, effective size provided all round the pit.

well water for drinking and boiling may be a practice in some homes. ‘Point of Use’ treatment is slowly growing in though not rampant like in other cities. Commercial places like hotels are beginning to use R.O. systems.

No water-borne disease epidemic has been reported. The TMC does not report in its health data any significant problem of water borne diseases. However proactive tracking of health data is missing.

7. Sanitation

7.1 Households with Toilet

Nearly 96% of the households in Kundapura have toilets, mostly single leach pits. On an average, each household is built on 10 cents (4,300 Sq. Ft) of land with plenty of open space. The wells are built in front of the house and toilet pits at the back. Both are separated by a distance of 10 — 15 ft. Grey water is usually used for water the gardens. Typically, these home gardens have water intensive coconut trees and banana.

Single leach pits are 4—5 ft x 2.5—3 ft x 6 ft/8 ft/10 ft and an average of 2.8 cubic meters in volume. These leach pits take 10—15 years to fill up. Traditionally, laterite stone was used and therefore a “square / rectangular pit” was used but now there is a 70 — 80% change from laterite to cement. With this change, the pits too are becoming circular. This change is driven due to the cost-effectiveness of cement rings and labour constraints. Since most construction takes place during summer, it results in a sudden spike in the demand for and shortage of labour.

There is no underground sewerage system in place. A Sewerage Treatment Plant (STP) along with the UGD is in the works. The TMC has 1 honeysucker of 6,000 litres capacity and 1 honey-sucker cum jetting machine of 3,000 litres capacity. They charge ₹1,700 within the city limits. Municipal honeysuckers used to then empty their contents into the backwaters near the estuary. Due to the objections by the fisherfolk, this practice has changed and now empty it into the “private sewerage pipe network”.

In addition to this system of municipal honey suckers, the TMC along with KUWSDB is now planning to install a UGD and an STP. The Municipality has proposed 3 STPs for sewerage treatment including one big STP of 2.8 MLD capacity and 2 smaller ones with Membrane bioreactor (MBR) technology. They have also acquired 1 acre of land for this purpose. The capacity of 2.8 MLD is based on the current supply of 3 MLD of water. However, it is not clear how households not connected to municipal water supply are factored into this. If peoples start connecting to the UGD, will the STP capacity be enough remains an open question.

Figure 14: A Typical House In Kundapura With Open Well In The Front-Yard And A Septic Tank In The Backyard



Figure 15: Grey-Water Is Used For Fertigating Gardens



7.2 Households without toilet

In addition to this, 4% of the households do not have toilets, and these belong largely to the fisher folk who live along the coast. The TMC has constructed public toilets for them. The wastewater from these toilets are let into the estuary to be carried into the sea. Sometimes during high tides, these toilets tend to overflow.

Table 9: Quantity of Wastewater Generated

Wastewater	Quantity of Wastewater
HHs with toilets (8,310 HHs)	4,974 KLD
HHs without toilet (150 HHs)	67 KLD

Calculations: Avg members / house = 3.74; LPCD = 200; LPHD = 3.74×200

Quantity of Sewerage: HHs with toilet = (HHs×LPHD×80%)×1000; HHs without toilet = (HHs×LPHD×60%)×1000

7.3 Private Sewerage Pipe Network: An Informal Setup

About 15 years back, increasing consumption of water due to demands of “hygiene” especially in commercial places like hotels, lodges, apartment, and hospitals, onsite sanitation systems were found inadequate. Some such

establishments in a particular part of the town got together, sought permission from the Municipal authorities and laid their own private piped sewerage network. This piped sewerage is only for grey water and black water goes into leach pits.

This setup is also privately maintained. The maintenance is done based on need basis informally “with municipal labour paid for after office hours by the private parties”

The municipality, over time, has begun to “co-own” this system in two ways: (i) The Municipality has been giving connections of some new developments, both commercial and household, to this private sewerage network (ii) The municipal honey sucker releases its contents after emptying the pits into these private networks. It must be stressed here that the Municipality is conscious and uncomfortable talking about these aspects of the “co-ownership” and this behaviour is apparently “informal” behaviour on the part of the TMC.

Today, Kundapura has three such lines which empty into the estuary of Haladi River.

- Line 1 is connected to 25 hotels and 15 lodges
- Line 2 is connected to 20 hotels and 10 lodges; 1 Bank, 100 households and 7 apartments (150 flats)
- Line 3 is connected to 2 apartments and 10 hotels.

Further data needs to be collected to estimate the sullage quantities flowing into these sewerage lines.

The backwaters of the estuary have a daily cycle of high tide and low tide. Every day, these tides pull the river water along with wastewater into the sea and fresh sea water enters the back waters every day. This tidal rhythm is Kundapura’s final step of the sanitation solution for both the onsite and private piped sewerage networks.

7.4 Proposed projects in Sanitation

Traditional practices have been a roadblock to implement both the water supply as well as the sewerage infrastructure. Most people refuse metered connections as most of the households have access to private wells, which they have been using for generations. Most of the households also use grey water for watering their private gardens, where water-intensive coconut trees are common. Due to these traditional practices, the amount of wastewater flowing into the drains is not enough for the UGD to work. It is important to note that the town already has a localised system in place to reuse grey water. However, black water sucked out from onsite sanitation systems is discharged into the river.

8. A Brief Profile of Solid Waste

Kundapura has a door-to-door system of collection of garbage. The Municipality has provided 5,500 buckets for collecting waste. Despite this, getting people to segregate their waste has been a big challenge for the Municipality. However, segregation at source is happening at restaurants and markets.

Figure 16-17: Sewerage from the private drains is discharged into the river at low tide and is carried to the sea during high tide



Kundapura has a scientifically managed landfill spread over 15 acres at Kandavara. The TMC segregates waste at the landfill both manually and using sorting machines. The organic waste is composted and the recyclable waste is sent for recycling. Due to this relatively good solid waste management system, there is minimal interaction between solid waste and liquid waste.

Figure 18-21



Manual sorting of solid waste into dry and wet waste



Mechanical sorting of solid waste



Organic waste converted to compost



Recyclable waste

9. Risks and Challenges from a Water and Sanitation perspective

Kundapura is clearly blessed with abundant water — both surface and ground. Further, it is also blessed with a citizenry that has historically inherited practices of water self-reliance through openwells at home. Further, traditionally toilet usage has been high and pit toilets have been utilised for sanitation.

Infrastructure centric water supply and sanitation projects have been undertaken in Kundapura. While the best practices infrastructure water supply projects have been incorporated through consumption metering, increasing block tariff and high revenue realisation, the real challenges Kundapur TMC should frame for itself is to transition away from infrastructure-centric approach towards a management of the local practices approach. Citizens have been self-reliant with water and with on-site sanitation. The tidal rhythms of the sea, take the wastes of the town away into the large Arabian sea that “sanitises” Kundapura’s waste. The TMC should focus on ensuring that science adequately informs these practices so public health remains protected with changing habits and growth of the town.

More specifically, the risks that faces Kundapur are as follows:

9.1 Health and Environmental Risks and potential mitigants

- i. Kundapura's water and sanitation system poses potential health risks from one overriding perspective. There is no evidence that this risk has realised — therefore it is about monitoring and being careful in the future. This risk is the co-existence of wells and leach-pits in a shallow water-table area. There is no monitoring system by the TMC to check if wells are getting contaminated and if the citizens are at the risk of consuming faecal contaminated drinking water from their wells. There is no monitoring system by the TMC even at its own piped supply distribution points. Such a protocol can help monitor this risk.
- ii. Currently the TMC does not have any industrial effluent or waste getting into the liquid waste streams. If such developments do occur, this will require targeted response. This may represent both local health and environment risk — however, as of today this does not exist.
- iii. The town's solid waste management system is functioning well. Improving this and sustaining the good work on this front and demand managing solid waste generation will add to public health objectives significantly. This is especially true given its high rainfall regime and the potential health risks unmanaged solid waste in the town limits can cause during heavy rains.
- iv. Designing and enforcing appropriate leachpit and septic tank designs for different properties that are also practicable and enforceable will help managing onsite sanitation better. Informing citizen's practices of pit design with appropriate science (for example as per CPHEEO guidelines) and driving training exercises for the informal sector that actually designs and implements these in practice is an appropriate response.
- v. The use of faecal sludge and wastewater that are finally washed into the backwaters of the estuary is currently not found to pose significant health risk due to the tidal rhythm which washes the wastewater into the deeper sea. However, constant monitoring of this area and conversations with fishermen groups dependent on the estuary back water region for their livelihood can help monitor if this changes with time, either due to changing composition of waste (with growth) or increased population pressures.

The Critical Challenges that Kundapura faces are:

9.2 Sustainability Challenges

Given ample availability of water, source sustainability is not a significant issue in Kundapura. The key sustainability questions for the future is that of

infrastructure given self-reliant behaviour of citizenry, will large infrastructure become operational overheads and financial cost centres in the future, especially for sanitation? How can this be pre-empted for already invested in infrastructure and how to plan differently for the future are the key questions. A critical determinant, if population will accept the convenience of new sanitation infrastructure will be the relative cost of it. It must be kept in mind that STP running costs tend to be high.

9.3 Equity Challenges

- i. The equity challenge is not a very big one for Kundapura especially on the water supply side. The current water supply system is already providing water during peak summer when wells may be dry. Further distribution of water within the town for different socio-economic groups is not a significant issue given wells and access to wells are very common. The cost of openwell water also tends to be very low and therefore it is affordable.
- ii. The SBM is of course dealing with access to toilets and the town seems to be dealing with universal access to sanitation with the help of SBM.

9.4 The Staffing and Capacity Challenge

- i. Given the importance of groundwater, the TMC will do well in developing capacity to understand groundwater and local groundwater movements, replenishment with the rain and susceptibility to contamination. This dimension of knowledge does not seem to be integrated into the town as it is still surface water centric. Similarly marine-ecosystem expertise would help in understanding what is happening with wastewater and faecal sludge discharge into the estuary.
- ii. The institutional structure of TMCs implies finally, it is the EE, the two HIs and the JEs are the foot soldiers of the TMC to deal with the entire gamut of WATSAN challenges. In a context where the WATSAN on the ground is driven by self-reliant citizenry, the TMC's relative focus should shift towards monitoring of water quality, its linkages to health and education of the citizenry around these issues.
- iii. The health care delivery department (PHCs, government hospitals and private hospitals) and the TMC or the TMC's own health department need to coordinate and exchange more information and data to keep track of how health risks are realising within the town. Making health outcomes a critical focus for sanitation is still missing.

The Sanitation Safety Plan developed by the WHO⁷ can be simplified and used as a tool to address some of the above challenges. This however, to be institutionalized as a tool for such TMCs at the state level. The SSP is an ideal tool to allow groundwater scientists, health workers, marine eco-system experts and the WATSAN department of the TMC to converge and work together to take on these challenges.

⁵ World Health Organisation. (2016). Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta.



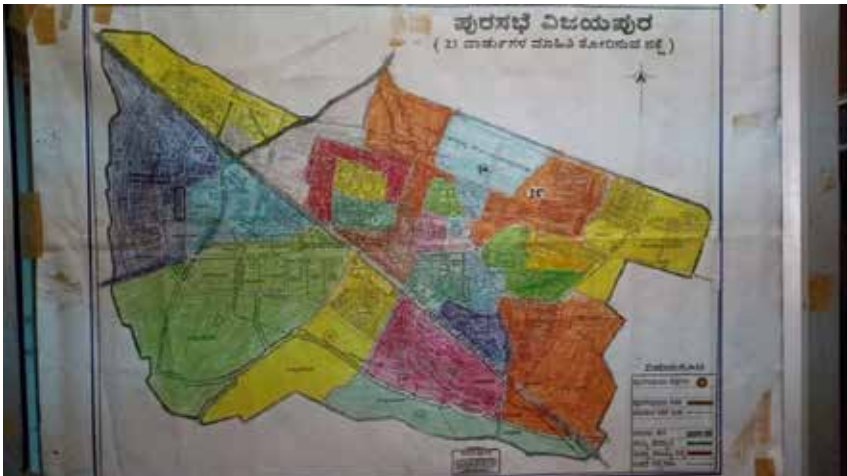
Section III

Urban Sanitation Management in Vijayapura

Brief Introduction

Vijayapura is a town of about 40,000 people in Bangalore Rural District, Devanahalli Taluk. It is located about 50 km north of Bangalore. This town is entirely dependent on groundwater in a context of falling water tables and water scarcity. The formal water supply caters to about 43% of the water needs and it is the private and informal sector (private borewells and tankers) that meets nearly 57% of the demand of the town. Approximately 7% of the town's households do not have toilets. Around 34% of the town's households have onsite sanitation system — primarily single leach pits. Both municipal and private informal honeysuckers empty these leach pits. All these honeysuckers informally dispose of the emptied contents mostly with farmers who compost the faecal sludge and apply it on farmlands as manure. Around 63% of the town is connected to a piped sewerage system but no sewerage treatment plant exists. Sewerage therefore flows in two main drainage channels across the town and into the neighbouring country side. However, farmers intercept these channels and use the flowing sewerage as source of nutrientrich water for irrigation — thus becoming the critical step that not only finally sanitises the sewerage but also treats it like a resource. There is no obvious evidence of health or environmental risks leading to epidemics or contamination of water sources thus far.

