



Preliminary Water Audit: Estimation of Water Losses and Strategy for Loss Reduction

City of Kalol, Gujarat, India

Submitted to:

PAS Project
CEPT University

Prepared by:

Sapient Techno Consultants

In association with Multi Media Consultants Pvt Ltd

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The findings of the preliminary water audit have been shared with the Nagarpalika staff and representatives of the elected body. We are highly grateful for their interest and for this opportunity to present the findings and collectively work out improvement measures to aim towards higher efficiency in management of water resource in the city. As other cities in Gujarat and Maharashtra begin to explore similar studies, lessons and experiences from this pilot study will be valuable. We see this as an evolving piece of work that will benefit from this experience.

Finally we would like to thank the project team members – Mr A.M. Patel, Mr Mitesh Shah and other colleagues from Sapient and Multi Media – who contributed very generously during meetings with Kalol Nagarpalika staff and field work.

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Abbreviations

AIILSG	All India Institute of Local Self Government
CARL	Current annual real losses
CPHEEO	Central Public Health and Environmental Engineering Organisation
DMA	District metered area
ESR	Elevated service reservoir
GWSSB	Gujarat Water Supply and Sanitation Board
hr	hour
ILI	Infrastructure leakage index
IWA	International Water Association
km	kilometre
kW	kiloWatts
lpcd	litres per capita per day
m ³	cubic metres
min/day	minutes per day
MLD	million litres per day
mm	millimetre
NRW	Non-revenue water
O&M	Operation and maintenance
OZ	Operating zone
PAS	Performance Assessment System
PVC	Polyvinyl chloride
UARL	Unavoidable annual real losses
UFW	Unaccounted-for water
UGSR	Underground service reservoir
ULB	Urban local body
UMC	Urban Management Centre
WDS	Water distribution station
WTP	Water treatment plant

Note: 1 lakh = 100,000.

1. Introduction

Access to water and sanitation services in urban India is widespread, but little is known about the quality and level of service, and coverage of the poor households. For new investments in the sector to be effective, it is important to assess the performance of the existing system and ensure its sustainability and reach for the poor and unserved.

Centre for Environmental Planning and Technology (CEPT) University has received a major grant from the Bill and Melinda Gates Foundation for developing and implementing a performance assessment system for urban water and sanitation in Gujarat and Maharashtra. The aim of this research programme is to develop better information on water and sanitation performance and to ensure its use by the cities for extending services to all, strive for financial viability and improve reliability and quality of services.

This research shall focus on the use of these performance indicators and benchmarks to facilitate consistent reporting, monitoring, planning, budgeting and investing in water and sanitation services in 400 urban areas of Gujarat and Maharashtra states.

The project is being implemented by CEPT University, with the Urban Management Centre (UMC) and the All India Institute of Local Self Governments (AIILSG). CEPT coordinates the project, with the UMC carrying out activities in Gujarat and the AIILSG in Maharashtra.

With its partners, CEPT University is working with state and local governments to develop a reliable and sustainable **Performance Assessment System (PAS)** for urban water and sanitation services. The PAS envisaged in this project includes: **Performance Measurement, Performance Monitoring, and Performance Improvement.**

The key project objectives of the **five-year project** are:

- **Objective 1:** To develop and implement a **performance measurement system** for regular and reliable urban water supply and sanitation information.
- **Objective 2:** To design and share results with urban local bodies (ULBs), state government agencies, other stakeholders and media through a **performance monitoring and dissemination system** for use in decision making, providing incentives and influencing demand.
- **Objective 3:** To facilitate development of **performance improvement plans** by ULBs with support from state government, non-governmental organisations and the private sector.

CEPT initiated studies to meet the first objective to develop and implement the Performance Measurement System. The pilot results from 30 cities in Gujarat and Maharashtra reveal that there are serious gaps in data availability related to water produced, distributed and losses incurred in urban water supply system. There is a need to tackle this data gap and brainstorm on possible reliable methods for measuring efficiency of urban water supply provision. There is also a need to focus more on issues related to the operation and maintenance (O&M) of water systems.

In response to these, an expert group meeting was organised by CEPT in January 2010, the objective being to understand and share the experience of specialists in the field and water

studies conducted in other parts of country, understand various methods and techniques of water flow/quantity measurement and estimation of non-revenue water (NRW).

Based on the discussions during the meeting, it was decided by CEPT to engage an external agency to carry out a basic water audit, to establish benchmark flow parameters and preliminary estimation of NRW. The initial pilot study was taken up in Kalol municipality. CEPT has decided to appoint us, that is, Multimedia Consultants Pvt Ltd, in association with Sapient Techno Consultants, to carry out these studies on its behalf in Kalol. Based on the experience gained from Kalol, further studies will be taken up in other cities.

This report discusses how the basic water audit approach has been applied to the distribution system in the city of Kalol, in the state of Gujarat in India. Kalol has a high level of NRW but also suffers from a shortfall in its own water resources, forcing the local body to augment supply with the addition of untreated water from ground water sources, forcing the local body to augment supply with the addition of untreated water from ground water sources.

The limited scope of the basic water audit does not permit a detailed estimation of all indicators. However, the attempt is to assess and make a preliminary estimate of losses by measuring the water produced, water supplied in the distribution network and water consumption estimate based on a sample study. It adapts the internationally and nationally accepted methodology of the International Water Association (IWA) using a standardised water balance for calculating losses from distribution networks.

The results of this study demonstrate the high NRW levels and its basic components using a relatively cost effective method. Further support can be provided to the Kalol ULB to identify areas of focus as well as to develop a strategy for regular measurement of NRW and measures for its reduction. In addition, based on this experience, steps in carrying out a basic water audit will also be identified.

2. Overview of Water Supply in Kalol

Kalol is located in central Gujarat, about 20 km by road from the state capital and district headquarter of Gandhinagar, and about 30 km from Ahmedabad, in the western part of India. It has a population of approximately 150,000 (111,700 as per 2001 census) and is classified as A-Class municipality with a population of more than 1 lakh.

While the majority of the population is dependent on farming and trading of farm produce, rapid industrialisation in Gujarat has led to the setting up of various medium and large scale industries in the fertiliser, engineering and pharmaceutical sectors, providing ample employment opportunities to the local population. This has also led to rapid urbanisation, migration from rural areas and rise in population in and around the city of Kalol, which is destined to become an important suburb of Ahmedabad. It is also emerging as a major education centre.

This has overburdened the existing water supply and sewerage system, with the city already facing problem of scarce resources and lack of proper funds to create additional facilities; insufficient revenue generation does not permit the assets to become self sustaining.

So, in February 2010, CEPT awarded the contract for measuring and estimating water losses for the city of Kalol. This contract was for four to six weeks and was undertaken by Sapient Techno Consultants Pvt Ltd in association with Multi Media Consultants Pvt Ltd. The studies commenced on February 1, 2010, and were concluded on March 9, 2010, and included measurement of flow at source to estimate the system input, flow measurement to estimate the supply input to distribution network and assess the combined losses in treated water mains and water distribution stations, and flow measurement at end user location (household connection) to estimate consumption and losses in supply network.

2.1 Population and Water Demand of Kalol City

As per 2001 India Census, Kalol City was estimated to have a population of about 111,700 (0.112 million). As per municipal officials of Kalol, the present population is estimated to be around 150,000 (0.15 million) due to the rapid growth that the city has witnessed in the last few years.

Considering 135 lpcd (litres per capita per day) supply and allowing for 15 per cent losses as per the Central Public Health and Environmental Engineering Organisation (CPHEEO), the household consumer demand is estimated to be about 15.07 MLD (million litres per day), requiring production at source of 17.74 MLD (considering a population of 0.112 million as per the 2001 Census).

However, assuming that the present population is 0.15 million, it would require about 20.25 MLD to meet household consumer demand, which would, in turn, require production at source of 23.8 MLD.

2.2 The Kalol Water Supply and Distribution System

The city of Kalol receives its water from two different types of sources – Surface Water and Ground Water Sources. This comprise of a total 22 different sources including one major source from Pratappura Water Treatment Plant based on Surface Water Source and rest twenty one Bore Hole sources within Kalol City, both together producing a total of 17.26 MLD. Schematic diagram of Kalol water supply system is given in figure 1.

The major source is from Pratappura Water Treatment Plant set up by the Gujarat Water Supply and Sewerage Board (GWSSB) that takes water from Narmada Canal, an initiative by the Government of Gujarat to provide irrigation water and drinking water facilities to drought-prone regions. This plant is located about 4 km from the city. This source provides approximately 12.5 to 13 MLD water at present.

Figure 1: Schematic diagram of Kalol's water supply system

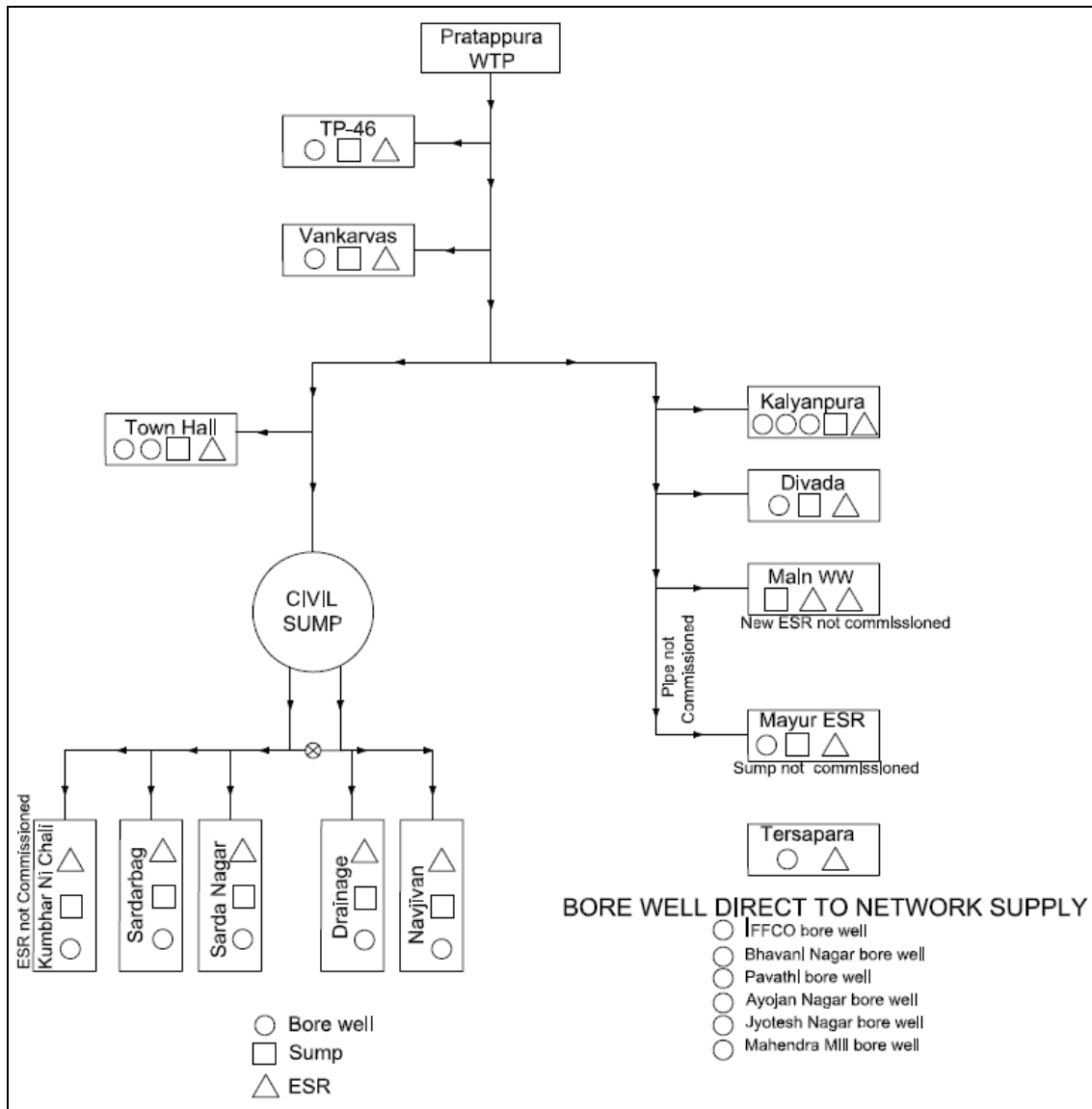
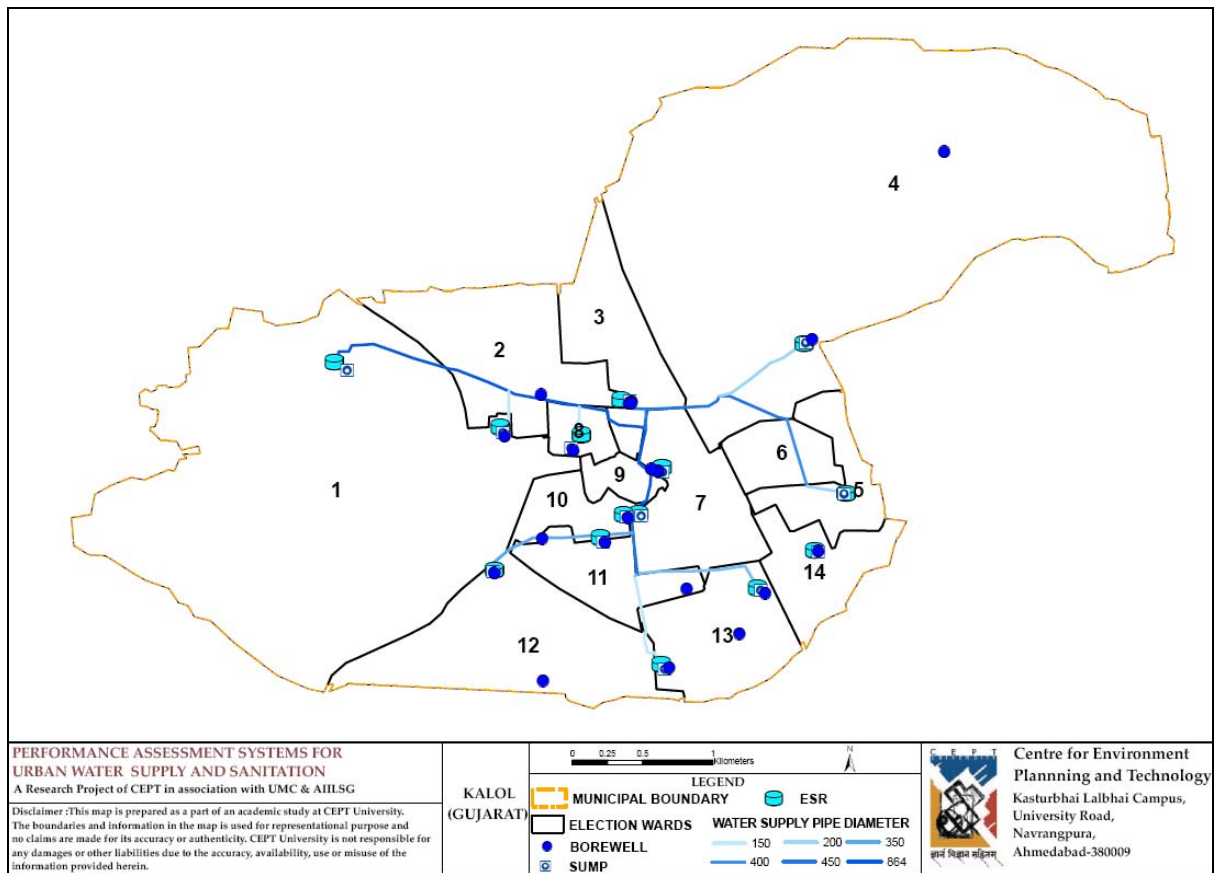


Figure 2: Map of Kalol's water supply system



Of the 21 borehole sources, the one located in Vankarvas is generally not used, that is, water is drawn only in case of stoppage of water treatment plant (WTP) water. Hence, the 20 different borehole sources within Kalol city together produce about 4.54 MLD.