Map 4: Map of Vijayapura displayed at the Town Municipal Council



Demography

According to the 2011 Census, the town's population is 34,866 comprising 17,129 females and 17,737 males with a sex ratio of 966 females per 1,000 males. The population density of this town is 2,396 persons per sq. km¹.

¹ Karnataka Municipal Data Society. (2016). Vijayapura Town Municipal Council. Retrieved July 24, 2017, from <http://www.vijayapuratown.mrc.gov.in/>

Vijayapura Town Municipal Council has administration over 8,086 houses. Nearly 25% of the population i.e., 8,751 people live in slums. Vijayapura has the highest percentage of slum population in Bangalore Rural District.

However, according to the data given by the Urban Local Body, as of 2017, there are over 9,500 households and the current population is about 39,000.

Table 10: Demography of Vijayapura

Population						No of households		Literacy			Workers			
Total	F	M	SC	ST	Slum	Total	Total	F	M	Total	F	M		
34,866	39,000*	17,129	17,737	3,625 (10.4%)	1,665 (4.8%)	8,751 (25%)	8,086	9,500*	81%	76.1%	85.8%	41.5%	22.5%	59.9%

Source: Census 2011

*Current Population. Source: Municipal Data

Climate

Among the ten agro-climatic zones of Karnataka, Vijayapura lies in the 'Eastern Dry Zone'². It receives an average rainfall of 750 mm per year from July to October. The average minimum temperature is 16°C and maximum temperature is 31°C. Most areas have red loamy soil.^{3,4}

Economy

Vijayapura has historically been a trading centre for silk. Even today, the most important commodity manufactured in Vijayapura is silk yarn. This is followed by sarees and beedis.

Agriculture

Crops grown in Vijayapura include

- Cereals and Millets: Ragi, Jowar
- Commercial Crops: Mulberry, Fodder, Flowers
- Plantation and Horticulture: Beetroot, Greens

People are engaged in dairy and sheep rearing.

TMC Institutional Structure

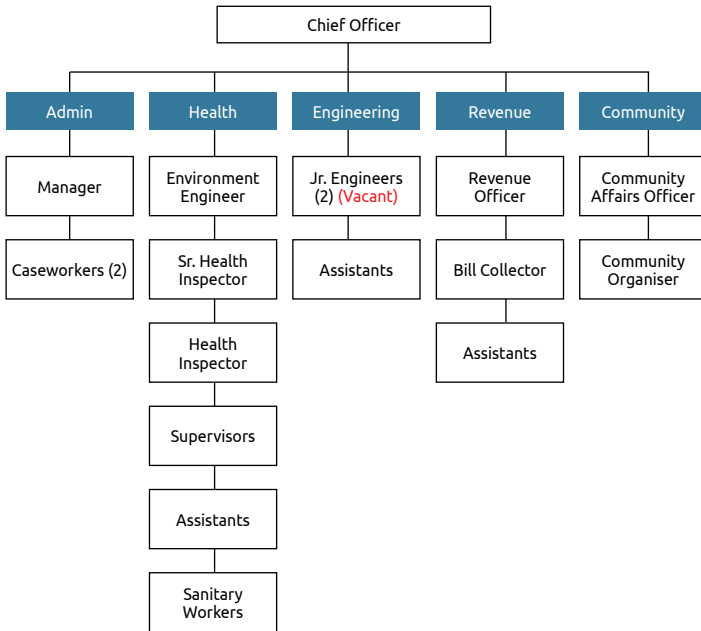
Vijayapura has 23 wards each with a council member. This TMC has five departments under the Chief Officer. The organogram below represents the institutional structure.

² Karnataka State Department of Agriculture. 2017. "Agro Climatic Zones of Karnataka." Accessed August 17. www.raitamitra.kar.nic.in/stat/kacz.htm.

³ Directorate of Census Operations. 2011. District Census Handbook — Bangalore Rural.

⁴ Karnataka State Department of Agriculture. 2017. "Agro-Climatic Zones." Accessed August 17. <http://raitamitra.kar.nic.in/agriprofile/zonedet.htm>.

Figure 22: TMC Institutional Structure



Water

Vijayapura is currently entirely driven by groundwater. Historically, a major source of water used to be Badanekere, a downstream tank and open wells were also used for domestic water. Anecdotal evidence suggests that the tank was last seen full fifteen years ago. There are five step-wells in the town and all are completely dry.

Three high-yielding borewells have been dug in this tank bed to supply water to the town. Water is first pumped into three pump houses at Yeluvalli, Dharmapura Road, Chikballapur Road and then supplied to individual houses. Water is also sourced from 62 low-yielding borewells and supplied through tankers. Groundwater is at 900–1000 ft depth indicating water scarcity in Vijayapura. Agriculture related livelihoods also suffer due to low availability of water.

The following section gives a break-up of the sources and supply.

Water Sources

A. Municipal Bore-wells

1. There are 62 functional borewells in the town with relatively lower

yield. They largely supply water to municipal tankers within the town. Municipal tankers supply water to household needs only.

2. There are 3 high yielding borewells in the tank bed of Badanekere which supplies the bulk of water for the piped water supply.

B. Other sources of water

There is no source of surface water available for Vijayapura. There are no functional open wells either. The town has 5 historic step wells too but they are in disuse.

However, many tankers source from private borewells.

Vijayapura, which draws all its water from groundwater is also extremely water scarce. Groundwater is only available at depths of more than 1000 ft and has high levels of TDS. The entire town’s water economy is driven by water scarcity.

Table 11: Sources of Water for Vijayapura

	Surface Water (River/Tank)		Ground Water		Wastewater Reuse
	Municipal	Private	Municipal	Private	
Quantity (KLD)	0	0	1504	1800 — 2200	For irrigation only

Figure 23: Vijayapura TMC draws groundwater from the nearby Badanekere Tank. Wastewater flows into the two storm water drains (Rajakaluve 1 and Rajakaluve2) ultimately leading to the same tank. However, wastewater is intercepted by farmers for fertigitating their agricultural lands.



Map 5: Location Map of Vijayapura Town with Two Storm Water Drains (Rajakaluve 1 and Rajakaluve 2)



Water Demand and Supply

Despite the scarcity, municipal water supply is not metered and thus, there is no reliable measure of how much water is actually supplied by the Municipality.

According to the TMC website, the total water supply is 30 lakh litres and per capita water supply is 100 LPCD. The 2011 Census report says that untreated water sourced from tube-wells and boreholes is supplied as tap water. The report also mentions the town has an Overhead Tank of 8000 KL capacity and a Bore Well Pumping system of 4500 KL capacity.

According to the Human Development Report brought out by the Government of Karnataka, Vijayapura with 1,768 individual water connections is the lowest in the district. Nearly 84% of the households had access to tap water and 29% have access to water within 100 m of their premises. This report also states that the Municipality supplies 1.89 MLD and 57 LPCD of water. There are 683 public stand-posts. Water is supplied for 2 days per week for 60 minutes. The monthly water charges are ₹80 for domestic and ₹160 for commercial connections.

However, based on interviews with the Municipal officers and the residents, the following estimates were arrived at:

A. Municipal Piped Water

About 1,152 KL treated drinking water is supplied every day. Each household is charged about ₹80/month. This accounts to per capita supply of 29.5 LPCD.

B. Municipal Tanker

Around 344 KL per day is supplied through tankers, which amounts to per capita supply of 8.8 LPCD. This water is supplied free of cost.

C. R.O. Plants

There is one functional R.O. Plant in the town, which caters around 400 cans (of 20 litre capacity) of water which is 8 KL per day or 0.2 LPCD. TMC charges 5 per can.

Total water supplied by the Municipality is 38.6 LPCD.

D. Private Tankers

There are about 60—80 private tankers operate in Vijayapura with capacities ranging from of 800 L — 4,000 L. The bigger tanker costs ₹300 — 400 while the smaller one costs ₹180 — 200. These private tankers supply to about 6 households a day and also cater to nearby villages. Their business models have been further discussed in section

Table 12: Water Supply in Vijayapura through various means by both Municipality and private operators

	Municipal			Private/Informal
	Piped	Tanker	RO	Private Borewells+ Tankers
Quantity (KLD)	1152	344	8	2,000
Total (L per day)	11,52,000	3,44,000	8,000	20,00,000
LPCD	29.5	8.8	0.2	51.3
Total (LPCD)	38.6			51.3

As shown in the table above, the Municipality supplies only 38.6 LPCD. From a small sampling survey done in Vijayapura, it can be inferred that the real water consumption in the town is around 90 LPCD. Therefore the gap of 51.3 LPCD is estimated to be filled up by private borewells or private tanker supplies. This means the scale of private / informal freshwater supply is estimated to be 2,000 KLD. As shown in the graph below, water supply by the informal sector in Vijayapura accounts to 57% of the total supply. Yet, the total LPCD is only 90 LPCD as against the benchmark of 135 LPCD for a town with piped sewerage.

This number is an estimate based on our field research as the Municipality does not have these figures. The information gaps about the informal sector also shows their services are not fully acknowledged by or accounted for by the formal sector. The informal sector charges around ₹80-100 per kilolitre of water, which is estimated to be around ₹5 to 8 crores per annum.

Figure 24: Water Supply in Vijayapura

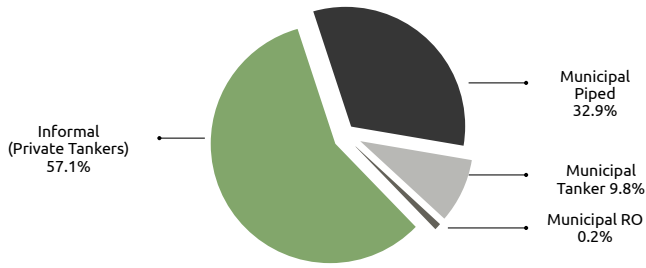


Figure 25: Private Tankers: Various Capacities And Modes Of Transport



Figure 26: R.O. Plant at Vijayapura



Pricing

Price of the municipal piped water supply is not volumetric but a flat rate of ₹80 is charged. All other means of supply priced based on volumes. Table 13 below gives a comparison of these prices. The municipal tanker supplies water free of cost. Water supplied by the Municipality at ₹ 22 for 1 KL of water is the cheapest. However, anecdotal evidence suggests that given the poor supply of water, people do not pay their bills for piped water.

Water supplied through R.O. and by private suppliers through sealed cans is the most expensive. Slum dwellers who do not have access to Municipal water supply depend on private water tankers, thus spending a considerable amount of their income on water.

Table 13: Price of water based on water supply

Mode of Supply	Charges	Price (per KL)
Municipal Piped	Rs 80/Month/HH Current Supply at 120.95 LPHD	₹ 22.05
Private Tanker	Charged on a per load basis. Available at 2000L and 4000L per load	₹ 100.00
	₹3 per pot of 15 L	₹ 200.00
R.O.	@ ₹5 per can of 20 L	₹ 250.00
Privately Supplied Cans	@ ₹ 30 for 20 L	₹ 1500.00

Water Quality

The Municipality undertakes chlorine and alum dosing at the pumping stations. However, the TMC doesn't have a record of regular water quality tests done. They do, however, undertake water quality testing when new borewells are dug. There are no diligent records maintained by them. At this stage, water quality reports from the TMC are awaited.

The private tanker operators supply untreated water. Typically, this water is not used for drinking. Point of use treatment systems though prevalent, not common. People use treated water from the R.O. plants or buy cans for drinking.

It is expected that TDS is high due to low groundwater-levels. Vijayapura lies in a belt where the likelihood of fluoride presence in groundwater is very high. The TMC, however, does not officially verify this. For the purpose of this study, water quality tests will be undertaken independently.