Table 1 provides details of various sources and estimated production quantity at each source.

Table 9: Daily average water supply from various sources

Sr no	Source location	Avg inst flow (m ³ /hr)	Avg working hr	Avg daily flow (m ³)	Avg daily flow (MLD)
(A) Surface water (Pratappura WTP)					
1	Narmada water (Pratappura)	753	17	12717	12.72
Sub-total (A)					12.72
(B) Ground water (To sump)					
1	Vankarvas bore (used only in absence of WTP water)	35	0	0	0.00
2	Kalyanpura bore-2	61	4.5	274	0.27
3	Kalyanpura bore-3	33	5	167	0.17
4	Divada bore	76	3.5	266	0.27
5	Mayur Housing bore	36	3	108	0.11
6	Kumbhar Ni Chali bore	68	7	476	0.48

Sr no	Source location	Avg inst flow (m ³ / hr)	Avg working hr	Avg daily flow (m ³)	Avg daily flow (MLD)
7	Sardarbag bore	30	2	60	0.06
8	Navjivan bore	35	6	210	0.21
9	Jyotesh Nagar bore	54	21	1130	1.13
	Sub-total (B)				2.69
	(C) Ground water (to ESR)				
1	Mayur Housing bore	36	1	36	0.04
2	Tersaparu bore	14	3.5	49	0.05
	Sub-total (C)				0.09
	(D) Ground water (Direct to network)				
1	Civil Hospital bore	56	5	280	0.28
2	Sardarbag bore	30	1	30	0.03
3	Navjivan bore	35	2.5	87	0.09
4	IFFCO bore	62	3.5	218	0.22
5	Bhavani Nagar bore	50	6	307	0.31
6	Pavathi bore	49	3	147	0.15
7	Ayojan Nagar bore	81	4	324	0.32
8	Jyotesh Nagar	54	3	161	0.16
9	Mahendra Mill bore line 1	58	0.45	26	0.03
10	Mahendra Mill bore line 2	20	0.45	9	0.01
11	Pump for tanker filling at Sardarbag				0.05
12	Mayur Housing bore	36	1	36	0.04
	Sub-total (D)				1.68
	(E) Ground water (To garden / hospital tank)				
1	Civil Hospital bore	56	1	56	0.06
2	Sardarbag bore (garden water storage tank)	30	1	30	0.03
	Sub-total (E)				0.09
	Grand total (A+B+C+D)	Auth. billed		in MLD	17.17
	Grand total (A+B+C+D+E)	Tot. auth.		in MLD	17.26

Source: Actual flow measurement using portable flow meter at Kalol.

Note: The water supply at (E) are for public utilities like garden and civil hospital which forms part of authorised consumption but shall not be a part of billed consumption. We shall be considering this supply for the purpose of water balance chart only and is ignored for other calculations.

While the water supply of 17.17 MLD is adequate to meet the water demand of the population (as per 2001 census), it can be estimated that there is a current shortfall of water of about 28 per cent considering the demand of 24 MLD for the present population (see Table 2).

Table 10: Water demand and population

Population as per	Popula tion	Demand @135 lpcd (MLD)	Provisio n for 15% losses (MLD)	Total demand (MLD)	Actual water supply (MLD)	Supply shortfall (MLD)	% Shortfall of supply
2001 Census	100,008	13.5	2.02	15.53	17.17	-	-
Present – 2010 (assumed)	150,000	20.25	3.57	23.82	17.17	6.65	27.92%

Till a few years ago, Kalol was totally dependent on ground water sources. The water supply from the recently commissioned Pratappura WTP has helped Kalol reduce its reliance on, and exploitation of, ground water sources, and also led to improved quality of water.

The Kalol transmission main is about 9 km; the distribution system comprises asbestos cement, PVC and CI pipe work. There are approximately 17,874 service connections of various sizes of ½ inch, ¾ inch and 1 inch connections. A summary of the connection sizes and number of connections of each size is given in Table 3.

Table 11: Ferrule size-wise number of authorised connections

Sr no	Type of connection	Domestic connections	Commercial connections	Authorised connections
1	1/2 inch	17725	58	17783
2	3/4 inch	55	3	58
3	1 inch	10	23	33
	Total	17790	84	17874

Source: Kalol property tax department.

A transmission main of Kalol's water supply system is 850 mm diameter M.S. line linking the main source of water, the Pratappura WTP, and the town of Kalol in the newly developed water distribution station (WDS) at Civil Hospital Water Works campus. The treated mains supply water to TP-46, Vankarvas and Town Hall WDS on way to Civil Hospital Campus through branch lines.

The treated water mains branches off before Town Hall WDS on way to Civil Hospital WDS to supply water up to Main Water Works WDS of Kalol City, which is the oldest supply system of Kalol through 500 mm, 450 mm and 400 mm size lines, and also feeds to Kalyanpura and Divada WDS en route.

The Civil Hospital WDS in turn supplies water to Sarda Nagar, Sardarbag and Kumbhar Ni Chali (to be commissioned) WDS through one transmission main, and to Navjivan and

Drainage WDS through another. Both these mains are interconnected and each is fed by a dedicated set of pumping machinery.

These M.S. transmission mains have been laid recently. Problems or losses are therefore not anticipated in them.

However, the distribution network of Kalol is a combination of some very old and new lines; the network is interconnected and no records/drawings are available with Kalol authorities and pose a problem in determining both physical losses and non-physical losses (mainly theft of water). The distribution network comprises a variety of pipe material including asbestos cement pipes, PVC pipes and cast iron pipes of various sizes which are suspect to leakage due to various factors including age/life of pipe, workmanship/quality, tampering for unauthorised connections, sections of pipes subjected to very high pressures to boost pressure before supply, illegal drawl of water by pumping machinery leading to low pressure/cavitations of pipelines, etc.

In absence of network drawings and records, the system was visually surveyed. Location-wise sketches were prepared incorporating all the relevant details required to understand the system (see Annexure 1 for details).

Supply to the city is intermittent, with supply hours varying from 0.75 to 1.5 hours; the average supply hours observed are less than one hour. The connections are unmetered.

2.3 Estimated Cost of Water and Revenue Demand for Kalol

The water tariff charged by the GWSSB for treated water supply from the Pratappura WTP is Rs 4 per 1,000 litres (per m³).

The cost of power for operating bore wells was estimated by measuring the actual power consumed by each bore (except Kalyanpura bore number 3 where power measurement was not possible). The details are presented in Table 4.

It should be noted that the measured values of actual current and power consumed were observed to be much higher than the rated bore well ratings furnished by the authorities during data collection. This indicates that either the pump/motor set efficiency is very low, or the pump may not be operating at duty point or there may be higher frictional losses due to lower line size, etc. It should also be noted that the winding of the motor is not as per designed requirement or might have been changed during operation as it is observed to carry much higher current than the rated current allowed as per pump/motor rating.

Based on the connected load of bore well and assuming power tariff of Rs 4.50 per unit, the estimated cost of operating bore well for augmenting water supply to city is expected to be around Rs 21,918 per day with connected load totalling to about 650 kW.

Table 12: Details of power cost according to bore well

Sr no	Source location	Avg flow (m ³ /hr)	Avg working hrs	Pump kW	Current measurement (Amp)	Actual kW	Approx power cost (Rs)
(A)	Ground water (to sump)						
1	Vankarvas bore (used only in absence of WTP water)	35	0	30	55.0	34.8	0
2	Kalyanpura bore 2 (in compound wall)	61	4.5	45	62.0	33.7	682
3	Kalyanpura bore 3 (o/s compound wall) (current/kW not measured, so power is assumed)	33.5	5	25	-	15.0	337
4	Divada bore	76	3.5	45	68.0	42.2	664
5	Mayur Housing bore	36	5	30	63.0	39.0	877
6	Kumbhar Ni Chali bore	68	7	45	96.6	61.1	1925
7	Sardarbag bore	30	3	45	67.4	50.6	683
8	Navjivan bore	35	8.5	45	76.0	45.4	1736
9	Tersaparu bore	14	3.5	22	42.0	26.7	421
10	Jyotesh Nagar bore	53.8	24	45	80.0	70.0	7560
11	Civil Hospital bore	56	5	45	97.0	65.0	1462
12	IFFCO bore	62.5	3.5	45	98.0	73.7	1161
13	Bhavani Nagar bore	50	6.15	45	73.0	79.4	2197
14	Pavathi bore	49	3	45	87.5	53.7	725
15	Ayojan Nagar bore	81	4	45	93.0	72.3	1301
16	Mahendra Mill bore	58	0.9	45	62.0	45.4	184
	Total			645			21918
Cost per m ³ for producing 4,453.05 m ³ water per day (Rs)							4.92

Note: Based on measurement of actual power consumption.

The estimated total cost of production per annum is thus expected to be as per Table 5.

Table 13: Approximate cost of water production

Source of water	Supply (m ³ /annum)	Cost (Rs/m ³)	Total cost (Rs/year)
Pratappura WTP	4,641,705	4.00	18,566,820
Bore well	1,607,478	4.92	7,908,793
Total (Rs/annum)			26,475,613

Ground water extraction cost (Rs 4.92 per m³ which includes only operational cost) is higher than Narmada bulk purchase cost (Rs 4 per m³). The operation cost of bore well is assumed considering the power cost only and the actual cost shall be much higher after adding the cost of manpower, spares, etc, incurred as part of the O&M schedule. All the water supply connections in Kalol are unmetered and the authorities till now levied a fixed charge based

on size and type of connection. Recently Kalol has also introduced a special water tax. Accordingly, the approximate amount of revenue demand is as per Table 6.

Table 14: Details of revenue demand (FY 2009–10)

	Size of connections	1/2 inch	3/4 inch	1 inch
1	DOMESTIC			
	No of connections	17,725	55	10
	Water charges	300	900	1800
	Sub-total (A)	5,317,500	49,500	18,000
	Water tax/connection	120	120	120
	Sub-total (B)	2,127,000	6,600	1,200
	Total – Domestic (A+B)	7,444,500	56,100	19,200
2	COMMERCIAL			
	No of connections	58	3	23
	Water charges	600	1,800	3,600
	Sub-total (C)	34,800	5,400	82,800
	Water tax/connections	120	120	120
	Sub-total (D)	6,960	360	2,760
	Total – Commercial (C+D)	41,760	5,760	85,560
	Total – Domestic + Commercial	7,486,260	61,860	104,760
	Grand total (Rs)	7,652,880		

Source: Kalol property tax department.

Table 6 suggests that the revenue demand is only about Rs 76.5 lakh against the estimated cost of production of about Rs 264.7, excluding the cost of manpower and maintenance incurred by Kalol municipality.

It is worth noting that that the billed demand is only 50 per cent of estimated energy and raw water costs. Thus, Kalol municipality needs to initiate measures on all fronts to make the operation financially self sustaining through measures such as water conservation and improved distribution efficiency, and policy decisions for enhanced revenue generation to reduce this deficit. Before resorting to tariff increases, the ULB needs to reduce its costs and increase its revenues as far as possible. One key element in this is to reduce NRW which will help to reduce need for new resource generation and reduce operating costs. It is for this purpose that a basic water audit was conducted for Kalol municipality.

3. The Approach to Water Audit in Kalol

The water audit is a well established procedure that **identifies productive uses and needless waste.**

If one knows where water is used and lost, a saving plan of water can be planned. By conducting a water audit, one can track water usage and focus on activities that cause water loss and what that loss costs the utility. Identifying and repairing leaks saves a substantial quantity of water, saving expenditure for the ULB and also avoiding the need to look for new water sources to meet the increase in water demand. Thus, a water audit can deliver expected results by identifying and fixing water problems and make a water utility financially sustainable.

The overall goal of a water audit should be to select and implement programmes that reduce water losses. By conducting a water audit, an assessment of the capacity of total water produced and actual quantity water distributed is worked out. This will help to compute estimation of water losses in the system.

In the case of Kalol, the study was limited to a basic water audit to make a preliminary assessment of water losses by measuring flows at source, intermediate locations in network as permissible and at the consumers' end (random sampling). The study was carried out over a period of one month. It focused on developing good estimates of total supply of water and water received at the consumers' end. A more detailed water audit which would include demarcation of district metered areas (DMAs) along with hydraulic modelling could be taken up later if the results show high NRW levels.

Sketches of important nodes of the network – which were prepared after visual inspection and were based on data obtained from the Kalol Nagarpalika – are given in Annexure 1.

Methodology Adopted for Conducting a Basic Water Audit in Kalol

The studies were conducted in Kalol city over a month in February and March 2010. The major aspects covered in the study include:

Background Study:

- Understanding the supply system and familiarisation with existing distribution network. As time and other constraints did not permit undertaking detailed survey and system mapping of the entire supply and distribution network of Kalol city, it was agreed to cover only major components of the system such as WTPs, underground storage reservoirs (UGSRs), elevated service reservoir (ESRs), etc, for the study.
- A meeting was conducted with ULB officials to understand the water supply scheme of Kalol city and obtain the maps of the supply network. Details for quantity and quality of supply, supply pattern, time of supply and other aspects were also discussed.
- A visit/visual inspection was carried out at all major points of supply, that is, WTPs, UGSRs, ESRs, etc, to verify the data provided by the ULB and prepare an updated

sketch of major points of the supply system. It was also studied to check possibility for measurement of flow and pressure in the system.

- Details of registered connections of various sizes were collected from the ULB. The latest population data were also obtained.

Quantity Measurement:

- Measurement of supply included:
 - System input, that is, flows at source (production) comprising supply from WTPs as well as measurement of ground water resource supply, that is, tube/bore wells. System input (water produced at source) was measured using portable ultrasonic flow meters. The source measurement comprised measuring flows of treated water pumps at WTPs and tube/bore well pumps within Kalol city.
 - The assessment of treated water mains feeding the treated water to various UGSRs was carried out by measuring the volume of water supplied from WTPs and reaching critical/last point UGSRs in the network. The WTP flow/volume during study was monitored with portable flow meter and the water supply volume at UGSRs was measured by volumetric method.
 - The booster pump discharge provided in various UGSRs feeding water to associated ESRs as well as flow on ESR inlet pipe to ESR, where possible as per site conditions, were assessed using portable flow meters. This would enable getting an idea of the total water supply fed to ESRs and also a rough estimation of the volume/capacity of ESRs.
 - ESR outlet discharge was measured (except for one very old ESR) to assess the quantity of water fed to the distribution system using portable flow meters. The total supply to the city comprised ESR outlet flow plus tube well supply fed into the network to boost pressure as well as direct supply to population in certain pockets of the city.
- Consumption (or supply at the consumers' end) was measured by studying the demography and number of connections of various sizes and finalising the location and number of samples to be studied in consultation with CEPT. A survey was conducted and details were obtained for the supply hours. The team was deputed to the selected locations/households during the supply hours to measure the quantity of water received and also get an idea of the residual pressure at connection with respect to ground level. The flow was measured using bucket method, wherein graduated buckets of 12-litre capacity were used; two-three measurements were carried out at each location during supply hours, and supply timings were also observed to derive average quantity of water received by the household. Data regarding the number of members served by the connection under measurement were also obtained in case of individual households and for common connection to flats, average five members per flat for total number of flats served by the connection.

As agreed with CEPT, measurements were to be carried out as per site condition in existing system only without any modification or puncture in the pipe line / system.

4. Results of Basic Water Audit for Kalol

The basic water audit for Kalol comprised five main steps. The results for each step are described here.

Step 1: Estimating Water Supply per Day

The system input, that is, water produced at source, was measured and found to be 17.26 MLD (17.17 MLD excluding public utilities) with average water supply of 12.72 MLD from WTPs, and rest 4.54 MLD from ground water sources at various locations, as indicated in Table 1.

The supply to public use/utilities in Kalol is observed to be maintained separately by the ULB, which is about 0.09 MLD as indicated in (E) of Table 1. No standposts are provided/maintained by the ULB as per records. However, water supply of 0.05 MLD fed by tankers is considered by us as per (D)11 of Table 1 in system input

It is further observed that the average pump capacity of WTPs is 750 m³/hr with an average 17 hours of daily pumping, thereby providing daily supply of about 12.5–13 MLD to Kalol. There is permanent flow measurement facility on Kalol water mains and log books at WTPs were observed to be maintained properly. The billing data of the GWSSB to the ULB were also checked and verified.

The remaining 4.54 MLD supply of the city is met by ground water sources, from about 20 tube wells, with one to 24 hours of working. While the working hours of tube wells have been reduced, it is observed that the ULB cannot do away with tube wells in many locations for the following reasons:

- Being an intermittent supply, used in filling booster pumps to maintain pressure in line
- Certain pockets of the ULB are still dependent on only ground water sources as the required network to feed the WTP water does not exist.
- Tube wells act as additional sources Narmada (WTP) water received is insufficient at a given location.

Step 2: Estimating Water Supply from Treated Water Mains

As can be seen from the network sketches in Annexure 1, the WTP feeds water to the city through two major branches of treated water mains: one up to the main water works sump and the other to the Civil Hospital sump. As is apparent from the network scheme, the WTP supplies treated water to 11 UGSRs located in various parts of Kalol city.

The measurement of flow reaching up to main water works sump along with other sumps en route in one branch and flow at Civil Hospital sump for the second branch was carried out with volumetric method in parallel to measurement of flow volume discharged from the WTP during the same time duration, and the results were compared as indicated in Annexure 2.

As observed from the study, the flow variation ranges from 0.03 per cent to 5.75 per cent during three different studies, and considering meter inaccuracy as well as inaccuracy of up to 5 per cent associated with volumetric measurement, the result of the study for assessment

of treated water mains are observed to be satisfactory. We presume the losses in treated water mains as negligible or near the permissible limit of 1 per cent as per norms, and we believe the same as this line is new and laid recently with the commissioning of the WTP.

Step 3: Estimating Treated Water Conveyance – ESR + Direct

The supply to the distribution network is through 12 ESRs and 11 bore wells feeding the network directly. Out of 12 ESRs, 11 are fed by booster pumps provided in associated UGSRs and one ESR is being filled directly by a bore well. The details are elaborated in Annexures 3 and 4.

The supply to the ESR from the UGSR and direct supply from ground water sources were measured using portable flow meter. For main water works, the data were taken as per details furnished by ULB staff as measurements at these locations, either volumetric or with flow meter, was not possible. The flows were measured individually at each location, with supply derived by assessing flow and time of pump operation.

As can be observed from the measurements as per Annexure 3, the total treated water conveyance from UGSR/direct by bore well was observed to be 15.58 MLD as against supply of 17.17 MLD (excluding public utility supply), which indicates a loss of about 9.26 per cent which includes measurement inaccuracy of up to 5 per cent.

In addition, the ESR outlet flows were measured during the supply hours at the outlet of each ESR (except main W/W) using portable flow meter. The total supply to the distribution network from ESRs plus direct bore well supply was observed to be 14.97 MLD against system input of 17.17 MLD representing a variation/loss of about 12.81 per cent, which includes measurement inaccuracy of up to 5 per cent, error due to water balance at UGSRs as the measurement method spanned over a few days and actual loss.

It can be presumed that the loss from WTP supply up to the point of input to distribution network can be 3–5 per cent, mainly resulting from water seepage from UGSRs, leaking treated water conveyance lines, minor to heavy leakages in ESRs, pump/valve and pipe joint leakages, etc.

Step 4: Measurement of Consumption

As per the details obtained from the ULB, the city has 17,874 authorised water supply connections comprising 17,783 ½-inch connections, 58 ¾-inch connections and 33 1-inch connections. This includes both domestic as well as commercial. (See Table 3 for details.)

The distribution of connections is concentrated towards residential properties; also within each area, the concentration of ½-inch connections is more. To arrive at reliable estimates we need to consider two aspects. In the first place we should identify a sample size which is statistically reliable to provide meaningful estimates at a municipality level with a certain precision. The second step is to make sure that the sample is allocated across the population so that it represents all the units within the population.

It was agreed jointly with CEPT to carry out measurement of about 39 samples. This sample size will provide reliable estimates at a 90 per cent confidence level. Ideally one would need to take about 137 samples for a 95 per cent confidence level. The shortage of time and resources dictated that a 90 per cent confidence level could be considered adequate.

The final task is to distribute the sample across wards and type of connections so that all wards and all types of connections are represented. An estimated ward-wise distribution of population and households is given in table 7. There are 17,874 water supply connections of ½-inch and ¾-inch connections.

Table 15: Ward-wise details of households and connections

Ward no	2009 projected population	2009 projected households	Connections	Zone
1	9,908	2,583	1,350	Zone 1
2	9,309	2,428	1,269	
3	9,323	2,431	1,271	
4	9,643	2,514	1,314	
5	10,192	2,658	1,390	Zone 2
6	9,340	2,435	1,273	
7	8,533	2,225	1,163	Zone 3
8	9,926	2,589	1,354	
9	9,014	2,351	1,229	
10	9,232	2,408	1,259	
11	8,768	2,286	1,195	Zone 2
12	10,001	2,608	1,365	
13	9,219	2,403	1,256	
14	8,454	2,205	1,153	
Total	130,862	34,124	17841	

As the connections are unmetered, consumption was measured through indirect means: 12-litre capacity buckets were used to measure the flow rate. Two to three measurements were made during the supply time at each location to obtain an average flow rate and using the total time of supply the total supply to each connection was derived. Here an assumption is made that all the water supplied at the tap is consumed. Refer to Annexure 5 for details.

As per the measurements indicated in Annexure 5, the total supply consumed was observed to be 9.26 MLD as against a system input of 17.17 MLD.

Step 5: Analysis of Data and Computation of NRW

The measurement of NRW was done using the IWA water balance chart, through nine tasks as depicted in Table 8. Details are given in Annexes 2 to 5.

Task 1: System Input Volume: The system input volume for Kalol is **6,299 ML/annum** based on 17257.05 m³/day (17.26 MLD) supply.

Task 2: Billed Metered and Billed Unmetered Consumption: Kalol does not have any metered consumption. The billed unmetered consumption is estimated to be **3,381 ML/annum**.

Task 3: Calculate the Volume of Non-revenue water: The volume of non-revenue water works out to **2,918 ML/annum**.

Task 4: Calculate the Unbilled Authorised Consumption: The unbilled authorised consumption is observed to be **33 ML/annum** considering authorised supply of 86,000 litres/day for public utilities.

Table 16: Standard IWA water balance

System input volume 6,299 (Task 1)	Authorised consumption (54.2%) 3,414 (Task 5)	Billed authorised consumption (53.7%) 3,381 (Task 2)	Billed metered consumption 0.0	Revenue water (53.7%) 3,381	
			Billed unmetered consumption (53.7%) 3,381		
		Unbilled authorised consumption (0.5%) 33 (Task 4)		Unbilled metered consumption 0	Non-revenue water, NRW (46.3%) 2,918 (Task 3)
				Unbilled unmetered consumption (0.5%) 33	
	Water losses (45.8%) 2,885 (Task 6)	Apparent losses (16.8%) 1,058 (Task 7)		Unauthorised consumption (16.8%) 1,058	
				Consumer metering inaccuracies 0	
		Real losses (29%) 1,827 (Task 8)		Leakage on service connections up to point of customer metering (15.6%) 980 (Task 9)	
				Leakage on transmission mains (9.9%) 624 (Task 9)	
			Leakage and overflows at utility's storage tanks (3.5%) 223 (Task 9)		

Source: Based on actual flow measurement using portable ultrasonic flow meter and bucket survey method at the consumers' end.

Task 5: Calculate Authorised Consumption: The total authorised consumption is observed to be **3,414 ML/annum** (Billed Non-metered + Unbilled Authorised).

Task 6: Calculate Water Losses (NRW):

Water loss = System input – Authorised consumption

Accordingly, water loss is observed to be **2,885 ML/annum**.

Task 7 Calculate Apparent Losses: As the scope of study did not involve the total survey and mapping of network and also the leak detection programme, it was not possible to identify and calculate the apparent and real losses. But an estimate of apparent losses has been made from the bucket survey and other details of water connections in slum areas that are not paying the special water tax. Around 6,000 connections are estimated to be 1,058 ML/annum (2.9 MLD).

Task 8: Calculate Real Losses:

Real losses = Water losses – Apparent losses

Accordingly, real losses are calculated to be 1,827 ML/annum which is 29 per cent of system input volume.

Task 9: Kalol Water Balance Calculation: Based on this analysis, NRW in Kalol is observed to be 46 per cent. The NRW figures for Kalol city are observed to be high and similar to the figures arrived at by various authorities after conducting water studies in various cities of the country and as associated with intermittent supply system prevailing in most parts of country. There is considerable scope for improvement in the efficiency of the delivery system.

5. Suggestions for Reducing Non-revenue Water

Based on the observations made during the basic water audit and its results, a few key suggestions for improved measurement of NRW as well as for its reduction have been identified. The first set of suggestions includes those that can be taken immediately and at relatively lower costs by the Kalol municipality. A second set of suggestions for more detailed studies is also identified for further diagnostic to reduce NRW and improve efficiency in service provision.

Urgent/immediate steps for NRW measurement and reduction:

- ***Repair ESRs and leaking valves, and reduce overflow of tanks:*** From the standard IWA water balance (Table 8), it is noticed that 3.5 per cent water losses are at the WDS level. These are mainly due to leakage in valves and storage tanks and also their overflow. Field studies and results showed that Kalyanpura, Divada, Sarda Nagar, Sardarbag and Navjivan ESRs are leaking heavily and require immediate repair.

Maintenance of valves and fittings such as tightening loose bolts, positioning gland packing, replacing damaged parts of valves and fittings, etc, are needed to reduce or stop leakage from valves and fittings.

Staff's awareness is needed to reduce overflow of storage tanks.

- ***Identify and regularise illegal connections:*** Illegal withdrawal of water from distribution lines is one of the reasons resulting in low or even negative pressure. To overcome this, Kalol municipality needs to undertake steps to detect and then regularise illegal connections to reduce NRW. This will also avoid illegal use of booster pumps and result in improved performance of the water distribution network.

There is also a need to introduce a simpler and special procedure for giving connections to slum households. A property tax bill is required as proof of residence when applying for a water connection. Slum properties are often not assessed and so do not have property tax bills. Therefore, slum households are not eligible to apply for water connections. There is a need to provide a property tax bill for slum households and thus ease the process of giving connections to slum households.

- ***Establish water quantity data recording and processing system*** to regularly monitor and reduce water losses. There is no data recording system at present which results in non-availability of data for records to assess the performance at various levels. Creating awareness and training the staff is needed for maintaining proper log books. It is also necessary to set up a system to report the hours of pumping to concerned officers of the water supply department. This information should then be used with the calibrated pump discharge from the basic water audit, to calculate the water quantity supplied from various sources and WDS. This will help improve reliability of data and measure NRW on a regular basis. Ideally, the ULB needs to install bulk flow meters and pressure gauges to measure flow and pressure in the lines at all pump discharges and critical points in the network.