The officials claim that there are no major issues of water contamination, their argument is based on the fact that there have been no major outbreak of epidemics. However, a visit to the Primary Health Centre (PHC) revealed that there are several cases of diarrhoea, typhoid, and other water-borne diseases both among children and adults.

1. Sanitation

Number of toilets

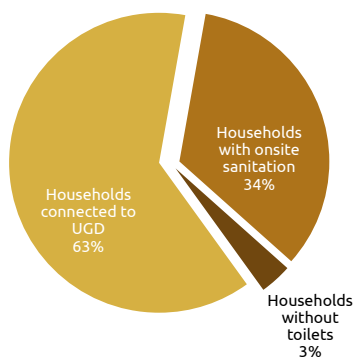
The 2011 Census report says that Vijayapura has a total of 7,377 toilets of which 1,451 are pit toilets; 5,675 are of the flush/pour-flush type and 251 of miscellaneous category. The town has a combination of open and closed drainage system. According to this data, 91.2% of the households had toilets in 2011.

The municipal records state that the town currently has 9,239 individual household toilets and 5 public toilets. According to this data, 97% of households have toilets. Around 6,000 houses are connected to the Underground Drainage (UGD). Households with onsite sanitation are likely to discharge grey water into open storm water drains.

Table 14: HHs with and without toilets

Total Households	9,500
Households with toilet	9,239
Households without toilet	261

Figure 27: Percentage of households with different types of sanitation facilities in Vijayapura TMC as per current data provided by the Municipality.



Underground Drainage

Vijayapura is the only ULB in Bangalore Rural District with a sewer network. Nearly 63% of households have a sewer connection. Vijayapura does not have a sewerage treatment plant (STP). Hence, black water from the underground drainage gets mixed with grey water and flows out into the drains that are connected to two Rajakaluves (storm water drains), each discharging raw sewerage into Badanekere. However, the wastewater reaches this tank only during the rainy season. In other seasons, farmers capture this wastewater to grow crops such as maize, beetroot, mulberry and fodder.

Table 15: Quantity of Sewerage Generated in Vijayapura

System	Quantity of Sewerage (KLD)
Underground Drainage (6,000 HHs)	1,770
Onsite sanitation (3,239 HHs)	956
Households without toilets (261HHs)	77

Calculations: Avg members/house = 4.1; LPCD = 90; LPHD = 4.1×90
Quantity of Sewerage = (HHs×LPHD×80%)×1000

Onsite sanitation

Most onsite sanitation systems are in the “extension” areas that have emerged as city grew. They are mostly single leach pits rather than septic tanks. Only black water goes into these systems, grey water typically flows into open storm water drains. There are a total of three honeysuckers operating the this town — two by the Municipality and one by private operator. Both the municipal and private honeysuckers charges Rs. 1,000 per operation.

Proposed projects in Sanitation

Open defecation is less prevalent, there are around 483 applications for construction of new toilets. Work order has been released to construct 222 toilets under Swachh Bharat Mission (SBM) Program.

Water and Sanitation in Slums

Nearly 25% of Vijayapura’s population lives in slums. There are 12 slums of which five are notified. According to the 2011 census, there are approximately 8,751 people living in 1,738 houses.

There are 1,031 public taps and 65 individual water connections.⁵

⁵ Bengaluru Rural Zilla Panchayat & Government of Karnataka. (2014). Bengaluru Rural District Human Development Report, 2014.

Table 16: Comparison of households with and without toilets in Vijayapura TMC vs Slums. Source: Census 2011

	Vijayapura TMC	Vijayapura Slums
Total HHs	8,086	1,738
HHs with toilets	7,377 (91%)	1,267 (73%)
HHs without toilets	709 (9%)	471 (27%)

The Census report states that 73% i.e., 1,267 houses have toilets. Of these 19% are pit toilets and 81% are waterborne (flush or pour flush) toilets. It is to be noted that of the total households without toilets in Vijayapura, 66% are in slums. Most of the slums have open drainage system except Basavanakatte — 2, which has both open and closed drainage systems.

Data from the Census report is given in Appendix 1.

A Brief Profile of Solid Waste

The town generates 12—14 tonnes of garbage everyday and most of it is sent to the landfill at Devanahalli and some of it is also dumped in dried openwells in nearby villages. A multinational company has recently proposed a waste-to-energy plant for Vijayapura. The administration is yet to decide on the matter.

Figure 28: Solid Waste Often Gets Mixed With Wastewater In Open Drains



The municipal officers claim that dry waste, wet waste and biomedical waste is segregated but this needs to be verified by visiting the landfill. There is also a need to assess the role of informal sector in segregating and transporting

recyclable waste to recycling units. The TMC need one auto for every 1000 households for waste collection. At present TMC has 5 autos, out of that only 3 are working. The TMC needs another 4—5 autos to meet the demand.

Solid waste often gets dumped into open drains, thus clogging them. This leads to stagnation of sullage and breeding of mosquitos. From interviews with the farmers, it is clear that solid waste also gets into the drains and interferes with the water flow. Farmers have devised ingenious methods of separating solid waste from wastewater.

There is also a need to assess if a combination of solid waste and stagnant wastewater leads to contamination of drinking water, especially in places where drinking water lines are placed close to the storm water drains.

2. The Informal Sector and their Business Models

Private Water Suppliers

Vijayapura has 60—80 private water tankers. In a parched landscape such as Vijayapura, the water supply sector provides ample business and employment opportunities. It is no wonder that these tankers come in such varied sizes ranging from 2,000 litres to 4,000 litres. It is not unusual to see water being transported on a variety of carriers such as bullock cards, hand carts, auto rickshas and tractors.

We interviewed one of the suppliers, Ranjan who supplies water on tractor to hotels, commercial complexes, farms and households. He charges around ₹180—400 for 2,000 to 4,000 litres of water. On a typical day, he supplies to 4—5 customers but it can go up during summer. He invested ₹2,50,000 for the tractor and tanker a year ago. He also has to pay the private borewell owner for the water. According to him with his current earning, he need two more years to break even. He says competition is very high in Vijayapura.

The private water suppliers are instrumental in providing livelihoods to at least 150 people.

Ring Manufacturers

Vijayapura has four private ring makers. They make rings of 2.5 ft to 5 ft diameter cement rings for the dual purpose of storing water and for sanitary pits. For water storage tanks, the gaps between the rings will be closed with cement. For sanitation, the gaps between rings will be increased by placing stone chips. Usually, the sanitation pit depth would be around 5 feet (3 rings of

1.5 ft height + the stone packing in between). On an average each vendor sells 3-5 rings per day and the 2.5 ft dia ring costs around ₹400. Each vendor employs three people. The ring manufacturers of Vijayapura provide employment to 12 people.

Private Honeysucker Operators

Vijayapura has only one private honeysucker. A resident of Vijayapura, this operator bought a second hand machine two years back for ₹8,00,000. He provides services not only in Vijayapura Town limits but also in nearby villages. He charges ₹1,000 per operation within town limits and upto ₹1,500 outside. If the client owns a farm, this faecal sludge is deposited on the client's farm. If not, the sludge is deposited on the land of any farmer willing to buy it. On an average he gets 20 to 30 orders per month. He also employs two people — one as a driver and another cleaner to whom he pays daily wages.

Farmers

Farmers around Vijayapura play an important role in resource recovery and reuse of nutrients in two different ways.

Farmers who directly use wastewater for fertigation

About 50 farmers with average land holding size of 4-5 acres are using the wastewater for irrigation purposes. Wastewater is used to grow mainly mulberry, maize and beetroots. They have an informal arrangement for sharing wastewater. Each farmer gets access to the wastewater once a week or once in ten days. Each farmer pumps 50,000 L to 1,00,000 L of wastewater.

Figure 29 - 34



Leach Pits



Wastewater stored in jackwells before use



Surface irrigation using gravity



Channelling wastewater into furrows



Faecal sludge from honeysuckers deposited on farms



Mulberry grown using wastewater

In one of the cases that we documented, Muniraju, a farmer who uses wastewater, does not use any fertilisers and uses less power to pump groundwater as compared to his neighbour who uses fertilisers worth nearly 50,000 per year/crop. He started this practice of wastewater fertigation due to acute shortage of freshwater availability. Muniraju now produces better quality mulberry which he sells at 500 per gunny bag compared to his neighbour who sells it at 400.

Farmers who use faecal sludge for fertilising their fields

Several farmers have an informal arrangement with the drivers of honeysuckers who deposit the faecal sludge on the lands for a fixed payment. This sludge is allowed to further decompose in large pits and later applied on soils.

Some farmers also apply faecal sludge directly on the soil and allow it to dry before ploughing. Their concern is that the sludge does not flow easily over their land and thus does not spread evenly over the land.

Vegetable Washing Units

Vijayapura has small units where vegetables are washed in freshwater after harvesting and before delivery to the markets. These units source freshwater from borewells. Three to four tanks are built to hold fresh water and vegetables, especially root vegetables are washed in each of these tanks before being packed into gunny bags.

Figure 35 - 37: Beetroots being washed at the vegetable washing Unit



The vegetable washers pay ₹10 per bag to the water tank owner and labour charges of ₹250— ₹300 per head. At least 10 labourers are required to wash a truckload of vegetables. While unwashed beet is sold at ₹22, cleaned beet is sold around ₹28 per Kg. Once washed, these vegetables are sold in markets as far as Chennai.

These washing units provide an essential service of washing vegetables that are grown using wastewater, thus mitigating any potential risks.

Contribution of informal enterprises and farmers to sanitation

The informal sector plays a crucial role in recovering and reusing water as well as valuable nutrients from wastewater by applying it to land. In this process, the farmers also ensure that wastewater is treated. In essence, these farmlands play the same role as an STP but at zero cost to the Municipality.

It is also important to note that the farmers are also reducing the load on the already depleting groundwater levels.

As mentioned earlier, the washing units also provide an important service of mitigating the potential risks involved in using wastewater in growing the crops.

The informal sector is instrumental in providing these essential services to the entire town while also generating hundreds of livelihood options. However, they are neither compensated, nor given any kind of support. It is important to recognise the public service they provide and support them by at least minimising the risks they are exposed to.

Risks and Challenges from a Water and Sanitation perspective

It is clear that the broader WATSAN challenge for Vijayapura is the overriding context of water scarcity. Groundwater being the lifeline, and groundwater tables having fallen dismally low, Vijayapura's larger challenge is ensuring source sustainability and equity of water supply. The larger groundwater sustainability issues however, may be driven by agricultural groundwater practices around and the TMC may not be able to entirely manage groundwater within its boundary. Vijayapura is unique in Bangalore Rural District to actually have UGD infrastructure, even though facility to treat of wastewater is missing.

More specifically the Risks that faces Vijayapura are as follows

Health and Environmental Risks and Potential Mitigants

- i. Vijayapura's water and sanitation system poses potential health risks at different points. At the water supply end, with deep groundwater, new problems such as high fluoride levels may be emerging. This has partly

- been mitigated by the creation of a R.O. water vending kiosk. However, the benefits of this may not be equitable given the relatively higher cost of drinking water from even the Municipal R.O. plants. Regular monitoring of water quality is weak.
- ii. Within the town, water supply lines, sullage and solid waste are all mixed up in storm water drains causing stagnation, potential risk of contamination of water supply and potential vector-borne disease problem in the town, especially during rainy seasons. Focussing on solid-waste management will have significant benefits for sanitation. Further, creating a protocol for regular water testing at distribution points will help ensure integrity of water supply systems.
 - iii. Designing and enforcing appropriate leach pit and septic tank designs for different properties that are also practicable and enforceable will help managing onsite sanitation better.
 - iv. The use of faecal sludge and wastewater in agriculture is not found to pose significant health risk due to good practices such as crop choice, washing of edible products before reaching the markets and the farmers' own hygiene practices. However, risk mitigation could be undertaken through strengthening of practices of the farmers and honeysucker operators.
 - v. Given that Vijayapura has only domestic sewerage, it is not expected that application of sewerage or faecal sludge on soils should chemically contaminate it. Regular tests of sludge, waste-water and soil samples can help monitor and ensure this does not translate to environmental risks.
 - vi. The extent of increase in pesticide / herbicide use in urban and peri-urban agriculture due to wastewater use for irrigation may represent some environmental or health risk. However, this needs to be studied for the risks to be established.

The Critical Challenges that Vijayapura faces are:

Sustainability Challenges

- i. The most significant sustainability issue is that of water availability. Given that demand is at around 80-90 LPCD, demand management has limited scope within the town. Further, the private informal supply system prices water in a way that necessary economic signals for demand management are being sent. Designing and enforcing building bye-laws that can harvest rainwater and enhance local recharge will help towards augmenting water supply and contribute to groundwater sustainability.
- ii. A critical challenge is that the groundwater situation may be a result of the broader agricultural use of water around the town and therefore may not be entirely possible to manage within the town.

Equity Challenges

- i. Given the presence of a large informal private water supply system, a challenge that the municipality will need to deal with is the affordability of water for the relatively poor in the town.
- ii. The SBM is of course dealing with access to toilets and the town seems to be dealing with universal access to sanitation with the help of SBM.

The Staffing and Capacity Challenge

- i. The institutional structure of TMC implies that the Environmental Engineer, the two Health Inspectors and the Junior Engineers are the foot soldiers of the TMC to deal with the entire gamut of WATSAN challenges. In a context where the WATSAN “drama” on the ground is so complex, these foot soldiers need to be empowered and incentivised to observe, apply common sense and innovate in the way the TMC can respond to such a situation.
- ii. The health care delivery department (PHCs, govt hospitals and pvt hospitals) of the TMC or the TMCs own health department need to coordinate and exchange more information and data to keep track of how health risks are realising within the town. Making health outcomes a critical focus for sanitation is still missing.
- iii. To deal with the drama on the ground, interdisciplinary engagement looking at Water-Sanitation, health and agriculture is necessary. The TMC needs to be equipped to have such interdisciplinary responses.

However, in the context of Vijayapura, it is clear that both on the water supply and on the sanitation front, whatever is happening informally or privately is far too important to the Town’s water and sanitation needs. The scale of this “parallel” water and sanitation drama is in fact the mainstream and the formal municipal system is “supplemental”. The most important challenge that the municipality should be framing for itself is how will the municipality play a “stewardship” role of the informal system such that its positive benefits are retained and its negative externalities are minimised or mitigated.

The Sanitation Safety Plan developed by the WHO⁶ can be simplified and used as a tool to address some of the above challenges. This however, needs for it to be institutionalised as a tool for all such TMCs at the state level.

In summary, the informal sector, especially in sanitation, provides useful services and achieves resource reuse and recovery in Vijayapura. Any health risks it may introduce are easily mitigable and therefore the Municipality should evolve a response such that it “stewards” the informal sector to strengthen

⁶ World Health Organisation. (2016). Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta.

its service provision, equity, sustainability, resource-recovery and livelihood generation dimension and at the same time tries and minimises any potential risk or negative externality. Such a response can be broadly expressed as in the following table:

Table 17: Role of informal sector in Vijayapura Water and sanitation: Indicative responses that Municipalities can undertake

Service provision	Desirables achieved for the town	Potential risks introduced where municipality can add value through “nudges”
Water supply by Private water tankers	Meets a HUGE unmet demand in the town, Creates livelihoods	Inequitable distribution of groundwater based on affordability
Pit ring makers	Enable onsite sanitation, creates livelihoods	Educate pit ring makers and masons on building byelaws – pit and septic tank designs through workshops. Share information with these stakeholders
	Meet unmet demand for desludging in and around town, creates livelihoods	Discharge into farms. However given current farm practices, this does not represent big health risks. Municipality could register private honey suckers in a town and show them farmers who are willing to accept fecal sludge.
Farmers using fecal sludge	Sanitise the fecal sludge.	The current practice is to apply faecal sludge to land by spreading. This practice could be informed by science – municipality can help farmers with information on right kind of composting and safe use of compost . It can and keep an eye on farmers composting faecal sludge. But encourage them to practice good practices. It needs to partner with Agri-universities for this.
	Reuse nutrients from fecal sludge	Municipality along with an agriculture university can develop and share information on nutritional value of fecal sludge and how to apply it to various crops . GKVK in Bangalore already has some research conducted on these aspects.

Service provision	Desirables achieved for the town	Potential risks introduced where municipality can add value through “nudges”
Farmers using wastewater	Sanitise wastewater, reuse of both water and nutrients, ensure productivity of land and protect agricultural livelihoods.	<p>Sanitise wastewater, reuse of both water and nutrients, ensure productivity of land and protect agricultural livelihoods. Increased use of herbicides, pesticides. Potential contamination of food products though current farm practices suggest that health risks are small especially given the crop choice, “vegetable washing” enterprise and cooking culture.</p> <p>Municipality can work with farmers and GKVK to develop a “best practices” culture with farmers.</p>

Section IV

Synopsis: Learning from Informal Sector

Synopsis Learning from Informality

This document provides a synopsis of different informal sector businesses in the three towns and their relationship to the municipality. Further it illustrates (through the case of the Vijayapura Town) how the application of the Sanitation Safety planning process can forge a response of a municipality to this sector with the eventual aim of achieving universal sanitation services, resource recovery reuse and public & environment health management. In the process livelihoods are also generated and strengthened.

Synopsis of Informal Sector Businesses across Towns

The most relevant dimensions from the perspective of this research however, is how each of these businesses contribute to (or not) to universal service coverage, resource recovery and reuse of sanitation waste, livelihood generation or strengthening and health & environment risks or their mitigation.

Firstly, the very existence of many of these businesses is often because of the inadequacy of the formal Municipal system to deliver services. Secondly it can also be seen that often these informal businesses also compete with the Municipal system. Thirdly it can be observed that much enterprise has evolved in the critical space of the final resource recovery and reuse of the wastewater irrigation service providers, farmers using fecal sludge and wastewater for irrigation. Fourthly, there are informal enterprises, such as those that facilitate washing of vegetables with freshwater before they go to the markets, that are actually contributing to public health risk mitigation. The Municipality is particularly “absent” in its official capacity to take pro-active measures for disposal of fecal sludge (even when pit evacuation is conducted by the Municipality) or untreated wastewater in this context informal enterprise is demonstrating both resource-recovery and potential health and environment risk management thus completing the Municipalities incomplete sanitation chain. In doing so the informal enterprise also generates much needed local employment.

This raises the question then, how should the Municipality relate to these informal enterprises? Should it treat them as private players to be “regulated”? Or should it treat them as co-creators of value in a sanitation chain whose work can be integrated seamlessly into the Municipal system without taking away their autonomy and spirit of free enterprise? If it takes the latter route, can it in fact prove economical for the municipality and allow for an incremental approach to improving sanitation? In such a case how should the Municipality manage any risks posed to public health or the environment? We suggest, that WHO’s Sanitation Safety planning can be a very important tool/process that can help answer all these questions – it is specifically designed

for the context of increasing urbanisation when infrastructure cannot quite keep with its pace.

To demonstrate the above, the section following this one is the illustrative application of the Sanitation Safety Planning (SSP) process to two farm boundaries in the town of Vijayapura – where water tables are very deep, water is scarce, informal sector is thriving and the town struggles with water resource management. A part of the SSP is the articulation of a “sanitation improvement plan”. This then becomes the basis for recommendations for the town of Vijayapura. The final part of this research output will therefore be a set of detailed recommendations for the town of Vijayapura’s sanitation which they can implement, within their financial capacities and can demonstrate how they can integrate the work of the informal sector as an integral part of the Municipal sanitation vision.

The Sanitation Safety Planning (SSP) Process:

The Sanitation Safety Planning Process (SSP) is a tool developed by the WHO which will help apply its Wastewater Reuse Guidelines 2006-2007. This was developed in a context of increasing urban wastewater reuse in agriculture in the developing world. The SSP documents the existing sanitation chain and identifies in the existing chain critical hazards & hazardous events, exposure routes and exposure groups to these hazards and assesses risks of these exposures. It also identifies existing risk mitigants. Based on this it rates the different risks that a given Sanitation system represents within the boundary in which this exercise is carried out. It therefore guides improvement in the sanitation system by helping imagine new implementable risk barriers which need not be only infrastructure investments. It effectively brings all stakeholders together in the process thus ensuring health workers, sanitation engineers, farmers and the community interact to arrive at economical practical and incremental improvements to the sanitation system that incrementally reduces public health and environmental risks.

Applying the SSP to Vijayapura’s Waste-water based Agriculture:

This section presents the results of the application of the SSP exercise to two farms in Vijayapura using wastewater for irrigation. However, before delving into the specific SSP Exercise the below represent some observations of the town as a whole and reflects on different aspects from a public health and environment risk perspective.

Within the town, most parts of the town are connected to the Under-Ground

Drainage system (UGD) which discharges wastewater at specific points into open storm water drains. Further, it is observed that most people use “R.O. water” – vended through Kiosks - for drinking and cooking. Therefore, piped water is largely for domestic non-potable purposes such as washing and cleaning. Any limited leakage of wastewater from the UGD or any wastewater flowing in open storm water drains within the town has little risk of contamination of drinking or cooking water. Piped water contamination due to sewerage leaks has limited health risk consequence. However, solid waste clogging the drains is of concern as it tends to clog the UGD and storm water drains as well.

Once the UGD opens out into a natural storm water drainage, wastewater follows open channel flows. Here farmers are intercepting these flows and using it for irrigation in agriculture. This drainage takes these flows downstream into the nearby Badanekere Tank – flows reach this tank however only during the monsoon when wastewaters are highly diluted by monsoon storm water flows. The tank is dry most of the year and its surface waters when they do exist is not directly used as a source for any drinking water purposes. Vijayapura Town has sunk borewells in this tank as their source of water – however these borewells are in above a depth of 650 ft.

Broadly, it can be said that the entire wastewaters of Vijayapura are effectively being applied to the agricultural lands in and around Vijayapura because farmers are intercepting its flow before it reaches any water body. It is here that both the water and the nutrients of the wastewater are reutilized and the resource recovery objective of wastewater treatment is achieved. In order to examine the risks involved in this process, the farm becomes an ideal place to apply the Sanitation Safety Planning (SSP). This research has chosen two farms along one of the wastewater streams — one farm upstream and one downstream of wastewater flows.

The SSP Boundary Selection:

The overall flow of Municipal boundary and flow of wastewater in Vijayapura is depicted in the following map.

Map 6: Vijayapura Municipal Boundary

Vijayapura

- Vijayapura Town Boundary
- Storm Water Drain 1
- Storm Water Drain 2
- NO Plant
- Yekurvali Pump House
- Mariyappa's Farm
- Mangappa's Farm



Farm 1: Mariyappa's Farm

Mariyappa owns about 2 acres of land upstream of the storm water drain to which Vijayapura's UGD is connected.

Map 7: Location of Mariyappa's Farm



His only source of water, a 30 ft deep well went dry 30 years back. He has invested only in a pipeline to divert sewerage wastewater to his farm. The geographical location of his farm helped him to get wastewater through gravity.

He grows Mulberry, fodder crops and some vegetables such as tomatoes, chillis and brinjals in his farm. He is the first farmers (in order of flow of wastewater) to tap into the wastewaters.

Farm 2: Muniraju's Farm

Muniraju is one of the earliest and most successful farmers using wastewater for irrigation in Vijayapura. He owns 4 acres of land downstream of the same stormwater drain and largely grows mulberry. He tends to his farm with the help of his wife and four children. About 20 years ago, Muniraju's borewells went dry. Due to acute shortage of freshwater, both above and below ground, he hit upon the idea of diverting the wastewater stream that flows along his fields. He dug a jackwell-like structure where the diverted wastewater is stored. From here, the water is pumped to the field into furrows and spread across the field through gravity. However, the wastewater also brings with it a lot of solid waste. He has devised an ingenious method to separate this — he has fitted the pump with a mesh so that only water gets into the pump leaving the solid waste in the jack-well.

Initially the family grew mulberry and beets but are now growing mulberry due to increased market demand for the same. Vijayapura's economy largely relies on production of silk yarn for which mulberry is a key resource. Muniraju's mulberry especially has high demand because the nutrient-rich wastewater gives a better yield, both in terms of quality and quantity. Apart from mulberry, they also grow fodder crops. The crops are sold to local markets or to vendors who buy directly from him. Apart from the income, he also saves around Rs 50,000 per crop on the expenses of fertilisers, and borewell maintenance charges.

Muniraju's success with using wastewater is exemplary. Not only has he been able to educate with four children solely due to the income from the farm but has also set an example to neighbouring farmers.