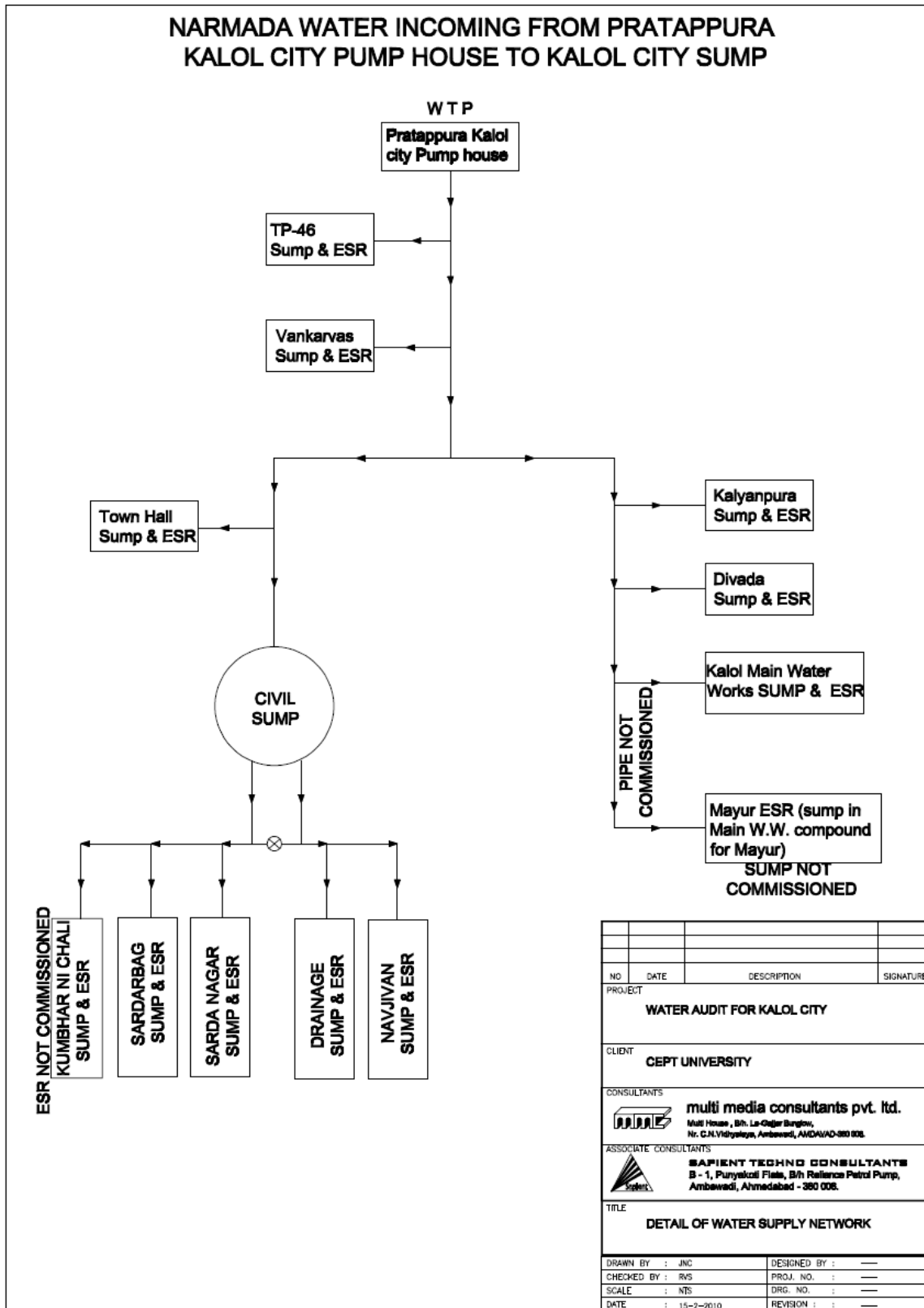
Further studies to improve system performance:

- ***Carry out energy audit:*** From field studies it is observed that pumps are running inefficiently. To identify replacement and rehabilitation of pumping machineries, it is necessary to carry out energy audits and implement suggestions resulting from them. This will help reduce both energy usage and the high expenditure on energy.
- ***Prepare system/network map and connections information:*** At present, Kalol municipality does not have proper maps of the distribution network. A survey of the complete distribution system needs to be carried out by the ULB to prepare a series of system maps. This should also include house-to-house surveys to obtain details about the actual connections, authorised and unauthorised, as well as household details catered to by these connections.
- ***Hydraulic modelling and creation of DMAs:*** As reported in Annexure 6, the pressure at ground level for each measurement connection in various areas was very low with negative pressure at several places against the desired minimum 7 m to 12 m pressure for satisfactory delivery. A hydraulic study of the present network is required to check its adequacy, to identify whether any replacements or upgradation is required or whether new lines are required to be laid to ensure proper service delivery including required pressure at each node. This would also help in reducing, to a great extent, the problem of inequitable flow distribution in Kalol.

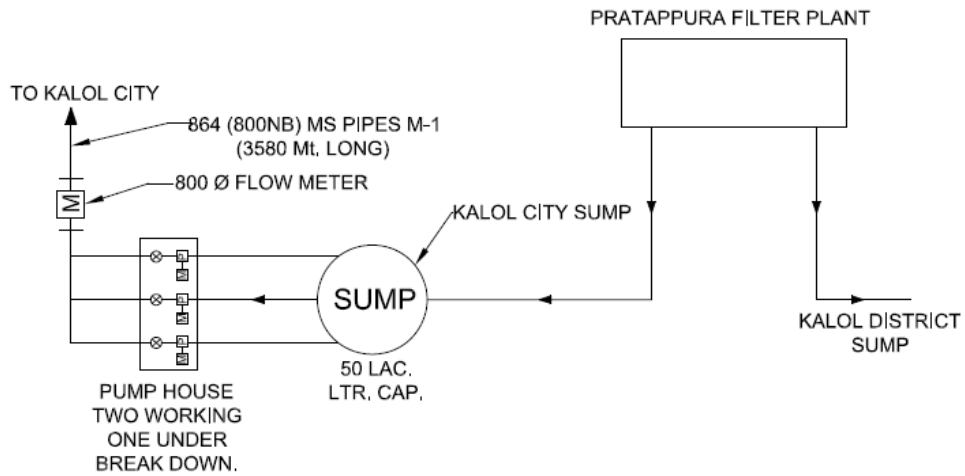
Demarcation of supply zones and formation of DMAs should be carried out with necessary isolation of each zone and metering of input to each supply zone, DMA and other critical nodes. This would help bring awareness about the supply to each locality including leakages, if any, with follow-up corrective actions by the ULB including leak detection. In addition, the supply can be staggered to enable supply with adequate pressure.

- ***Metering:*** Kalol municipality also needs to explore the possibility of measuring flow and pressure in the lines at all pump discharge and critical points in network. For this, the ULB needs to adopt metering of supply of water. This will also require creating awareness among the public and creating political will by assuring everyone about the benefits of continuous supply as against intermittent supply system. Proper steps taken by the ULB in this direction can lead to improved system efficiency and service delivery.
- ***Develop a bankable project to reduce NRW:*** Given the high NRW, there is scope for introducing a performance-based management contract by the municipal council to reduce NRW levels over time. This will require an assessment of capacity and interest of potential contractors to undertake such a contract. To develop this, a better and more reliable set of data will be needed as discussed earlier. A detailed risk assessment analysis will also be needed to develop a risk management plan for such a contract.









Annexure 1: Details of Kalol Main Water Supply Network



PRATAPPURA WTP



LEGEND :

-  ESR
-  U.G. SUMP
-  BORE WELL PIPE LINE
-  PIPE LINE
-  PUMP HOUSE
-  ESR FILLING (BOOSTER) SUB PUMP
-  VALVE
-  O.H. WATER SUPPLY LINE

(A) PUMP:-



HP:- 60 Q:- 720 M³/hr

(B) CITY WATER SUPPLY TIME:-

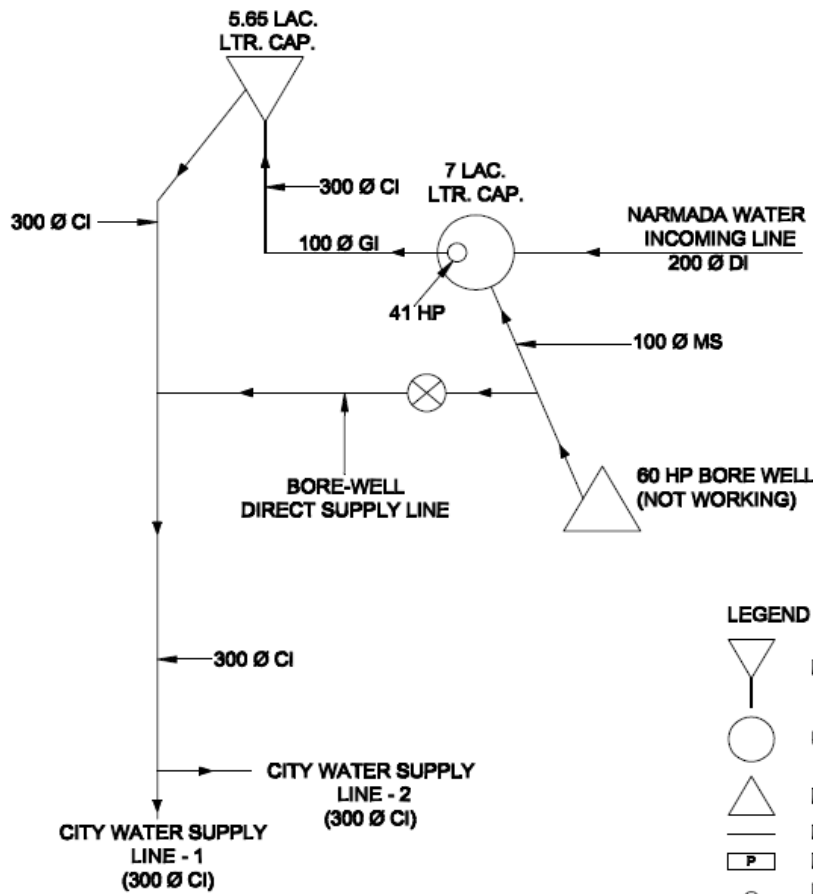
1:30 AM TO 11:00 AM
1:30 PM TO 9:00 PM

NOTES :









- (1) PR. GAUGE NOT WORKING
- (2) PUMP LEAKAGE OBSERVED
- (3) ELECT. METER AT PANEL NOT WORKING
- (4) ELECTROMAGNETIC FLOW METER IS PROVIDED AT MAIN HEADER.
- (5) PUMP - 2 IS NOT IN USE DUE TO DAMAGED FOUNDATION

NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
		multi media consultants pvt. ltd. M/J House , 8th, La-Ga[ar] Bungalow, Nr. C.N.V.Hydraya, Ambawad, AMDAVAD-380 006.	
ASSOCIATE CONSULTANTS			
		SAPIEN TECHNO CONSULTANTS B - 1, Panyakotl Flats, 8th Rallance Petrol Pump, Ambawad, Ahmedabad - 380 006.	
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : —	
CHECKED BY : RVS		PROJ. NO. : —	
SCALE : NTS		DRG. NO. : —	
DATE : 15-2-2010		REVISION : : —	

TP 46 SUMP & ESR



LEGEND :

-  ESR
-  U.G. SUMP
-  BORE WELL PIPE LINE
-  PIPE LINE
-  PUMP HOUSE
-  ESR FILLING (BOOSTER) SUB PUMP
-  VALVE
-  O.H. WATER SUPPLY LINE

(A) ESR FELLING SUB PUMP (BOOSTER PUMP):-

HP:- 41 Q:- 140 M³/hr

WORKING TIME :-
5:00 AM TO 8:30 AM
2:00 PM TO 5:30 PM

(B) TUBE WELL (BORE) SUB PUMP:-



HP:- 60 Q:- NOT IN WORKING

(C) CITY WATER SUPPLY TIME:-

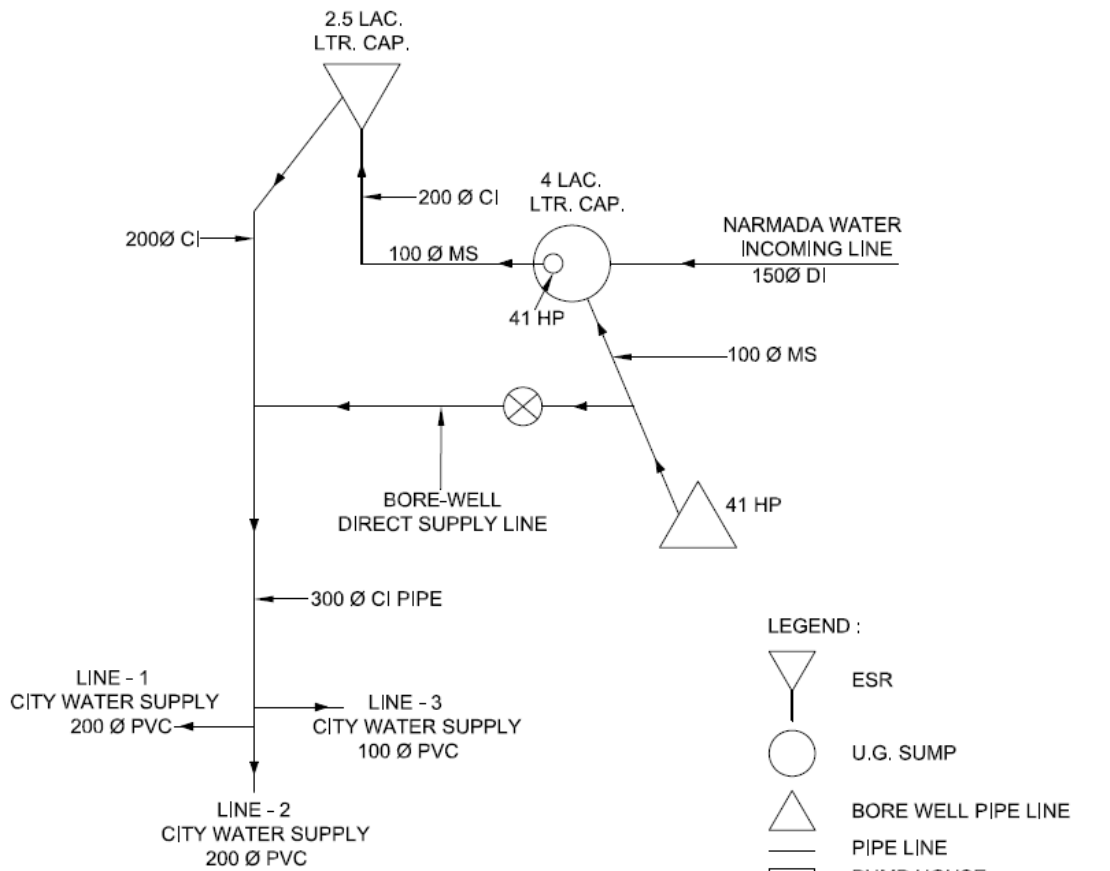
8:30 AM TO 9:15 AM
5:30 PM TO 6:15 PM

NOTES :

- (1) TANK OVERFLOWING TO OPEN GROUND
- (2) LEVEL INDICATOR NOT WORKING
- (3) INLET VALVE LEAKS/PASSES.
- (4) ESR & SUMP WATER LEVEL GAUGE IS NOT WORKING
- (5) BOOSTER PUMP DISCHARGE PIPE IS LEAKING

NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
		multi media consultants pvt. ltd.	
Multi House , B/H. Lo-Giger Bunglow, Nc. G.N.V. Vidyapeeth, Ambarwad, AHMEDABAD-380 008.			
ASSOCIATE CONSULTANTS			
		SAPIENT TECHNO CONSULTANTS	
B - 1, Purnyakoti Flats, B/H Reliance Petrol Pump, Ambarwad, Ahmedabad - 380 008.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC	DESIGNED BY : ---		
CHECKED BY : RVS	PROJ. NO. : ---		
SCALE : NTS	DRG. NO. : ---		
DATE : 15-2-2010	REVISION : : ---		

VANKARVAS SUMP & ESR



LEGEND :

- ESR
- U.G. SUMP
- BORE WELL PIPE LINE
- PIPE LINE
- PUMP HOUSE
- ESR FILLING (BOOSTER) SUB PUMP
- VALVE
- O.H. WATER SUPPLY LINE