Map 8: Location of Muniraju's Farm



The SSP Risk Assessment and Sanitation Improvement Plan

The Enclosed XI sheet titled “SSP Application to Vijayapura town” provides a risk assessment within the aforementioned SSP Application boundary. The basis for the risk assessment is

- a. Rapid one-on-one discussions with key stakeholders such as farmers, labourers, informal sector entrepreneurs and municipal officials (Refer to Annexure I). During these discussions conversations on health and lived experience of illnesses or diseases were also included.
- b. Sampling and Lab testing of water quality samples (Refer to Annexure II)

Farmers & farm labourers, Sanitary workers of the town, Resident community of the town and end consumers of agricultural produce have been considered as the various stakeholder groups for whom health risks have been assessed. These risks have been analyzed specifically for the use of waste-water for irrigation in local agriculture. A similar exercise can also be done for use of fecal sludge in agriculture. Different elements in the sanitation chain are considered within the relevant boundary, and for each element hazardous events and hazards that will expose different stakeholder groups to health risks are identified. Existing barriers to these risks are also documented. These risks are then rated based on a semi-quantitative method.

What can be seen from the SSP Risk assessment matrix is as follows:

1. There are many existing health risk barriers built into the sanitation chain that are effective. These risk barriers are many and particularly effective

for agricultural produce consumers. The risks to general residents of the town are also relatively. The farmers, farm labourers and sanitary workers do get exposed to some high risks – however hygiene practices amongst farmers are found to be currently a significantly important barrier to risk realization.

2. An engagement with the Farmers and Sanitary workers to develop good practices that create further risk barriers and that enhance the awareness of their members to the risks they are subjecting themselves to will be very beneficial in managing overall public health risk.
3. The critical physical points of risk exposure are the points where wastewater flows are diverted from the open channel drainage, brought into the farm into a temporary “jack well” from which it is then pumped across the farm for irrigation. Therefore, concentrating on these points for possible interventions that reduce risks here will be of great usefulness.
4. Some heavy metal load is observed, likely from the cottage industry of silk dyeing that exists in the town. The scale of this industry is small and the town has to ensure that these pollutants do not mix with domestic sewerage in the UGD.

Recommendations for Vijayapura : A Sanitation improvement Plan

Based on the risk assessments, the following are the key recommendations:

- I. Begin to address upstream and connected problems:
 - a. Solid waste management of the town needs to be improved. Segregation, recycling of dry-wastes, disposal of bio-medical wastes as per bio-medical waste guidelines and wet-waste management so as to capture its nutrient value is recommended. This is a journey in itself – however it is critical to invest in that for overall sanitation.
 - b. Ensure chemical pollutants from the cottage silk-dyeing industry is captured and contained and preferably not allowed to mix with domestic sewerage.
- II. Some simple Engineering and integration of wetlands to reduce risks for farmers & sanitary workers:
 - a. If diversions of wastewater from storm drains into farm jack wells can be engineered so as to minimize manual handling and direct contact of farmers with wastewater, a significant set of risks will be reduced.
 - b. Inculcating a culture of protective gear to be worn by farmers and sanitary workers during operations & maintenance at these physical locations will help reduce risks. This can be an uphill task given Indian culture however.

- c. Integrating wetlands into the storm drains will help reduce nutrient and heavy metal loads.
 - d. Instead of the jack well, farmers could be diverting the wastewater into a small wetland in their farms which will help with one level of treatment of the wastewater. Wetland species can be such that fodder crops for cattle can come from the wetlands. In this way, both land is utilized productively as well as it doubles up as a resource to build resilience against pollutants.
- III. Engage with Farmers and Sanitary workers, informal sector operators and develop best practices & share this information:
- a. Share health related risk information with these stakeholders and information on risk mitigating behavior such as personal hygiene practices after farm operations.
 - b. Involve agriculture experts to fine tune and hone practices of wastewater irrigation or fecal sludge composting and application on the farm to maximize agriculture benefits, minimize undesirable effects on agriculture as well as minimize health risks from these practices. Share these practices with farmers. Create space and allow farmers to learn from one another.
 - c. Register private and informal honeysuckers (vacuum trucks) and share with them the information of which farmers are interested in using fecal sludge in their farms. Develop best practices / SOPs for discharging the contents of the vacuum trucks into the farms. Share this information with informal operators and farmers.
 - d. Design regular (annual or bi-annual) free health camps for farmers, labourers and sanitary worker communities to monitor health especially from potential risks related to waste-water or fecal sludge use. Utilize local health professionals for this try and get private hospitals to participate too. Encourage through this process a “vigilant public health watch” eco-system that is watching in parallel to the formal system.
 - e. Periodically monitor if best practices and hygiene practices are being followed and investigate if not why not – so as to take corrective measures.
- IV. Regular watch on water quality and public-health developments:
- a. Create a protocol for regular water testing at source level, distribution level and consumption level. Town will have to work out access to water testing labs for this appropriately. Local private hospitals can also become a part of this process to look for micro-biological contamination for water borne diseases.
 - b. Similarly regularly monitor wastewater quality if possible – this may require access to some advanced lab. Monitor especially those kinds of

- pollutants that local industry (if any) is expected to discharge.
- c. Keep health data available from both government and key private hospitals – and constantly try and correlate health risks and actual diseases burdens.
 - d. This “Watch” function should feed into corrective and preventive actions that can reflect themselves as further improvements in sanitation as time progresses.

Conclusion

As can be seen from the above set of recommendations, improvements can be small and incremental. These need not always be investments in infrastructure. More importantly there is equal emphasis on stakeholder awareness and behavior management – therefore communication is given equal importance. In this paradigm, dialogues will need to be built between the informal players and the municipality without delegitimizing informality and the benefits of the same.

The approach is to try and learn from the strengths of these practices, strengthen its weaknesses and mitigate the risks embedded. Through this approach, in small towns, sanitation can begin to achieve the goals of public and environmental health, resource recovery and reuse, equity of service provision and livelihood protection incrementally and sustainably. Perhaps, this will also be the more economical way to sanitize our small towns.

Table 18: Comparison of different Informal sector Watsan Businesses

This spreadsheet captures the business models of all the informal businesses in the water and sanitation sector in the three towns selected for this study. It also gives a comparison of the sectors in different contexts of each town/city. The last two rows documents the relationship of these businesses with the TMC/CMC and safety issues from the sanitation perspective.

Estimated number of businesses	Ring Makers		Private Honeysucker Operators		Farmers Using Faecal Sludge		Farmers Using Wastewater		Irrigation Service Providers	Vegetable Washing Units	
	Belagavi	Vijayapura	Kundapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Vijayapura	
	5	4	Not Known	1	1	Not known. Only the private honeysucker deposits it on farmlands.	7—8 Farmers	1,300 (Based on an estimate that about 2,000 hectares of land is fertigated along 15km of the Bellary Nala, i.e., upto 3km on either side of the Nala. The average landholding is about 4 acres).	50	50	4—5 Units
Service/Product	Ready made toilets for leach pits or septic tank, including rings for leach pits and components of the septic tank. Pre-cast concrete toilet parts are made in rural areas of Belagavi and these are shipped throughout Belagavi district including Belagavi City. Around 15-20 parts of toilets shipped to the client place and fitted within a day's time.	Pre-cast concrete rings for lining of leach pits and water storage tanks. Typically, single pits are used for toilets. Diameter of each ring may vary from 2ft – 5ft and are 3-5 ft deep. The rings may also be used to build cheap storage of non-potable water	Traditionally, laterite stone was used and therefore a square / rectangular pit was used but now there is a 70—80% change from laterite to cement. With this change, the pits too are becoming circular. This change is driven due to the cost-effectiveness of cement rings and labour constraints. Since most construction takes place during summer, it results in a sudden spike in the demand for and shortage of labour.	10-year old honeysucker truck. Operates around Belagavi City to empty septic tanks. Faecal sludge in open areas or in private farm lands.	2-year old honeysucker truck. Operates in around Vijayapura town to empty single leach pits or septic tanks. Dumps the faecal sludge in open nalas or in private farm lands.	Farmers use faecal sludge to grow crops.	Farmers use faecal sludge to grow crops.	Farmers along either side of the Bellary Nala, use waste water generated in the city to grow a variety of crops.	Farmers along two storm water drains that carries waste water generated in the Town grow a variety of crops.	Farmers pump sewage water to their respective farms and neighbouring farms upto the distance of 2-3 kms.	Ground water is pumped into three to four tanks where vegetables grown in neighbouring villages and towns are washed before transporting to markets. Sometimes Farmers from as far as 100 km come here to wash their produce.

Activities of the Business	Ring Makers		Private Honeysucker Operators		Farmers Using Faecal Sludge		Farmers Using Wastewater		Irrigation Service Providers	Vegetable Washing Units	
	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura			
	Pre-cast concrete parts are made as per order in rural Belagavi. The charges include transportation, labour and fitting charges	In a defined spot, the concrete rings are cast. This is done on a pre-ordered basis. The "transportation partner" transports the rings to the client	Traditionally, laterite stone was used and therefore a square / rectangular pit was used but now there is a 70 — 80% change from laterite to cement. With this change, the pits too are becoming circular. This change is driven due to the cost-effectiveness of cement rings and labour constraints. Since most construction takes place during summer, it results in a sudden spike in the demand for and shortage of labour.	Manager gets orders through phone call. The driver visits the place, collects the faecal matter into the honey sucker tank. Deposits the collected matter in private farm lands or open areas	Own-er-cum-driver gets orders through phone. Visits the place, collects the faecal matter into the honey sucker tank, dumps the collected matter in private farm lands or in private Farmlands	Belagavi: Farmers near the City buy Faecal Sludge from Honey-sucker operators through an informal arrangement, compost it on their field and use the compost as manure to grow crops. Some farmers also spread Faecal sludge directly on the Farm and allow it to dry/compost before ploughing the field. In this process, they help in reuse and recycling of nutrients.	Vijayapura: Farmers around Town buy faecal sludge from Honey-sucker operators through an informal arrangement, compost it on their field and use the compost as manure to grow crops. Some farmers also spread Faecal sludge directly on the Farm and allow it to dry/compost before ploughing the field. In this process, they help in reuse and recycling of nutrients.	Belagavi: Farmers either intercept the wastewater stream directly or buy wastewater from the 'Irrigation service providers' and use the wastewater to grow crops. Apart from recycling and cleaning the wastewater, this process also helps in recovery of nutrients. Farmers who use wastewater have an informal arrangement of sharing the water. This planning and sharing is done cooperatively by all the Farmers. As a result, each Farmer irrigates the land every three to seven days.	Vijayapura: Farmers either intercept the wastewater stream directly and use it to grow crops. Apart from recycling and cleaning the wastewater, this process also helps in recovery of nutrients. Farmers who use wastewater have an informal arrangement of sharing the water. This planning and sharing is done cooperatively by all the Farmers. As a result, each Farmer irrigates the land every three to seven days.	Belagavi: Install a pump and motor on the banks of the Bellary Nala, placing filter around the pump, provide necessary power connection and lay down pipelines till the farms.	Vijayapura: Three to four tanks are built to hold fresh water and vegetables, especially root vegetables are washed in each of these tanks before being packed into gunny bags. Ample parking space is provided for transport vehicles to park. These washing units provide an essential service of washing vegetables that are grown using wastewater, thus mitigating any potential risks.

Market	Ring Makers		Private Honeyucker Operators		Farmers Using Faecal Sludge		Farmers Using Wastewater		Irrigation Service Providers		Vegetable Washing Units	
	Belagavi	Vijayapura	Kundapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Vijayapura
	Any household, school or commercial complex who are looking for quick construction of toilet without much fuss.	Typically, any new household or commercial complex being constructed use these rings to make toilets. Households, shops, farms etc building small water storages will need these rings	Traditionally, laterite stone was used and therefore a square / rectangular pit was used but now there is a 70 — 80% change from laterite to cement. With this change, the pits too are becoming circular. This change is driven due to the cost-effectiveness of cement rings and labour constraints. Since most construction takes place during summer, it results in a sudden spike in the demand for and shortage of labour.	Any household, industries, schools and commercial complexes in peri-urban areas where municipal services dont exist	Any household, industries, schools and commercial complexes	Depending on produce Farmers use their existing market linkages to sell their products which could be middlemen, local markets, APMC yards, commission agents etc	Depending on produce Farmers use their existing market linkages to sell their products which could be middlemen, local markets, APMC yards, commission agents etc	Depending on produce Farmers use their existing market linkages to sell their products which could be middlemen, local markets, APMC yards, commission agents etc	Depending on produce Farmers use their existing market linkages to sell their products which could be middlemen, local markets, APMC yards, commission agents etc	Farmers farming on both sides of the Bellary Nala upto 2-3 km on either side for a distance of around 15 km from Belagavi	Middlemen and aggregators of vegetable produce who are transporting vegetables after procurement from farmers to either local or markets in cities such as Chennai and Bengaluru	

Revenue streams	Ring Makers		Private Honeycucker Operators		Farmers Using Faecal Sludge		Farmers Using Wastewater		Irrigation Service Providers		Vegetable Washing Units	
	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura
	Payment towards product and services	Payment towards product		Payment towards per trip per certain distance	Payment towards per trip per certain distance. Good-will payment from farmers who buy faecal sludge, not a reliable source of income	Sale of produce grown on the land.	Sale of produce grown on the land.	Sale of produce grown on the land.	Sale of produce grown on the land.	Sale of produce grown on the land.	Hourly charges of pumping sewage charges to the respective farmers	Vegetable washers pay ₹10 per bag to the water tank owner
			Traditionally, laterite stone was used and therefore a square / rectangular pit was used but now there is a 70 — 80% change from laterite to cement. With this change, the pits too are becoming circular. This change is driven due to the cost-effectiveness of cement rings and labour constraints. Since most construction takes place during summer, it results in a sudden spike in the demand for and shortage of labour.									

Resources	Ring Makers		Private Honeysucker Operators		Farmers Using Faecal Sludge		Farmers Using Wastewater		Irrigation Service Providers	Vegetable Washing Units
	Belagavi	Vijayapura	Kundapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi
<p>1. Typically a 3-5 member team with skills of casting</p> <p>2. A land of 40-60 ft or more.</p> <p>3. A water storage tank</p> <p>4. A shed to store cement, msand and reinforcement</p> <p>5. A rented or own vehicle to ship toilet models with labourers</p>	<p>A 3-member team with skills of casting. Small piece of land of size approx 30-40ft or more. They may use roadside public space too. A water storage tank (usually self fabricated)</p> <p>Source of water, may be even tanker. Shelter to store cement, M sand, reinforcement, steel, and moulds</p>	<p>Traditionally, laterite stone was used and therefore a square / rectangular pit was used but now there is a 70 — 80% change from laterite to cement. With this change, the pits too are becoming circular. This change is driven due to the cost-effectiveness of cement rings and labour constraints. Since most construction takes place during summer, it results in a sudden spike in the demand for and shortage of labour.</p>	<p>3-member team, a manager, driver and a cleaner.</p>	<p>2-member team, a driver-cum-owner and a cleaner.</p>	<p>A composting pit 15-20' wide and 4-6' deep. Also composted with sheep/goat/horse manure</p>	<p>A composting pit 15-20' wide and 4-6' deep. Also composted with sheep/goat/horse manure</p>	<p>Family-run. Some farmers dig jackwell-like structures to store wastewater. A pump, motor, improvised devices to separate solid-waste from sewage, pipes.</p>	<p>Family-run. Some farmers dig jackwell-like structures to store wastewater. A pump, motor, improvised devices to separate solid-waste from sewage, pipes.</p>	<p>One operator, Pump, motor and pipelines</p>	<p>A pump, tanks made of stone or cement</p>

	Ring Makers		Private Honeysucker Operators		Farmers Using Faecal Sludge		Farmers Using Wastewater		Irrigation Service Providers	Vegetable Washig Units
	Belagavi	Vijayapura	Kundapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi
Pricing	Range varies from 1,200 to 15,000 depending on the toilet model. Shipping charges might be extra if the client place is too far.	"Depends on the size of the ring. A 2.5' dia ring costs ₹400. A 3' dia costs ₹".	Traditionally, laterite stone was used and therefore a square / rectangular pit was used but now there is a 70 — 80% change from laterite to cement. With this change, the pits too are becoming circular. This change is driven due to the cost-effectiveness of cement rings and labour constraints. Since most construction takes place during summer, it results in a sudden spike in the demand for and shortage of labour.	₹ 1,800 — 2,200 per trip	₹ 1,000 — 1,500 per trip	Farmers benefit from using faecal sludge, the economics of which need to be assessed	Farmers benefit from using wastewater, the economics of which need to be assessed. Anecdotal evidence shows that for a landholding of 4 acres in Vijayapura, about ₹50,000 is saved on inputs. Moreover, due to acute water shortage, the farmer is able to carry out farming solely due to wastewater availability. Further analysis required to understand the economics.	Farmers benefit from using wastewater, the economics of which need to be assessed. Anecdotal evidence shows that for a landholding of 4 acres in Vijayapura, about ₹50,000 is saved on inputs. Moreover, due to acute water shortage, the farmer is able to carry out farming solely due to wastewater availability. Further analysis required to understand the economics.	₹ 40 — 50 per hour	₹ 10 per bag of vegetables
Competition	4—5 vendors in Belagavi district now. They also compete with conventional toilet-building.	4 vendors competing with each other. Territorially distributed		None	None	None	None	Fresh water and Waste water compete and complement each other	None	Other washing Units
Total Employment	15—25	12	Not Known	3	2	Not Known	Not Known	1,300 Families	50	200 — 250 livelihoods

	Ring Makers		Private Honey sucker Operators		Farmers Using Faecal Sludge		Farmers Using Wastewater		Irrigation Service Providers		Vegetable Washing Units	
	Belagavi	Vijayapura	Kundapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Vijayapura
Relationship with Municipality	Individuals in the municipality are likely aware of the existence of these businesses and what and how they contribute to the sanitation chain. However the Municipality does not formally engage with them in anyway. These products ideally should comply with building bye-laws that lay down guidelines on Toilet, leachpit or septic tank designs.			The existence of private honey suckers is known to the municipality. There however is no formal relationship between the two. The private honey sucker enterprise competes with the municipality service and vice-versa. Private honey suckers often fill the service gap when municipality services are not available. The private honey sucker operators articulate that the "government should do something so they benefit - after all we are doing their work"								
				Municipal honey suckers discharge their contents into Bellary Nala from which farmers pick up irrigation water directly or through irrigation service enterprises. Private honey suckers directly discharge into private farms. Narratives suggest that Municipality had disseminated brochures to farmers discouraging use of waste water from Bellary Nala for irrigation. However there is no enforcement of this.	Municipal honey suckers discharge their contents to the farmers field. However this arrangement is not "official". It is driven by the operators networks and relationships rather than sanctioned by the Municipality. There is awareness of these practices however amongst the individuals of the Municipality.	Both Private and municipal honey suckers discharge their contents into Bellary Nala from which farmers pick up irrigation water directly or through irrigation service enterprises. Narratives suggest that Municipality had disseminated brochures to discourage use of waste water from Bellary Nala for irrigation. However there is no enforcement of this.	Municipality is aware of the practice but does nothing to either encourage it, enhance its safety or discourage it. There is also no attempt to link health data or public health related disease burdens with these practices.	Both Private and municipal honey suckers discharge their contents into Bellary Nala from which farmers pick up irrigation water directly or through irrigation service enterprises. Narratives suggest that Municipality had disseminated brochures to discourage use of waste water from Bellary Nala for irrigation. However there is no enforcement of this.	Municipality is aware of the practice but does nothing to either encourage it, enhance its safety or discourage it. There is also no attempt to link health data or public health related disease burdens with these practices.	Both Private and municipal honey suckers discharge their contents into Bellary Nala from which farmers pick up irrigation water directly or through irrigation service enterprises. Narratives suggest that Municipality had disseminated brochures to discourage use of waste water from Bellary Nala for irrigation. However there is no enforcement of this.	Municipality is aware of these enterprises but does not consider or link the Vegetable washing units with food safety / or treat it as a part of the sanitation chain	

Safety Issues From the Sanitation perspective	Ring Makers			Private Honey sucker Operators		Farmers Using Faecal Sludge		Farmers Using Wastewater		Irrigation Service Providers	Vegetable Washing Units
	Belagavi	Vijayapura	Kundapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura	Belagavi	Vijayapura
	<p>From a Sanitation perspective these products have to ideally comply with Building bye-laws. However the municipality can take an "education" approach and try and share preferred practices information with the toilet makers and ring-makers.</p>			<p>The private as well as the formal municipal honey suckers are discharging their fecal sludge in open drains where waste water flows or in farms where farmers demand for the same to use in agriculture. Farmers have developed their own methods to compost / apply fecal sludge to different crops. Safety issues around the operations of the honey suckers and their discharge do exist. These safety issues and their implications for public and environmental health are explored in detail in the application of the Sanitation Safety Planning Exercise on two farms which use waste water in Vijayapura Town as a sample. This same process can be applied for use of Fecal sludge in farming too.</p>							<p>This enterprise greatly reduces risk of food contamination from use of fecal sludge or waste water irrigation. They contribute positively to enhancing larger public health goals. The Municipality should begin to understand this as a part of their sanitation chain.</p>
Notes on Kundapur	<p>Kundapur is a very water rich town with a historical practice of open-wells in each house as well as a toilet with a septic tank/leach pit in each house. Grey water of the house is used up completely in household gardens. Waste waters of the town flow into the estuary which is cleansed by the tidal cycles of the Arabian Sea. Given this history, all "watsan markets" (and therefore informal enterprises) are small and not rampant. However informality in the digging of wells and pits remain and they form the most significant part of the watsan solution for the city. Further there has been informal cooperative piped sullage infrastructure developed by commercial establishments in certain areas which carries their sullage into the estuary. The Municipality is now using this infrastructure to discharge Municipal honey sucker contents to avoid perception of direct discharge into the estuary. The Municipality has and continues to invest in piped infrastructure (water supply and sanitation). Piped water supply however has been only partially accepted by the citizenry.</p>										

5.1 Water Supply Businesses

Table 19

	Private Water Tankers	
	Belgaum	Vijayapura
Estimated number of businesses	120—150	60—80
Purpose	Supplying water in tankers fixed on a tractor, mini truck with a capacity of 2,000 to 6,000 litres capacity.	Supplying water in various sizes and modes tankers fixed on a bullock cart, mini tiller, tractor, mini truck, TATA 407 with a capacity of 500 to 6,000 litres capacity.
Brief Description of the Business	<ul style="list-style-type: none"> a) Buying water from private wells or bore wells b) Supplying to households, industries, commercial complexes and institutions 	<ul style="list-style-type: none"> a) Buying water from private bore wells or extracting from own borewells b) Supplying to needy households, industries, commercial complexes and institutions c) Customized various sizes and modes of water transportation can be seen, like water tankers fixed on push cart, bullock cart, mini tiller, tractor, TATA 407 etc., d) Often the smaller tankers (500-1000 litre range) are supplying to multiple households from a single loading - effectively different households are "sharing a tanker" - a service particularly relevant for smaller households.
Market	Any household, school, commercial complex, industry etc.,	Household, school, commercial complex, farms, small and medium agro industries, cottage industries etc., In the case of Vijayapura town many times even poor households are dependent on the smaller tanker for water supply.
Revenue streams	Payment towards per trip of water supply	Payment towards per trip of water supply
Resources	<ul style="list-style-type: none"> 1. Typically one or two people per vehicle 2. An investment on vehicle customized with a water storage tank and plumbing 3. A water storage tank 4. A shed to park the vehicle 	<ul style="list-style-type: none"> 1. Typically one or two people per vehicle 2. An investment on vehicle customized with a water storage tank and plumbing 3. A water storage tank 4. A shed or a public place to park the vehicle

	Private Water Tankers	
	Belgaum	Vijayapura
Pricing	The rate per kilo litres varies from ₹80/- to 100/-. Price varies based on distance and long term commitment.	The rate per kilo litre varies from ₹ 60 to 100/-. The pricing depends on the mode and quantity of the supply. A bullock cart charges around 80/- to 100/- per kilo litre, whereas a 4000 litre capacity on a mini truck charges 300/- to 350/-
Competition	Competition between different water tankers exist. Water tanker supply usually complements municipal supply. In some cases/areas it is the sole supply. Municipal supply is very limited. “Bulk consumers” with regular/ repeat relationship with same water tanker is common	Competition between different water tankers exist. Water tanker supply usually complements municipal supply. In some cases/areas it is the sole supply. Municipal supply is very limited. “Bulk consumers” with regular/ repeat relationship with same water tanker is common. Sharing of single water tanker amongst many customers also exists especially amongst the poor with low household storage capacities.
Total Employment	150—200	80—100
Relationship with Municipality	Services provided by the private water tankers complement public water supply and thus help in filling a large gap.	
Safety Issues from the Sanitation perspective	The water is supplied directly to the consumers without any filtering. However it is not generally used for drinking.	
Notes on KUNDAPURA	Kundapura town is not facing any water scarcity. Most of the households have individual wells which yield water in the summer too. These private wells supply majority of the Kundapura town water demand. The entire town has only one private water tanker which is used by public in case of emergencies, functions or during mass public event.	