(A) ESR FELLING SUB PUMP (BOOSTER PUMP) :-

HP:- 41 Q:- 124 M³/hr

WORKING TIME :-

8:00 AM TO 8:30 AM
3:30 PM TO 5:00 PM
6:15 PM TO 7:15 PM

(B) TUBE WELL (BORE) SUB PUMP:-

HP:- 60 Q:- 35 M³/hr

WORKING TIME:-



(IN ABSENCE OF NARMADA WATER BORE WILL BE USED)

(C) CITY WATER SUPPLY TIME:-

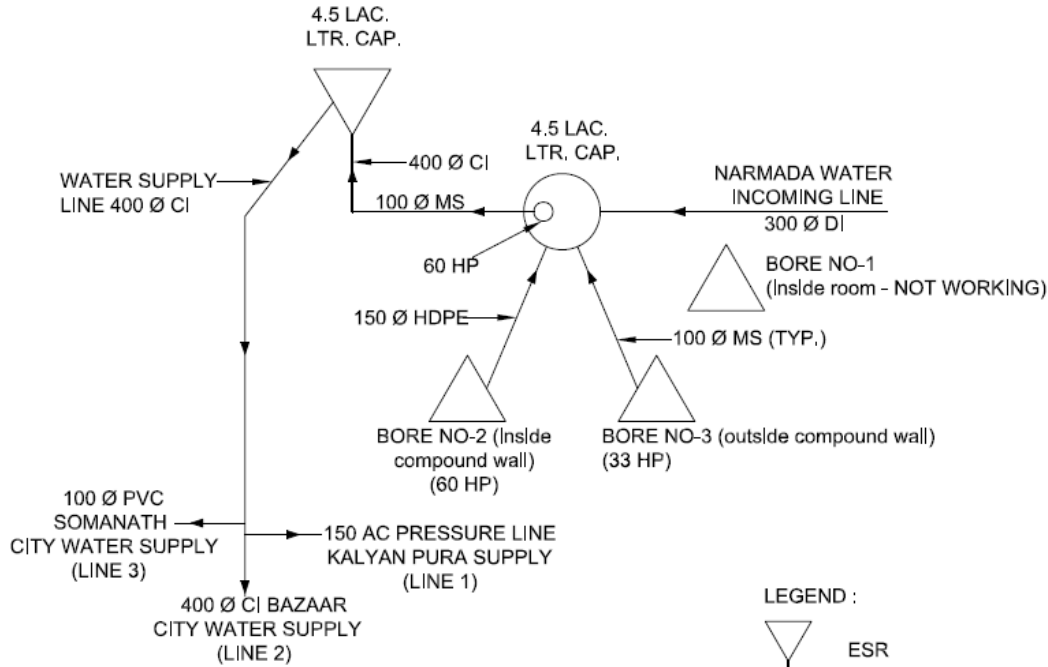
8:30 AM TO 9:15 AM
5:30 PM TO 6:15 PM

NOTES :

- (1) ESR & SUMP WATER LEVEL GAUGE IS NOT WORKING
- (2) TUBE WELL (BORE) SUB PUMP ; HUGE AIR MIXTURE

NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Multi House, B/h, La-Gajar Bunglow, Nr. C.N.Vidhyalaya, Ambawadi, AMDAVAD-380 006.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B - 1, Purnyakot Flats, B/h Reliance Petrol Pump, Ambawadi, Ahmedabad - 380 006.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : —	
CHECKED BY : RVS		PROJ. NO. : —	
SCALE : MTS		DRG. NO. : —	
DATE : 15-2-2010		REVISION : : —	

KALYANPURA SUMP & ESR



(A) ESR FELLING SUB PUMP (BOOSTER PUMP):-
HP:- 60 Q:- 213 M³/hr

WORKING TIME :-
2:00 AM TO 5:00 AM (UP TO ESR OVER FLOW)
5:00 AM TO 7:30 AM (UP TO SUMP EMPTY)
9: 00 AM TO 11:00 AM
12: 00 PM TO 06:45 PM

(B) TUBE WELL (BORE) SUB PUMP:-
BORE -2 - HP:- 61 Q:- 61.35 M³/hr

WORKING TIME:-
6:00 AM TO 9:00 AM
11:30 AM TO 1:00 PM

BORE -3 - HP:- 33 Q:- 33.5 M³/HR

WORKING TIME:-
4:00 AM TO 9:00 AM

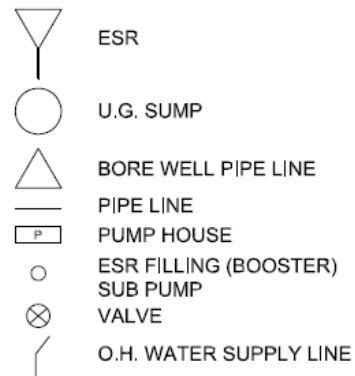
(C) CITY WATER SUPPLY TIME:-

5 AM TO 5:45 AM, 1:30 PM TO 2:15 PM -KALYAN PURA
8:30 AM TO 9:15 AM, 5:30 PM TO 6:15 PM - BAZAR
10:30AM TO 11:00 PM - SOMAANATH

NOTES :

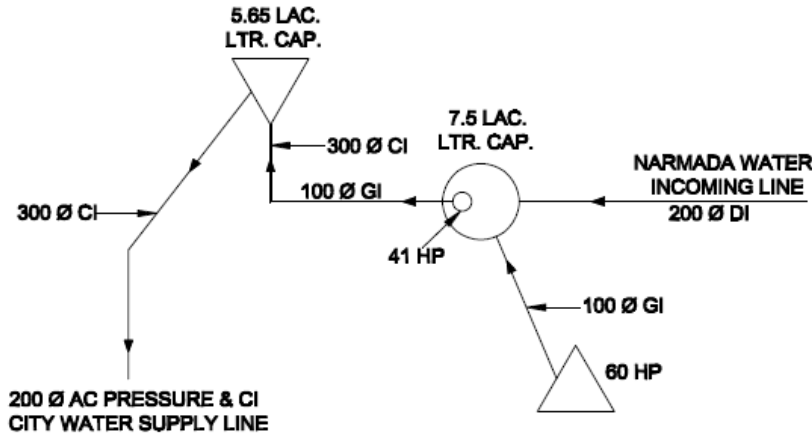
- (1) BORE - 1 FAILED
- (2) BORES ARE REQUIRED TO RUN TO FILL THE SUMP
- (3) ESR HAS HEAVY LEAKAGE
- (4) ESR & SUMP WATER LEVEL GAUGE IS NOT WORKING
- (5) VALVES ARE LEAKING

LEGEND :



NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
		multi media consultants pvt. ltd. Multi House , B/h, La-Gajar Bungalow, Nr. C.N.Vihyalaya, Ambawadi, AMDAVAD-380 006.	
ASSOCIATE CONSULTANTS			
		SAPIENT TECHNO CONSULTANTS B - 1, Punyakot Flats, B/h Reliance Patrol Pump, Ambawadi, Ahmedabad - 380 006.	
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : ---	
CHECKED BY : RVS		PROJ. NO. : ---	
SCALE : MTS		DRG. NO. : ---	
DATE : 15-2-2010		REVISION : : ---	

DIVADA SUMP & ESR



(A) ESR FELLING SUB PUMP (BOOSTER PUMP):-

HP:- 41 Q:- 145 M³/hr

WORKING TIME :-
 2:00 AM TO 7:00 AM
 10:45 AM TO 12:45 PM
 2:30 PM TO 6:00 PM

(B) TUBE WELL (BORE) SUB PUMP:-

HP:- 41 Q:- 76 M³/hr

WORKING TIME:-
 1:00 PM TO 2:30 PM
 5:30 PM TO 7:30 PM

(C) CITY WATER SUPPLY TIME:-

6:00 AM TO 6:45 AM
 6:00 PM TO 6:45 PM

NOTES :

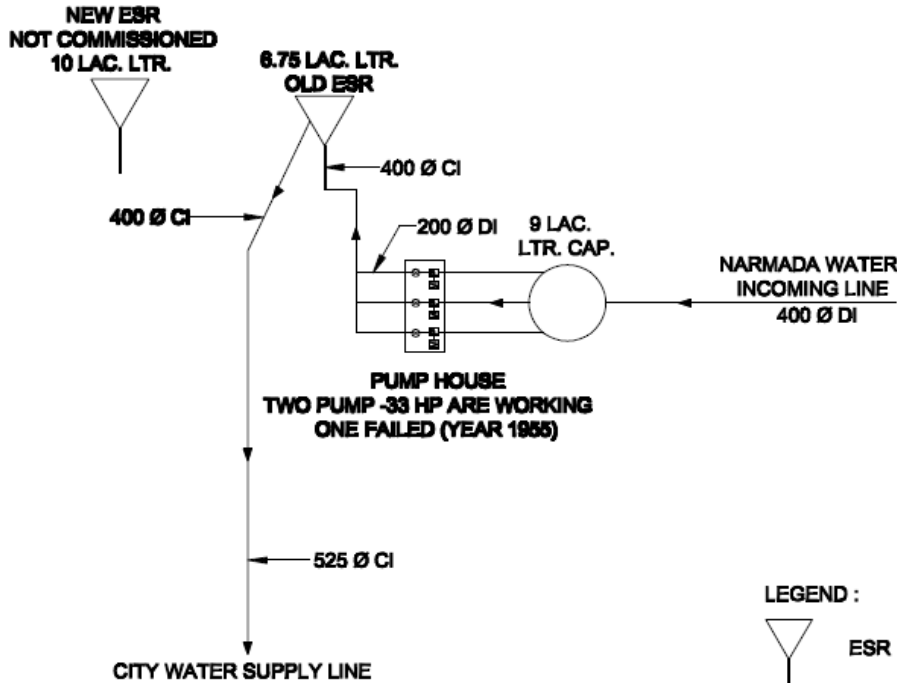
- (1) ESR DOWN LINE VALVE LEAKAGE
- (2) BORE SUB PUMP OR BOOSTER SUB PUMP ANY ONE CAN RUN
- (3) ESR & SUMP WATER LEVEL GAUGE IS NOT WORKING
- (4) BOOSTER PUMP DISCHARGE PIPE IS LEAKING
- (5) UNDER GROUND PIPES ARE FOUND LEAKING (AT 2 PLACES)

LEGEND :

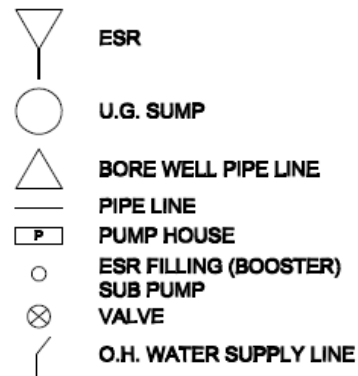
- ESR
- U.G. SUMP
- BORE WELL PIPE LINE
- PIPE LINE
- PUMP HOUSE
- ESR FILLING (BOOSTER) SUB PUMP
- VALVE
- O.H. WATER SUPPLY LINE

NO.	DATE	DESCRIPTION	SIGNATURE
PROJECT WATER AUDIT FOR KALOL CITY			
CLIENT CEPT UNIVERSITY			
CONSULTANTS multi media consultants pvt. ltd. Multi House , B/h. Le-Cajjar Burglar, Nr. C.N.Vidyalaya, Ambawadi, ANDHRA PRADESH.			
ASSOCIATE CONSULTANTS SAPIENT TECHNO CONSULTANTS B - 1, Panyakoti Flats, B/h Reliance Petrol Pump, Ambawadi, Ahmedabad - 380 008.			
TITLE DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC	DESIGNED BY : ---		
CHECKED BY : RVS	PROJ. NO. : ---		
SCALE : NTS	DRG. NO. : ---		
DATE : 15-2-2010	REVISION : : ---		

MAIN WATER WORKS



LEGEND :



(A) ESR FELLING PUMP NO. 1 & 3 (BOOSTER PUMP):-

KW/HP:- 22/30 Q:- 110 M³/hr

PUMP NO. 2 : NOT IN USE

WORKING TIME :-

2:30 AM TO 7:00 AM

1:10 PM TO 6:15 PM

(B) CITY WATER SUPPLY TIME:-



6 AM TO 6:45 AM

6 PM TO 6:45 PM - EAST AREA (MON/WED/SAT)

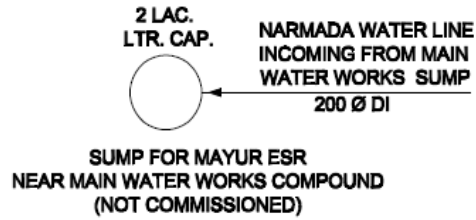
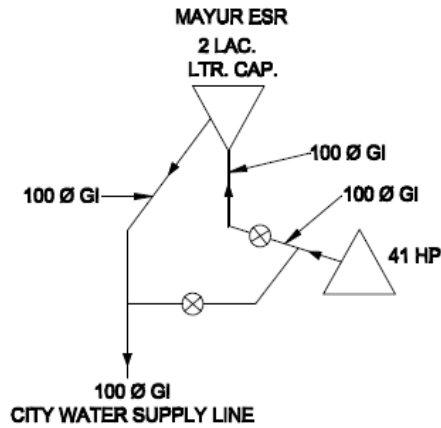
5:30 PM TO 6:15 PM - CITY BAZAAR AREA (TUE/THU/FRI/SUN)

NOTES :









- (1) PUMP NO. 3 FAILED / SUCTION LINE CLOSED
- (2) WATER LIKING FROM PUMP NO. 1 & 2
- (3) BOTH PUMP ARE WORKING FOR ESR FILLING
- (4) HT POWER SUPPLY
- (5) OLD ESR CIVIL WORK IS MORE DAMAGED.
- IN DILAPIDATED CONDITION.
- (6) SPIRAL STAIR IS DAMAGED.
- (7) ESR FILLING LINE IS DAMAGED.
- (8) ESR WATER LEVEL GAUGE IS NOT WORKING
- (9) OLD ESR BECOME FULL IN 3 HOURS WITH 2 PUMPS.

NO.	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Muff House , B/h. Le-Gajar Burglar, Nr. C.N.Vidyalaya, Ambawadi, AMDAV/AD-380 008.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B - 1, Purnyakoti Flats, B/h Reliance Petrol Pump, Ambawadi, Ahmedabad - 380 008.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : ---	
CHECKED BY : RVS		PROJ. NO. : ---	
SCALE : NTS		DRG. NO. : ---	
DATE : 15-2-2010		REVISION : : ---	

MAYUR SUMP & ESR



LEGEND :

-  ESR
-  U.G. SUMP
-  BORE WELL PIPE LINE
-  PIPE LINE
-  PUMP HOUSE
-  ESR FILLING (BOOSTER) SUB PUMP
-  VALVE
-  O.H. WATER SUPPLY LINE

(A) ESR FELLING FROM BORE SUB PUMP (BOOSTER PUMP):-

HP:- 41 Q:- 35.9 M³/hr

WORKING TIME:-
9:00 AM TO 12:00 NOON



(B) CITY WATER SUPPLY TIME:-

6:00 AM TO 6:45 AM
8:00 PM TO 8:45 PM

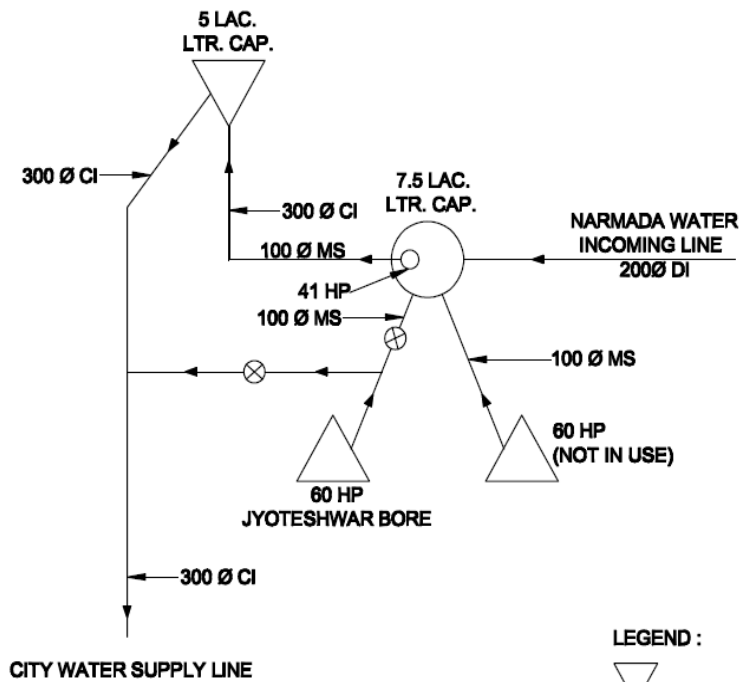
BORE DIRECT SUPPLY:- 4:30 PM TO 5:30 PM

NOTES :









(1) ESR WATER LEVEL GAUGE IS NOT WORKING

NO.	DATE	DESCRIPTION	SIGNATURE
PROJECT WATER AUDIT FOR KALOL CITY			
CLIENT CEPT UNIVERSITY			
CONSULTANTS  multi media consultants pvt. ltd. Multi House , B/h. Le-Gajar Bungalow, Nr. C.N.Vidyalaya, Ambawadi, AMDA/VAD-380 008.			
ASSOCIATE CONSULTANTS  SAPIENT TECHNO CONSULTANTS B - 1, Paryakot Flats, B/h Reliance Petrol Pump, Ambawadi, Ahmedabad - 380 008.			
TITLE DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY :	JNC	DESIGNED BY :	---
CHECKED BY :	RVS	PROJ. NO. :	---
SCALE :	NTS	DRG. NO. :	---
DATE :	15-2-2019	REVISION :	---

TOWN HALL SUMP & ESR



LEGEND :

-  ESR
-  U.G. SUMP
-  BORE WELL PIPE LINE
-  PIPE LINE
-  PUMP HOUSE
-  ESR FILLING (BOOSTER) SUB PUMP
-  VALVE
-  O.H. WATER SUPPLY LINE

(A) ESR FELLING FROM BORE SUB PUMP (BOOSTER PUMP):-

HP:- 41 Q:- 101 M³/hr

WORKING TIME:-
8:30 AM TO 11:15 AM
4:45 PM TO 8:45 PM

(B) CITY WATER SUPPLY TIME:-



8:30 AM TO 9:15 AM
5:30 PM TO 6:15 PM

(C) JYOTESHWAR BORE SUB PUMP:-

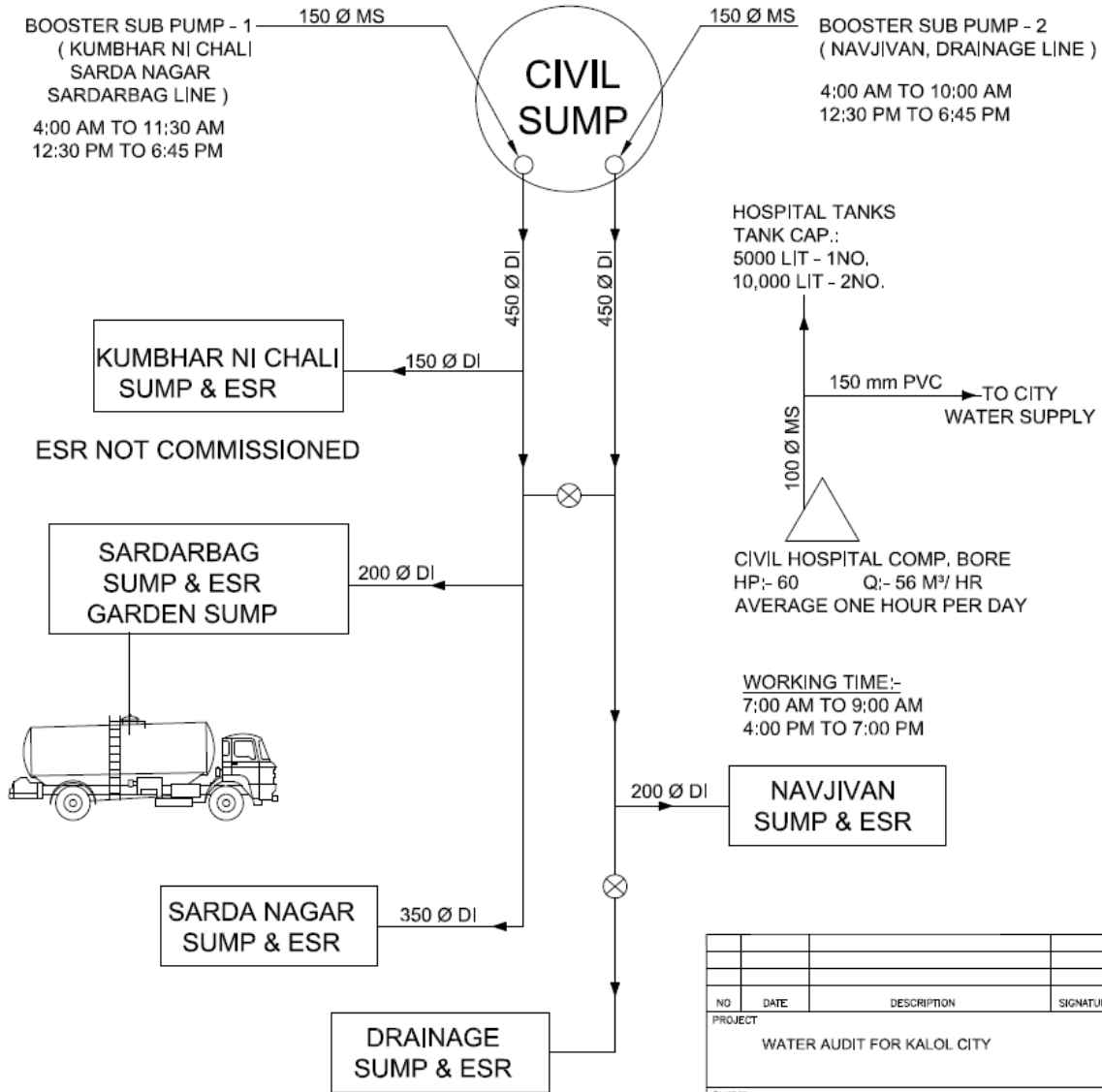
BOOSTER DIRECT SUPPLY:- 6 AM TO 9 AM
TOWN HALL SUMP:- REMAIN 21 HOURS
(BORE IS RUNNING FOR 24 HOURS)



NOTES :

- (1) SUMP WATER LEVEL GAUGE IS NOT WORKING
- (2) BOOSTER PUMP DISCHARGE PIPE IS LEAKING
- (3) VALVES ARE LEAKING

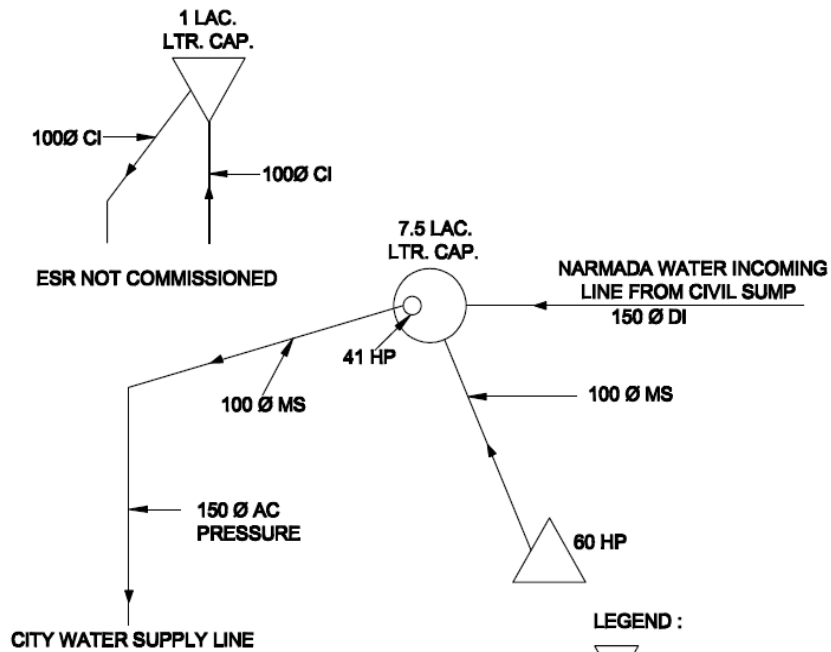
NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Multi House , B/h. Le-Gajar Bunglow, Nr. C.H. Vidhyalaya, Ambawadi, AMDAVAD-380 008.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B - 1, Purnyakoti Flats, B/h Reliance Petrol Pump, Ambawadi, Ahmedabad - 380 008.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : —	
CHECKED BY : RYS		PROJ. NO. : —	
SCALE : NTS		DRG. NO. : —	
DATE : 15-2-2010		REVISION : —	

NARMADA WATER FROM CIVIL SUMP TO CITY DIFFERENT SUMPS











NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Multi House , B/h, La-Gajar Bungalow, Nr. C.N.Vidhyalaya, Ambawadi, AMDAVAD-380 006.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B-1, Purnyakoti Flats, B/h Rollanca Petrol Pump, Ambawadi, Ahmedabad - 380 006.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : —	
CHECKED BY : RVS		PROJ. NO. : —	
SCALE : NTS		DRG. NO. : —	
DATE : 15-2-2010		REVISION : —	

KUMBHAR NI CHALI SUMP & ESR



LEGEND :

-  ESR
-  U.G. SUMP
-  BORE WELL PIPE LINE
-  PIPE LINE
-  PUMP HOUSE
-  ESR FILLING (BOOSTER) SUB PUMP
-  VALVE
-  O.H. WATER SUPPLY LINE

(A) ESR FELLING SUB PUMP (BOOSTER PUMP):-

ESR NOT COMMISSIONED

(B) TUBE WELL (BORE) SUB PUMP:-

HP:- 60 Q:- 68 M³/HR
 WORKING TIME:-
 9:45 AM TO 01:00 PM
 6:30 PM TO 10:00 PM



(C) CITY WATER SUPPLY TIME:- (THROUGH BOOSTER)

BOOSTER PUMP HP:- 41 Q:- 113 M³/hr

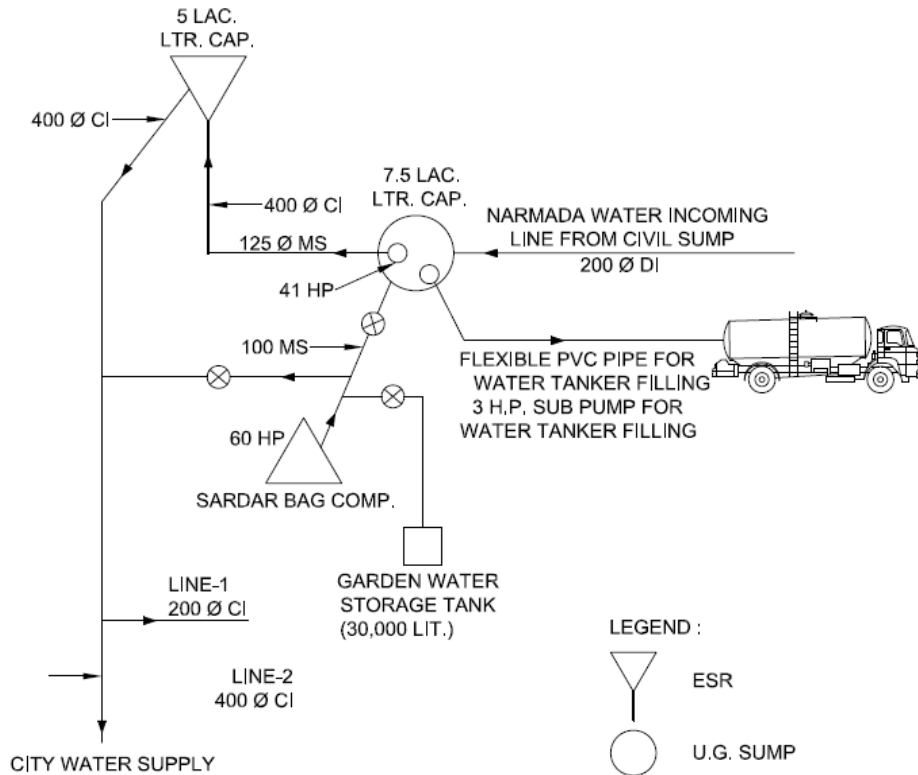
8.00 AM TO 9.30 AM
 5 PM TO 6.30 PM

NOTES :

- (1) SUMP WATER LEVEL GAUGE IS NOT WORKING
- (2) BOOSTER PUMP DISCHARGE PIPE IS LEAKING

NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Multi House , B/h. La-Gajar Bunglow, Nr. C.H. Vidyalaya, Ambewadi, AHMEDABAD-380 008.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B - 1, Punysakodi Flats, B/h Reliance Petrol Pump, Ambewadi, Ahmedabad - 380 008.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : —	
CHECKED BY : RVS		PROJ. NO. : —	
SCALE : NTS		DRG. NO. : —	
DATE : 15-2-2010		REVISION : —	

SARDAR BAG SUMP & ESR



LEGEND :

- ESR
- U.G. SUMP
- BORE WELL PIPE LINE
- PIPE LINE
- PUMP HOUSE
- ESR FILLING (BOOSTER) SUB PUMP
- VALVE
- O.H. WATER SUPPLY LINE

(A) ESR FELLING SUB PUMP (BOOSTER PUMP):-
HP:- 60 Q:- 177 M³/hr

WORKING TIME :-
5:00 AM TO 8:00 AM
8:30 AM TO 9:30 AM
12: 30 PM TO 3:30 PM

(B) TUBE WELL (BORE) SUB PUMP:-
HP:- 60 Q:- 30 M³/hr

WORKING TIME:-
9:00 AM TO 12:00 NOON
4:30 PM TO 5:30 PM (DIRECT SUPPLY)