5.2 SSP Application to Vijayapura town

Sanitation Safety Planning: Risk Assessment for Reuse of Wastewater in Irrigation in Farms of Vijayapura

Exposure groups:

- F : Farmers, their family and farm labourers. These are the farmers either staying in the farm or everybody who is working together in the farm.
- S : Sanitary workers of the municipality. These are involved in cleaning and smooth functioning of UGD lines and storm water drains.
- R : Residential Community. The Vijayapura population who stay next to these farms, or visit the farms or interact with farmers.
- C : Consumers. People who buy and consume produce grown by farmers.

Table 20: Sanitation Safety Planning : Risk Assessment For Reuse Of Wastewater In Irrigation In Farms In Vijayapura

Sanitation Chain Element	Hazard/ Hazardous Event	Exposure Route	Existing control measures	Risk Assessment				Proposal for new control measures (Sanitation improvement plan)		
				Exposure Group	Likelihood	Severity	Score		Risk rating	
UGD and stormwater drain	Operations at and Cleaning of stormwater drain after UGD has opened out into the drain near the jackwell to divert wastewater into the jackwell:	Dermal contact and ingestion through cuts and injuries	No significant control measure	S	4	4	16	High	(a) Solidwaste management of Town to be fixed (b) Ensure Silk Dyeing cottage industry liquid wastes are confined and does not mix with sewage (c) Engineer intakes from drain to farm so that minimal direct manual intervention necessary (d) Integrate Wetlands into stretches of open channel flow and maintain the same (e) Try and inculcate a culture of using Gloves and Boots for these operations among the farmers, farm labourers and Sanitary workers	
			No significant control measure	F	4	8	32	High		
	Accidental ingestion	No significant control measure	R	1	4	4	4	Low	(a) Conduct regular health camps for Farmers and Sanitary workers and provide preventive care such as Deworming, vaccinations etc	
			S	3	4	12	Medium			
	Ingestion through the Respiratory system	Washing and bathing after work before consumption of food or drink	F	3	4	12	12	Medium	(a) Conduct regular health camps for Farmers and Sanitary workers and provide preventive care such as Deworming, vaccinations etc	
			R	1	4	4	4	Low		
	Vector borne -through mosquito bites	Does not have any control measures	S	4	1	4	4	Low	(a) Conduct regular health camps for Farmers and Sanitary workers and provide preventive care such as Deworming, vaccinations etc	
			F	4	1	4	4	Low		
	Use of available solutions like Odorous, mosquito coil, mosquito net etc.,	Does not have any control measures	R	1	4	4	4	Low	(a) Conduct regular health camps for Farmers and Sanitary workers and provide preventive care such as Deworming, vaccinations etc	
			S	4	2	8	8	Medium		
F			4	2	8	8	Medium			
				R	3	2	6	6	Low	

Sanitation Chain Element	Hazard/ Hazardous Event	Exposure Route	Existing control measures	Risk Assessment				Proposal for new control measures (Sanitation Improvement plan)	
				Exposure Group	Likelihood	Severity	Score		Risk rating
Reuse of wastewater -intake into Jackwell	Installation/ maintenance of irrigation pump and jackwell : (a) Exposure to bacteria, Viruses, (b) Helminth (c) Lead/ Chromium (Heavy metals)	Dermal contact and ingestion through cuts and injuries	Does not have any control measures	F	4	4	16	High	(a) Try and inculcate a culture of using Gloves and Boots for these operations among the farmers and farm labourers (b) Can the Jackwell be reengineered to be a wetland in the farm that has Fodder species so it is not a loss to the farmer as well as it doubles up as a next level of treatment and risk barrier.
		Accidental ingestion	Washing and bathing after work before consumption of food or drink	F	2	4	8	Medium	(a) Conduct regular health camps for Farmers and Sanitary workers and provide preventive care such as Deworming, vaccinations etc
		Ingestion through the Respiratory system	Does not have any control measures	F	4	1	4	Low	
		Vector borne -through mosquito bites	Uses available solutions like Odomos, mosquito coil, mosquito net etc.,	F	4	2	8	Medium	(a) Conduct regular health camps for Farmers and Sanitary workers and provide preventive care such as Deworming, vaccinations etc

Sanitation Chain Element	Hazard/Hazardous Event	Exposure Route	Existing control measures	Risk Assessment				Proposal for new control measures (Sanitation improvement plan)	
				Exposure Group	Likelihood	Severity	Score		Risk rating
Resource recovery reuse-irrigating the crops and waste water on soil	Making of furrows and standing in irrigation water during farming. (a) Exposure to bacteria, viruses (b) Helminth (c) Heavy metals	Dermal contact and ingestion through cuts and injuries	Does not have any control measures	F	3	2	6	Low	
		Accidental ingestion	Washing and bathing after work before consumption of food or drink	F	2	2	4	Low	
		Ingestion through the Respiratory system	Does not have any control measures	F	2	1	2	Low	
		Vector borne -through mosquito bites	Uses available solutions like Odorous, mosquito coil, mosquito net etc.,	F	4	2	8	Medium	(a) Conduct regular health camps for Farmers and Sanitary workers and provide preventive care such as Deworming, vaccinations etc
Resource recovery reuse-consumption of produce	Consuming the farm produce - (a) Exposure to bacteria, viruses, Helminth and heavy metals	Ingestion	Risk is mitigated in 3 levels. 1) Farmer mostly grows non edible crops 2) The farm support system washes the produce before sending to market 3) The consumer washes the produce again, peels the skin and consumes the cooked food	S	2	2	4	Low	
				F	2	2	4	Low	
				R	2	2	4	Low	
				C	2	2	4	Low	

Risk Rating Guide

Semi-quantitative risk assessment matrix

			SEVERITY (S)				
			Insignificant	Minor	Moderate	Major	Catastrophic
			1	2	4	8	16
LIKELIHOOD (L)	Very unlikely	1	1	2	4	8	16
	Unlikely	2	2	4	8	16	32
	Possible	3	3	6	12	24	48
	Likely	4	4	8	16	32	64
	Almost Certain	5	5	10	20	40	80
Risk Score R=(L)x(S)			<6	7 - 12		13-32	>32
Risk level			Low Risk	Medium Risk		High Risk	Very High Risk

Annexures

Annexure I:

Conversations with stakeholders

Does the Municipality have honey suckers to service onsite sanitation? If yes, how many? **One honeysucker and one jetting machine**

1. Around how many requests do you get per day? What are the charges ?
The municipal honeysuckers get 4-5 requests per day. Most of them on cleaning the blocked UGD lines and chambers. The chambers are blocked frequently due to dumping diapers, plastic and clothes through toilet lines. These services are not charged. Citizens has to give an application and pay 1,000/- (inside town) and 1,500/- (outside town) to clean their toilet pits. The private honeysuckers are competitive and hence most of the private pits are cleaned by private honeysuckers.
2. Where do these honey suckers release the waste?
The municipal honeysuckers have been asked to release in Devanahalli FSTP. However due to distance and time most of the time they release in the stormwater drain or in the nearby private farms.

Drainage System

1. Does sewerage flow in open drains?
75% of the town has UGD lines which carries sewerage is let open in the storm water Rajakaluve. The sullage is flowing in the open drains.
2. Are these storm water drains? If yes, where does water from these drains flow to?
Yes, all the wastewater of the town including sewerage flows in two Rajakaluves and heads towards the Yeluvahalli lake
3. What are the Gaps in terms of geography and demography in different wards (can these gaps be quantified)?
No major gaps identified
4. Is there any industry in the city/town — what are the key industries? What is their effluent? How is it treated? Does it join the same sewerage streams?
There are no major industries in the town. Household level silk rearing, silk extraction, dyeing and weaving cottage industries are there. Yes, the effluents join the sewerage streams. We observed the red and pink colors floating in the sewerage.

- Is biomedical solid and liquid wastes differently treated or joins the same? Are hospitals connected to sewerage network or honey suckers pick up these wastes - where do these go?
The TMC made arrangement to collect bio-medical waste from all the hospitals. The only big government hospital(which is outside the town) is not connected to sewerage network.
- Are there any maps related to water supply/sanitation that can be shared?
Official maps not available. We made one <https://drive.google.com/open?id=1x3RvAHGtynN9di7xqRNeCetsfGI&usp=sharing>

Wastewater and Faecal Sludge Reuse and Recycling

- Is agriculture around the town utilising faecal sludge / wastewater?
Yes
- If yes, what are the crops grown? What are the irrigation practices?
Mulberry, Jowar, Fodder Crops, Ragi, Greens, Flowers.
- What is the estimated average of agricultural land utilises wastewater for irrigation?
Around 50 farms at an average landholding size of 4 acres.
- Is the practice safe? If no, What are the risks associated with it?
No major health risks reported by farmers. In fact the farmers using wastewater have better yield than the borewell water users. The farmers exposed to the sewerage water faces the risk of getting water borne diseases.
- Does the town people know who these farmers are and interact with them?
Yes
- Is there an STP in the town? If no, are there any plans in the pipeline?
No, no plans in the pipeline. The TMC is thinking to have decentralized small FSTPs

Private Players

- Are there private WATSAN service providers (Tankers / honeysuckers?) What is their role? What does the town think about their role?
Yes. There's one honeysucker and close to 100 private water tankers. The water tankers supply majority of the water demand. The town is much more reliable on private suppliers than municipal.

2. Private water tankers: How many? How much water do they supply per day? What are their charges? Where do they source the water from?
Close to 100 private water tankers operate in the town. The capacities vary from 500 litres to 6,000 litres. They get water from private borewells. The charges are 60-100 rupees per kilo litre.
3. Private honeysuckers: How many? What are their charges? Where do they deposit the focal sludge?
One private honeysucker. 800/- to 1,500/-. He deposits in the private land.

Solid Waste

1. What is the estimated waste generated per day for the entire town?
12-14 tonnes a day.
2. Is waste segregated? If yes, how is each category processed?
The waste is segregated in pockets.
3. Is biomedical waste being handled separately and properly or getting mixed with the general MSW?
Yes, a private vendor collects the biomedical waste.
4. Is there an informal sector that takes out useful waste and recycles/ sends it for recycling ?
Yes, the ragpickers collect some of the recyclable waste.
5. Does solid waste also flow into storm water drains ?
Yes
6. Does it interfere with wastewater — black or grey flows in the storm water drains or drainage canals?
Yes
7. Are there drinking water line / pipes laid out near storm water drains causing water contamination?
Yes
8. Implementing Solid Waste Plan — what do you think are the interdependence of sanitation and solid waste?
Vijayapura lacks its own solid waste management plant. Availability of land is also an issue. It used to send to Devanahalli plant. Now dumping the waste in the unused wells in the nearby villages. If the

SWM is handled in a separate plant, the sanitation management will be much easier. At present the municipal honeysuckers troubleshooting the mix of these two everyday.

Agriculture

1. What are the principal crops of the region: season-wise crops
Mulberry, Jowar, Fodder Crops, Ragi, Greens, Flowers. Ragi and Greens in the rainy season
2. What are the major irrigation systems used by farmers?
Borewell water through sprinklers and drip irrigation. Wastewater through furrow irrigation

Challenges of the City/Town

1. Have you had instances of drinking water contaminated by sewerage? If yes, did this contamination happen at the distribution level (i.e. in tanks / pipes) or is it happening at the source level (i.e. bore-well/lake/river)
No major instances reported
2. What, according to you, are the challenges in water supply and sanitation for the town?
Dependence on depleting groundwater, lack of SWM plant and STP to treat sewerage
3. What are the key environmental risks from the water supply and sanitation situation in the town?
Except hygienic compromises no major environmental risks found
4. What are key water quality or wastewater quality tests that you regularly undertake? Do you have records? Is it possible to share the results
No such data available with TMC
5. If not regularly, are there any one time tests that were undertaken?
No
6. Do you face problems of bandwidth with engineers, health inspectors, sanitary workers?
Yes, most of the posts are vacant or have deputed staff. Need another 40% more sanitary workers to cover all the wards

7. Do you feel you are understaffed? How many workers are there for what purpose?
Yes, engineers posts are vacant, 6 sanitary workers at present.
8. Do sanitary workers face any specific difficulties / safety issues? What are their complaints?
No major issues. Their major demand is to fill the vacant posts.
9. What are the difficulties you face?
Absence of elected chairman and interference of elected ward committee members in day to day activities of the TMC
10. What kind of training or exposure or learning or capacity building in WATSAN would you like?
Feels the trainings and exposure provided are adequate

Solid Waste:

1. Is there segregation ? If there is what is process post segregation.
No, segregation happens in pockets
2. Is biomedical waste being handles separately and properly or getting mixed here with the general MSW stream ?
No
3. Is there an informal sector that takes out useful waste and recycles/ sends it for recycling ?
Yes, Ragpickers collects recyclable waste
4. Is there too much solid waste stuck in storm water drains ?
Yes
5. Does it interfere with wastewater - black or grey flows in the storm water drains or drainage canals?
Yes
6. Are there drinking water line / pipes laid out near storm water drains and therefore combination of solid waste, stagnant liquid waste and drinking water contamination risk is there ?
Yes

Water Quality Reports:

Chlorine and alum dosing happens at the pumping stations. The TMC doesn't have record of regular water quality tests done. The private tanker people are supplying water without any treatment. We are yet to get the water quality reports from the TMC.