(C) CITY WATER SUPPLY TIME:-

8:30 AM TO 9:15 AM
5:30 PM TO 6:15 PM

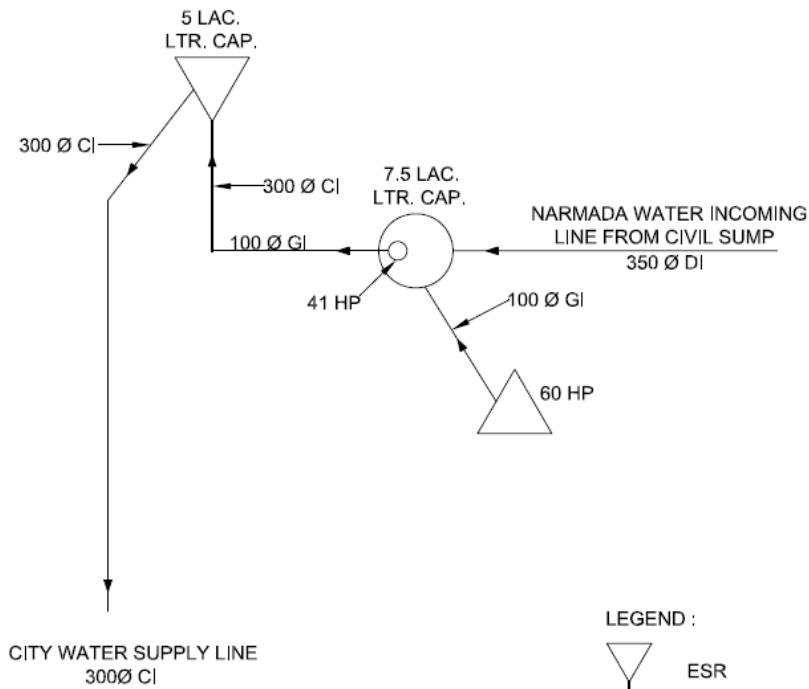
(D) WATER TANKER SUPPLY:-
5000LIT TANKER - AVG. DALLY 10 NOS.

NOTES :









- (1) ESR WATER SUPPLY VALVE IS LEAKAGE
- (2) ESR & SUMP WATER LEVEL GAUGE IS NOT WORKING
- (3) BOOSTER PUMP DISCHARGE PIPE IS LEAKING
- (4) BORE PUMP DISCHARGE PIPE IS LEAKING
- (5) TANKER VALVES ARE LEAKING

NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
multi media consultants pvt. ltd. Multi House , B/h, La-Ga[er] Bungalow, Nr. C.N.Vidhyalaya, Ambawadi, AMDAVAD-380 006.			
ASSOCIATE CONSULTANTS			
SAPIENT TECHNO CONSULTANTS B - 1, Punyakoti Flats, B/h Rallanca Patel Pump, Ambawadi, Ahmedabad - 380 006.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC	DESIGNED BY : —		
CHECKED BY : RYS	PROJ. NO. : —		
SCALE : NTS	DRG. NO. : —		
DATE : 15-2-2010	REVISION : —		

SARDA NAGAR SUMP & ESR



LEGEND :

-  ESR
-  U.G. SUMP
-  BORE WELL PIPE LINE
-  PIPE LINE
-  PUMP HOUSE
-  ESR FILLING (BOOSTER) SUB PUMP
-  VALVE
-  O.H. WATER SUPPLY LINE

(A) ESR FELLING SUB PUMP (BOOSTER PUMP):-

HP:- 60 Q:- 149 M³/ HR

WORKING TIME:-

5:30 AM TO 12:00 PM

1:00 PM TO 3:15 PM

(B) TUBE WELL (BORE) SUB PUMP:-

HP:- 60 Q:- 87 M³/ HR

WORKING TIME:-

(IN ABSENCE OF NARMADA WATER BORE WILL BE USED)

(C) CITY WATER SUPPLY TIME:-



5:30 AM TO 6:00 AM (HIGH WAY AREA)

8:30 AM TO 9:15 AM (JANTANAGAR AREA)

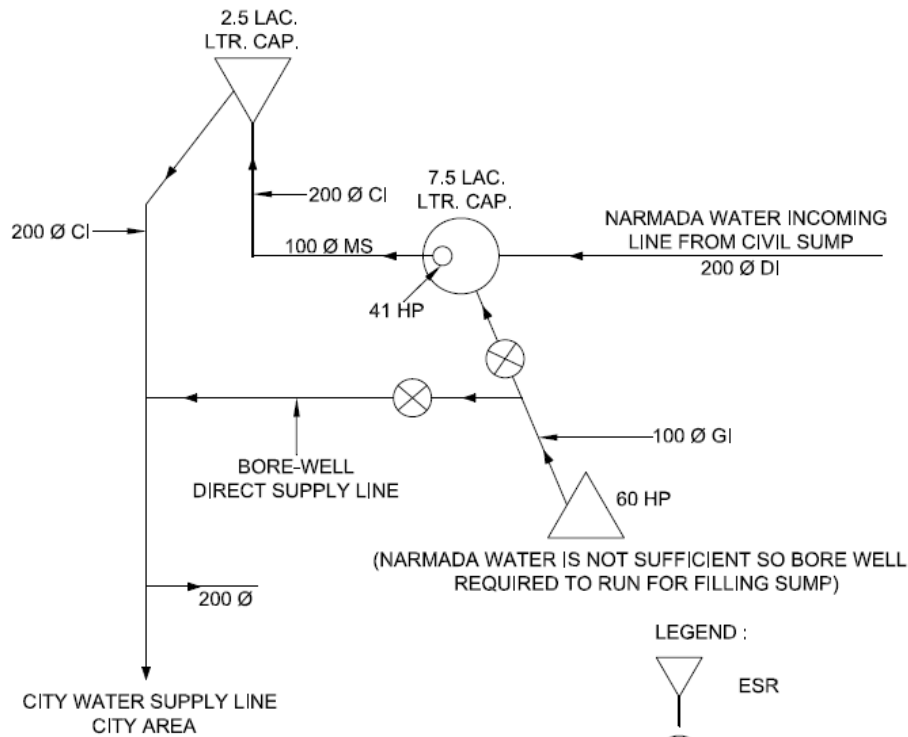
1:30 PM TO 2:15 PM (HIGH WAY AREA)

NOTES :









(1) ESR & SUMP WATER LEVEL GAUGE IS NOT WORKING

NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Multi House , B/h, La-Gajar Bunglow, Nr. C.N.Viharsays, Ambawadi, AMDAVAD-380 006.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B - 1, Punyakot Flats, B/h Reliance Petrol Pump, Ambawadi, Ahmedabad - 380 006.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : ---	
CHECKED BY : RVS		PROJ. NO. : ---	
SCALE : NTS		DRG. NO. : ---	
DATE : 15-2-2010		REVISION : : ---	

NAVJIVAN SUMP & ESR



LEGEND :

-  ESR
-  U.G. SUMP
-  BORE WELL PIPE LINE
-  PIPE LINE
-  PUMP HOUSE
-  ESR FILLING (BOOSTER) SUB PUMP
-  VALVE
-  O.H. WATER SUPPLY LINE

(A) ESR FELLING SUB PUMP (BOOSTER PUMP):-
HP:- 41 Q:- 203 M³/hr

WORKING TIME :-
9:15 AM TO 10:45 AM
6:15 PM TO 7:45 PM

(B) TUBE WELL (BORE) SUB PUMP:-
HP:- 60 Q:- 35 M³/hr

WORKING TIME:-
10:30 AM TO 4:30 PM

(C) CITY WATER SUPPLY TIME:-

8:30 AM TO 9:15 AM
5:30 PM TO 6:15 PM

BOOSTER DIRECT SUPPLY:- 8:30 AM TO 9:15 AM



BOOSTER DIRECT SUPPLY:- 5:30 PM TO 6:15 PM

BORE DIRECT SUPPLY:- 7:00 AM TO 8:30 AM

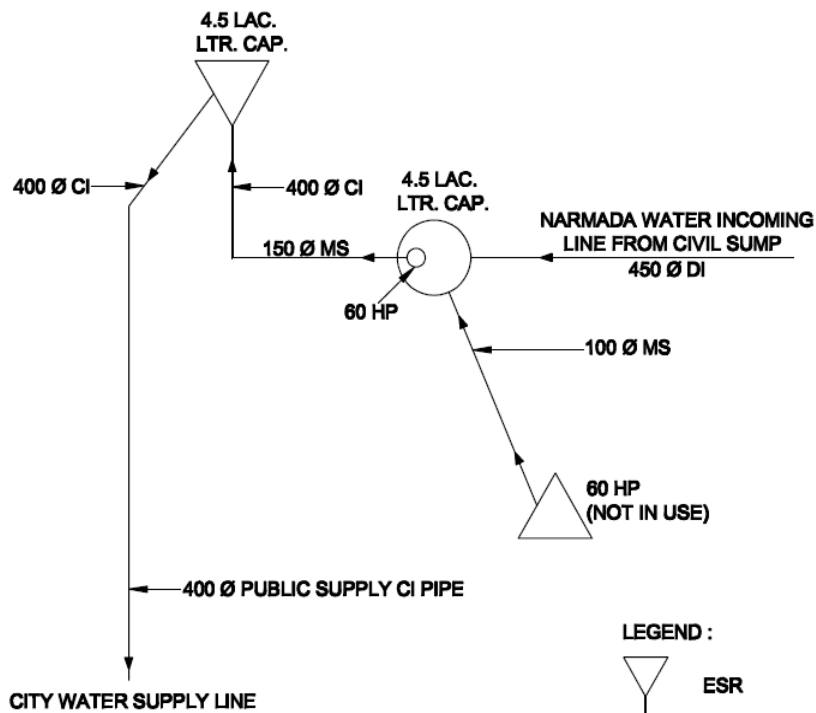
BORE DIRECT SUPPLY:- 4:30 PM TO 5:30 PM

NOTES :









- (1) NEW ESR BUT DOWN LINE VALVES ARE LEAKING
- (2) ESR & SUMP WATER LEVEL GAUGE IS NOT WORKING
- (3) BOOSTER PUMP DISCHARGE PIPE IS LEAKING

NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Multi House, B/h, La-Gajar Bungalow, Nr. C.N.Vidhyasaya, Ambawadi, AMDAVAD-380 006.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B - 1, Punyakoti Flats, B/h Reliance Patrol Pump, Ambawadi, Ahmedabad - 380 006.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : _____	
CHECKED BY : RVS		PROJ. NO. : _____	
SCALE : NTS		DRG. NO. : _____	
DATE : 15-2-2010		REVISION : _____	

DRAINAGE COMP. SUMP & ESR



LEGEND :

-  ESR
-  U.G. SUMP
-  BORE WELL PIPE LINE
-  PIPE LINE
-  PUMP HOUSE
-  ESR FILLING (BOOSTER) SUB PUMP
-  VALVE
-  O.H. WATER SUPPLY LINE

(A) ESR FELLING SUB PUMP (BOOSTER PUMP):-

HP:- 60 Q:- 196 M³/hr

WORKING TIME :- 3 AM TO 5 PM

(B) TUBE WELL (BORE) SUB PUMP:-

NOT IN USE

(C) CITY WATER SUPPLY TIME:-

5:30 AM TO 6:00 AM (HIGH WAY AREA)

8:30 AM TO 9:15 AM (KALOL GAM)

1:30 PM TO 2 PM (HIGH WAY AREA)



5:30 PM TO 6:15 PM (KALOL GAM)

NOTES :

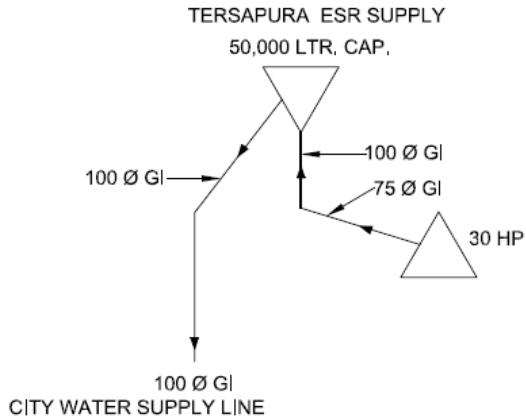
(1) ESR WATER SUPPLY VALVE IS LEAKAGE

(2) NARMADA WATER INCOMING VALVE IS LEAKAGE

(3) ESR & SUMP WATER LEVEL GAUGE IS NOT WORKING

NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Multi House , B/h. Le-Gajar Bunglow, Nr. C.N.Vidyalaya, Ambawadi, AMDAVAD-380 008.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B - 1, Purnyakoti Flats, B/h Reliance Petrol Pump, Ambawadi, Ahmedabad - 380 008.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC	DESIGNED BY : ---		
CHECKED BY : RVS	PROJ. NO. : ---		
SCALE : NTS	DRG. NO. : ---		
DATE : 15-2-2010	REVISION : ---		

TERSAPARU ESR



(A) TUBE WELL (BORE) SUB PUMP FOR ESR FELLING:-

HP:- 30 Q:- 14 M³/hr

WORKING TIME:-
5:30 AM TO 9:00 AM

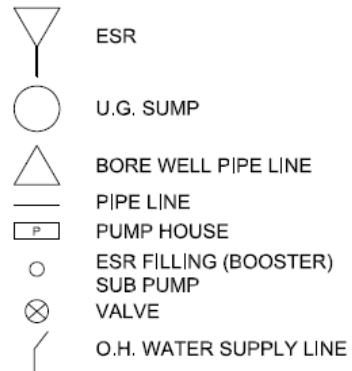
(C) CITY WATER SUPPLY TIME:-



9:00 AM TO 11:00 AM

NOTES :

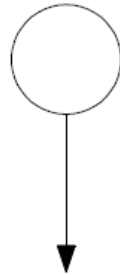
- (1) ESR WATER LEVEL GAUGE IS NOT WORKING
- (2) BOOSTER PUMP DISCHARGE PIPE IS LEAKING
- (3) UNDER GROUND PIPES ARE FOUND LEAKING (AT 2 PLACES)

LEGEND :



NO	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
 multi media consultants pvt. ltd. Multi House , B/h, La-Gajar Bungalow, Nr. C.N.Vidhyalaya, Ambawadi, AMDAVAD-380 006.			
ASSOCIATE CONSULTANTS			
 SAPIENT TECHNO CONSULTANTS B-1, Purnyakoti Flats, B/h Rollanca Petrol Pump, Ambawadi, Ahmedabad - 380 006.			
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : —	
CHECKED BY : RVS		PROJ. NO. : —	
SCALE : NTS		DRG. NO. : —	
DATE : 15-2-2010		REVISION : —	

BORE WELL DIRECT TO NETWORK SUPPLY



BORE WELL

DIRECT CITY WATER SUPPLY

1. IFFCO BORE WELL
 7:30 AM TO 9:00 AM
 5:00 PM TO 7:00PM
 LINE SIZE : 100 GI

H.P. : 60 Q : 62 M³/HR

2. BHAVANI NAGAR BORE WELL
 6:30 AM TO 9:00 AM
 3:00 PM TO 6:45 PM
 LINE SIZE : 100 MS

H.P. : 60 Q : 50 M³/HR

3. PAVATHI (AMBAJI MANDIR) BORE WELL
 7:00 AM TO 9:00 AM
 3:30 PM TO 7:00 PM
 LINE SIZE : 100 MS



H.P. : 60 Q : 49.1 M³/HR

4. AYOJAN NAGAR BORE WELL
 7:00 AM TO 9:00 AM
 3:00 PM TO 5:00 PM
 LINE SIZE : 100 MS

H.P. : 60 Q : 81 M³/HR

5. JYOTESHWAR BORE WELL
 6 AM TO 9 AM
 REMAIN 21 HOURS IN TOWNHALL SUMP
 LINE SIZE : 100 MS, H.P. : 60, Q : 53 M³/HR

6. MAHENDRA MILL BORE WELL
 6:30 AM TO 8:00 AM (45 MIN. TO EACH LINE)
 H.P. : 60
 LINE SIZE -1 : 200 MS Q : 20 M³/HR
 LINE SIZE -2 : 150 MS Q : 58 M³/HR

NO.	DATE	DESCRIPTION	SIGNATURE
PROJECT			
WATER AUDIT FOR KALOL CITY			
CLIENT			
CEPT UNIVERSITY			
CONSULTANTS			
		multi media consultants pvt. ltd. Multi House - 8th, Lo-Gajar Bungalow, Nr. Q.N.Vidyalaya, Ambawadi, AHMEDABAD-380 008.	
ASSOCIATE CONSULTANTS			
		SAPIENT TECHNO CONSULTANTS B - 1, Purnyakshi Flats, 8th Rd, Ramesh Patel Pump, Ambawadi, Ahmedabad - 380 008.	
TITLE			
DETAIL OF WATER SUPPLY NETWORK			
DRAWN BY : JNC		DESIGNED BY : —	
CHECKED BY : RVS		PROJ. NO. : —	
SCALE : NTS		DRG. NO. : —	
DATE : 15-2-2010		REVISION : —	

Annexure 2: Volumetric Measurement

Pipeline – WTP to Main Water Works (Divada/Kalyanpura/Main Water Works)

Time of measurement: 2:40 to 3:00 pm

Sr no	Location/description	Time duration of meas. (hr)	Area of sump (m ²)	Level rise (m)	UGSR fill volume as per level rise (m ³)	Booster pump status	Booster pump flow cap (m ³ /hr)	Booster pump correction volume (m ³)	Total fill volume of UGSR (m ³)
1	Divada UGSR	0.333	216.05	0.01	2.16	on	145	48	50.49
2	Kalyanpura UGSR	0.333	183.28	0.01	1.83	on	213	71	72.83
3	Main W/W UGSR	0.333	256.04	0.35	89.61	off	0	0	89.61
Total measured volume at UGSR (m³)									212.94
Pratappura WTP volume reading at totaliser									226.00
% variation									-5.78%

Pipeline – WTP to Main Water Works (Vankarvas/Kalyanpura/Main Water Works)

Time of measurement: 10:30 to 10:50 am

Sr no	Location/Description	Time duration of meas. (hr)	Area of sump (m ²)	Level rise (m)	UGSR fill volume as per level rise (m ³)	Booster pump status	Booster pump flow cap (m ³ /hr)	Booster pump correction volume (m ³)	Total fill volume of UGSR (m ³)
1	Vankarvas	0.333	121.09	0.19	23.01	off	0	0	23.01
2	Kalyanpura UGSR	0.333	183.28	0.16	29.32	on	213	71	100.32
3	Main W/W UGSR	0.333	256.04	0.37	94.73	off	0	0	94.73
Total measured volume at UGSR (m³)									218.07
Pratappura WTP volume reading at totaliser									218.00
% variation									0.03%

Pipeline – WTP to Civil Hospital Sump

Time of measurement: 7:00 to 7:30 pm

Sr no	Location/Description	Time duration of meas. (hr)	Area of sump (m ²)	Level rise (m)	UGSR fill volume as per level rise (m ³)	Booster pump status	Booster pump flow cap (m ³ /hr)	Booster pump correction volume (m ³)	Total fill volume of UGSR (m ³)
1	Civil Hospital Sump	0.500	1243.47	0.36	447.65	OFF	0	0	447.65
Total measured volume at UGSR (m³)									447.65
Pratappura WTP volume reading at totaliser									466.00
% variation									-3.94%

Annexure 3: ESR Inlet Flow Details

A. ESR Inlet Flow (UGSR booster pump to ESR)

Sr no	Booster pump/ESR location	Pump discharge flow (m ³ /hr)	Avg working hrs	Avg daily flow (m ³)	Avg daily flow (MLD)
1	TP- 46	140	7	980	0.98
2	Vankarvas	124	3	372	0.37
3	Kalyanpura	213	14	2,982	2.98
4	Divada	145	10.5	1,522.5	1.52
5	Main Water Works (2W Pumps) (Volumetric Estimation of ESR flow as flow measurement on pump discharge not possible)	110	9.5	1,045	1.05
6	Mayur Housing (Bore to ESR)	36	3	108	0.11
7	Town Hall	101	6.75	681.75	0.68
8	Sarda Nagar	149	9.75	1,452.75	1.45
9	Sardarbag	177	7	1,239	1.24
10	Navjivan	203	3	609	0.61
11	Drainage	196	14	2,744	2.74
12	Tersaparu (Bore to ESR)	14	3.5	49	0.05
	Sub-total (A)				13.79

B. Direct Ground Water Flow to Distribution Network

Sr no	Source location	Avg inst flow (m ³ /hr)	Avg working hrs	Avg daily flow (m ³)	Avg daily flow (MLD)
1	Civil Hospital bore	56	5	280	0.28
2	Sardarbag bore	30	1	30	0.03
3	Navjivan bore	35	2.5	87.5	0.09
4	IFFCO bore	62.5	3.5	218.75	0.22
5	Bhavani Nagar bore	50	6.15	307.5	0.31
6	Pavathi bore	49	3	147	0.15
7	Ayojan Nagar bore	81	4	324	0.32
8	Jyotesh Nagar	53.8	3	161.4	0.16
9	Mahendra Mill bore line 1	58	0.45	26.1	0.03
10	Mahendra Mill bore line 2	20	0.45	9	0.01
11	Kumbhar Ni Chali (WTP + ground water by booster pump direct to n/w)	68	3	204	0.20
	Sub-total (B)				1.80
	Grand total (A+B)				15.58

Annexure 4: ESR Outlet Flow Details

A. ESR Outlet Flow to Distribution Network

Sr no	ESR location	Total flow reading (m ³ /hr)	Supply hrs	Avg daily quantity (m ³)	Avg daily quantity (MLD)
1	TP- 46	633	2	1,266	1.27
2	Vankarvas	274	2	548	0.55
3	Kalyanpura	531	4.5	2,389.5	2.39
4	Divada	559	2	1118	1.12
5	Main Water Works (2W Pumps) (ESR inflow taken as ESR outflow as flow is not measurable)		2	1,045	1.05
6	Mayur Housing (bore to ESR)	149	2	298	0.30
7	Town Hall	475	2	950	0.95
8	Sarda Nagar	381	3	1,143	1.14
9	Sardarbag	534	2	1,068	1.07
10	Navjivan	279	2	558	0.56
11	Drainage (ESR inflow taken as ESR outflow as flow is not measurable)			2,744	2.74
12	Tersaparu (bore to ESR)	14	3.5	49	0.05
	Sub-total (A)				13.18

B. Direct Ground Water Flow to Distribution Network

Sr no	Source location	Avg inst flow (m ³ /hr)	Avg working hrs	Avg daily flow (m ³)	Avg daily flow (MLD)
1	Civil Hospital bore	56	5	280	0.28
2	Sardarbag bore	30	1	30	0.03
3	Navjivan bore	35	2.5	87.5	0.09
4	IFFCO bore	62.5	3.5	218.75	0.22
5	Bhavani Nagar bore	50	6.15	307.5	0.31
6	Pavathi bore	49	3	147	0.15
7	Ayojan Nagar bore	81	4	324	0.32
8	Jyotesh Nagar	53.8	3	161.4	0.16
9	Mahendra Mill bore line 1	58	0.45	26.1	0.03
10	Mahendra Mill bore line 2	20	0.45	9	0.01
11	Kumbhar Ni Chali (WTP + ground water by booster pump direct to network)	68	3	204	0.20
	Sub-total (B)				1.80
	Grand total (A+B)				14.97

Annexure 5: Details of Bucket Survey at Consumers' End

A. Volumetric Bucket Method: ½-inch and ¾-inch Connection Supply Measurement

Sr no	Location of sample measurement	Household members	Time of supply as per ULB (min/day)	Average flow measured (LPM)	Measured app time of supply at location, (min/supply)	Measured time of supply at location (min/day)	Avg pressure from GL (m)	Avg water available, (lit/day)	Avg. LPCD supply	Remarks
Zone 1										
1	TP-46 (Patel Colony)	4	45	4.97	56	56.00	-0.35	278	69.52	
2	TP-46 (Talavadi)	6	45	3.08	60	60.00	-0.95	185	30.77	
3	Shakti Vijay Society	5	90	4.77	18	36	-1.58	172	34.33	
4	Tersaparu	6	45	24.83	25	25.00	4.50	621	103.45	
5	TP-46 (St Xavier's)	4	45	20.77	39	39.00	-0.35	810	202.54	
6	TP-46 (Ayojanpura)	8	45	14.55	75	75.00	1.24	0	0.00	Motor operated
Average (Zone 1)								413	88	
Zone 2										
1	Vaghrivas	4	90	10.54	20	40	2	421	105.37	
2	Railway East Area	5	90	13.85	30	60	0.76	831	166.15	
3	Bhavani Nagar	15	90	14.03	25	50	1	701	46.76	
4	Drainage	10	90	5.85	22	44.00	-0.18	258	25.76	
5	Swadesini Chali	6	90		30	60	0	0	0.00	Hand pump/motor operated
6	Navjivan Mill Ni Chali	5	90	17.42	30	60	3	1045	209.05	
7	Vakharia Char Rasta	7	90	1.89	15	30	0.08	57	8.11	
8	Fatepura	4	90	2.66	20	40	-0.92	106	26.6	
9	Pandyavas	5	90		30	60	0	0	0.00	Hand pump/motor operated
10	Motinagar	7	90	5.9	30	60	0	354	50.57	
11	Sarda Nagar	4	90	13.27	38	76.00	-2.2	1009	252.17	
12	Nathji Ni Wadi	3	90				0	0	0	Hand pump/motor operated
13	Juni Hadka Mill	6	45	6.52	15	30	0.04	195	32.58	
14	IFFCO Nagar	4	210	6.46	210	210	0.5	1356	339.01	
15	Mahendra Mill Ni Chali	7	90	7.38	20	40	0.73	295	42.17	
16	Navjivan Mill	4	90	12	30	60	1.15	720	180	

Sr no	Location of sample measurement	Household members	Time of supply as per ULB (min/day)	Average flow measured (LPM)	Measured app time of supply at location, (min/supply)	Measured time of supply at location (min/day)	Avg pressure from GL (m)	Avg water available, (lit/day)	Avg. LPCD supply	Remarks
	Ni Chali									
Average (Zone 2)								565	114	
Zone 3										
1	Somanath Society	3	45	6.64	20	20	0.70	133	44.24	
2	Gay No Tekro	4	90	17.7	30	60	2.41	1062	265.50	
3	Ambika Nagar						2	0		
4	Barot Vas	4	90	5.65	30	60	1.52	339	84.71	
5	Rajnaragar Society	5	45	5.6	15	30	0.5	168	33.6	
6	Amrut Kunj	5	90				0	0	0	Hand pump/motor operated
7	Dwarkesh Apartment	90	90	13.84	20	40	2.7	1107	12.3	
8	Vardhaman Nagar	10	90	15.65	25	50	3.20	783	78.26	
9	Jain Wadi	6	90	8.57	30	60	3.025	514	85.71	
10	Taluka Vikas Officer Kacheri		90		30	60	0	0		Commercial hand pump/motor operated
11	Nano Thakorvas	8	90	3.99	30	60	0.95	239	29.93	
12	Vallabhnagar Society	4	90		20	40	0	0	0	Hand pump/Motor operated
13	Jai Bhavani Nagar	7	45		20			0	0.00	Hand pump/motor operated
Average (Zone 3)								543	79	

Zone	No of registered connections	Average supply per connection (litre)	Average supply per day (litre)	Total supply (MLD)
1	5,204	413	2,149,445	2.15
2	7,632	565	4,314,416	4.31
3	5,005	543	2,718,364	2.72
Total	17,841		9,182,225	9.18

B. Volumetric Bucket Method: 1-inch Connection Supply Measurement

Sr no	Location of sample measurement	Household members	Time of supply as per ULB (min/day)	Average flow measured (LPM)	Measured app time of supply at location (min/supply)	Measured time of supply at location (min/day)	Avg pressure from GL (m)	Avg water available (lit/day)	Avg. LPCD Supply
1	Ganesh Apartment	120	90	159	20	40	6.00	6360	106
2	Park Avenue	90	90	53	20	40	0.50	2120	47
3	Jyoteshvar Mahadev	5	90	9	20	40	2.54	360	72
4	Kashiba Nivas	4	90	15.31	30	60	3.05	918.6	229.65
		219						2,439.65	114

No of registered connections	Average supply per connection (litre)	Average supply per day (litre)	Total supply (MLD)
33	2,440	80,508	0.08

C. Summary Statement of Total Supply to Kalol City

Type of connection	No of registered connections	Total supply (lit/day)	Total supply (MLD)
½-inch and ¾-inch connection	17,841	9,182,225	9.18
1-inch connection	33	80,508	0.08
Total billed consumption	17,874	9,262,733	9.26
System input			17.26
Non-revenue water (NRW)		MLD	7.99
NRW		%	46.32%

The Performance Assessment System (PAS) Project

The PAS Project aims to develop appropriate methods and tools to measure, monitor and improve delivery of water and sanitation in cities and towns in India. The PAS Project includes three major components of performance measurement, performance monitoring and performance improvement. It covers all the 400+ urban local governments in Gujarat and Maharashtra.

CEPT University has received a grant from the Bill and Melinda Gates Foundation for the PAS Project. It is being implemented by CEPT University with support of Urban Management Centre (UMC) in Gujarat and All India Institute of Local Self-Government (AIILSG) in Maharashtra.

PAS Project

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