Farmers choice of crops:

Majority farmers who are using sewerage water are growing these. Non sewerage users are growing Millets, Coconut, Banana and all other vegetables.

Municipal honey sucker and its pricing and where it leaves the fecal sludge?

Municipal honey sucker is charging Rs. 1,000 inside town and 1,500 outside the town limits. They are leaving fecal sludge into the canal and in private farms.

Water and Sanitation in Slums:

Slum dwellers also depend on private water tankers and private borewell owners

Most of the small tankers are made for self consumption and for the own business needs. Commercial operators supply minimum of 1,000 litres at 80. Yes, they service slums too.

Informal Sector: Around 50 farmers with an average land holding of 4-5 acres are using the sewerage water to grow Mulberry and Jowar. They get access to sewerage once in a week/10 days. Each time the farmer pumps around 50,000 to 1,00,000 litres of sewerage water.

Vijayapura has only one private honeysucker. Srinivasayya (99729 20694), a resident of Vijayapura bought a second hand machine 2 years back for 8 lakh rupees. He takes orders in and around Vijayapura town. He dumps the fecal content in their (customer) own farm or into any farmer willing to get it in their farm. He charges around 1,000 inside town and upto 1,500 for the nearby villages. On an average he gets 20 to 30 orders per month. He says he need another 2.5 years to break even.

1. What are the crops that farmers apply faecal sludge for?

Mulberry and Jowar

2. If watertanker owner buys water from a borewell owner how much does he buy the water for?
Rs. 80 to 100 per tanker
3. Pricing of water tankers of different sizes? And what the customer segment for this is?
Rs. 2 to 3 for 20 litres and Rs. 80 for 1,000 litres
4. Pvt HOneysucker:
On an average he gets a load per day and earns around Rs. 1,000 Out of this including wages, diesel his expenses are around 650-700 rupees.

Vegetable washing units:

The vegetable washers pay Rs. 10 per bag to the water tank owner and pays labor of Rs. 250-300. Atleast 10 labourers required to wash a truckload of vegetables. The buying price of raw beet is around Rs. 22 and cleaned beet sold around Rs. 28 per Kg.

Kundapura has very high water table. Each household has own well and water is available at 3-4 feet depth. Almost every household has single leach pit toilet. Municipality has 1 Honeysucker of 6000 litres capacity and 1 Honeysucker cum jetting machinw of 3000 litres capacity. They charge Rs. 1,700 in city limits. Only 2700+ HHs have piped water access.

The UGD line is still work under progress. Interestingly, the commercial buildings, apartment complexes and lodges have contributed money to have 3 independent sewer lines. All these lines lead to the river.

Line 1 has connected with 25 hotels and 15 lodges

Line 2 is connected with 20 hotels and 10 lodges, SBI, 100 hhs and 7 apartments (150 flats)

Line 3 has 2 apartments and 10 hotels. Municipal honeysuckers also leave the collection in these private lines!!! The fishing lacks toilets, for them municipality has constructed public toilets. The outlets of these toilets are let into into the river!

Municipal has proposed 3 STPs for septage treatment.





Kundapura has very high water table. Each household has own well and water is available at 3-4 feet depth. Town municipal has the developed the capacity to supply 3MLD of drinking water to the town at 135 LPCD. Only 2,892 / 8,860 HHs have piped water access. Town has 3 OHTs of 5 lakh litres capacity. The town has no RO plants. It has only one private tanker which too has not much busy. People use it only in case of emergency.

Almost every household has single leach pit toilet. On an average each HH has 10 cents (4,300 sq. ft) of space. The wells are built in-front of the house and toilet pits in the back (approximately 10-15 feet distance between both). Municipality has 1 Honey-sucker of 6,000 litres capacity and 1 Honey-sucker cum jetting machine of 3,000 litres capacity. They charge Rs. 1,700 in city limits. The UGD line is still work under progress. Interestingly, the commercial buildings, apartment complexes and lodges have contributed money to have 3 independent sewer lines. These were constructed 10-15 years back. All these lines lead to the Haladi river.

- Line 1 has connected with 25 hotels and 15 lodges
- Line 2 is connected with 20 hotels and 10 lodges, SBI, 100 hhs and 7 apartments (150 flats)
- Line 3 has 2 apartments and 10 hotels. Municipal honey-suckers also leave the collection in these private lines!!! The fishing community residing on the shore lacks toilets, for them municipality has constructed public toilets. The outlets of these toilets are also let into into the river!

Municipal authority has proposed 3 STPs for septage treatment. One big STP will be of 2.8 MLD capacity and 2 small MBR technology STPs to treat the sewerage of the town. The basis for this calculation, projection of town population for next 30 years x 135 lpcd water supply. 80% of that water supply is the base for STP capacity.

At present Kundapura is not finding any ecological or health issues with sewerage and sullage entering the backwaters of Haladi river. Because of 2 low-tides and 2 high-tides in a day, the wastewater get washed away into the ocean regularly, the species in the river and ocean live on the effluents. Kundapura has a natural water treatment system!

I have collected water samples (from 2 potable wells, a non-potable well, municipal tap connection water) and submitted to the MIT, Manipal lab for testing.

Belagavi municipal corporation has 3 honeysuckers, 2 jetting machines and 2 water tankers(for cleaning public toilets and drainages). There's only one private honeysucker which operates in outside city limits.

The residents give application to municipality for cleaning their septic tanks. The fees are Rs. 1,500 within citylimits and Rs. 2,500 outside city. Municipality's work of clearing blocked UGD chambers is the high priority. The honeysuckers leave the collected waste into UGD lines. If they are outside town, they leave into Bellary nala. Very rarely they dump in farm lands.

There are around 120-150 private water tankers in the city. They get water from private wells. The charges are between Rs. 180 to Rs. 500. They supply water to commercial establishments, swimming pools, industries and individual households.

Annexure II:

Water Quality Tests

Table 1: Sample Location - Muniyappa Farm, Vijayapura. Muniyappa uses raw sewerage from storm water drain, diverts to his farm through gravity force.

S No	Parameters	Test Protocol	Units	Desirable	Permissible	Results
1	pH value	IS:3025(P-11)-1983RA-2002	---	6.5 – 8.5	6.5 – 8.5	7.77
2	Total Alkalinity as CaCO ₃	IS:3025(P-23)-1986RA-2003	mg/L	200	600.00	530.91
3	Total Dissolved Solids	IS:3025(P-16)-1983RA-2002	mg/L	500	2000.00	720.00
4	Nitrates as NO ₃	IS:3025(P-34)-1983RA-2002	mg/L	45	100.00	34.60
5	Phosphates as PO ₄	ALPHA 19th Edition	mg/L	--	--	1.17
6	Total Chromium as Cr	IS:3025 (P-52)	mg/L	0.05	No relaxation	5.20
7	Lead as Pb	IS:3025 (P-47)	mg/L	0.05	No relaxation	1.55
8	BOD at 20° C for 5 days	IS:3025 (P-44)-1993	mg/L	--	--	59.55
9	Chemical Oxygen Demand	IS:3025 (P-56)-2006	mg/L	--	--	182.45
Bacteriological Tests						
10	E-Coli MPN/100ml	ALPHA 23rd Edition 9221-F	NS	Nil	Nil	280.00
11	Faecal Coliform MPN/100ml	ALPHA 23rd Edition 9221-F	NS	10	10.00	300.00



Table 2: Sample Location - Muniraju Farm, Vijayapura. Muniraju uses raw sewerage from storm water drain, stores in a jack well. After manually cleaning the solid wastes from it, pumps to the farm through furrow irrigation.

S No	Parameters	Test Protocol	Units	Desir-able	Permi-ssible	Results	
						Raw Sewerage	In the farm
1	pH value	IS:3025(P-11)-1983RA-2002	---	6.5 – 8.5	6.5 – 8.5	7.61	7.67
2	Total Alkalinity as CaCO ₃	IS:3025(P-23)-1986RA-2003	mg/L	200	600.00	614.19	676.65
3	Total Dissolved Solids	IS:3025(P-16)-1983RA-2002	mg/L	500	2000.00	840.00	860.00
4	Nitrates as NO ₃	IS:3025 (P-34)-1983RA-2002	mg/L	45	100.00	32.90	31.20
5	Phospates as PO ₄	ALPHA 19th Edition	mg/L	--	--	11.55	12.29
6	Total Chromium as Cr	IS:3025 (P-52)	mg/L	0.05	No relaxa-tion	2.11	1.66
7	Lead as Pb	IS:3025 (P-47)	mg/L	0.05	No relaxa-tion	3.20	2.20
8	BOD at 20° C for 5 days	IS:3025 (P-44)-1993	mg/L	--	--	30.22	22.45
9	Chemical Oxygen Demand	IS:3025 (P-56)-2006	mg/L	--	--	87.52	60.10
	Bacteriological Tests						
10	E-Coli MPN/100ml	ALPHA 23rd Edition 9221-F	NS	Nil	Nil	27.00	38.00
11	Faecal Coliform MPN/100ml	ALPHA 23rd Edition 9221-F	NS	10	10.00	49.00	46.00





Table 3: Sample location: Drinking borewell water, behind govt high school, Vijayapura. Residents complained that 2nd borewell (1000 ft) starts smelling after 2-3 days of storage.

#	Parameters	Test Protocol	Units	Desir-able	Permi-ssible	Results	
						Raw Sewerage	In the farm
1	pH value	IS:3025 (P-11)-1983RA-2002	---	6.5 – 8.5	6.5 – 8.5	7.28	7.55
2	Total Alkalinity as CaCO ₃	IS:3025 (P-23)-1986RA-2003	mg/L	200	600.00	239.43	281.07
3	Total Dissolved Solids	IS:3025 (P-16)-1983RA-2002	mg/L	500	2000.00	480.00	520.00
4	Nitrates as NO ₃	IS:3025 (P-34)-1983RA-2002	mg/L	45	100.00	3.50	5.60
5	Phosphates as PO ₄	mg/L	--	BDL	BDL		
6	Total Chromium as Cr	IS:3025 (P-52)	mg/L	0.05	No relaxation	BDL BDL	
7	Lead as Pb	IS:3025(P-47)	mg/L	0.05	No relaxation	BDL	BDL
8	BOD at 20° C for 5 days	IS:3025 (P-44)-1993	mg/L	--	1.25	2.10	
9	Chemical Oxygen Demand	IS:3025 (P-56)-2006	mg/L	--	4.20	6.30	
Bacteriological Tests							
10	E-Coli MPN/100ml	ALPHA 23rd Edition 9221-F	NS	Nil	Nil	Nil	Nil
11	Faecal Coliform MPN/100ml	ALPHA 23rd Edition 9221-F	NS	10	10.00	4.00	5.00

*BDL – Below Detection Level



Annexure III:

Census data on sanitation in Slums

Table 4: Sanitation in Slums, 2011 Census

Name of the Slum	Notified	No of House-holds	Population Estimate	Type of Drainage	Toilets		No of Tap points/ Public Hydrants for supply of protected water
					Pit	Flush/ Pour Flush	
Sathyamma Colony	Yes	90	450	OD	12	53	3
Mangasandra	Yes	73	370	OD	10	43	2
Basavanakunte -1	Yes	95	482	OD	13	56	3
A. D Colony	Yes	105	530	OD	14	62	3
Eedga Mohalla	No	157	794	OD	22	93	5
Bharath Nagar	No	279	1400	OD	39	165	8
Sunnakallugudu	No	66	336	OD	9	39	2
Basavankunte -2	No	96	482	BD	13	57	3
Santhinagara	No	154	770	OD	21	91	4
Indira Nagara	No	339	1695	OD	47	201	10
Rahamathnagar	No	75	380	OD	10	44	2
Durgathayi Colony	No	209	1062	OD	29	124	6
Total		1738	8751		239	1028	51

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