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Determination of real loss (the permanent loss) of water in Raiwada source network in Visakhapatnam water supply system - A case study

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ABSTRACT

Significant progress has been made in water sector in developing technologies and best practices for conserving, purifying, recycling, and desalination water etc., that effectively increase drinking availability. In the developed world, basic efficiency measures are now widely practiced to reduce un accounted flow of water in urban sector in the industrial and commercial sectors and include the use of low-volume plumbing fixtures, reduction of irrigation schedule, and efficiency improvement for water-cooling technologies and equipment. Industrial dischargers generally employ best available pollution control technologies. Basic drinking water and sewage treatment are, in place, throughout the developed world and developing nations. More efficient and effective technologies are gradually emerging. Water losses categorized into two groups, one is real losses and the other is apparent losses. Real losses are to usually from the leakages in the transmission and distribution sides, leakages and over flow in reservoirs, sumps and storage tanks and also the leakage of water on service connections up to a point of consumer metering. Apparent losses are due to in- accumulate metering, un authorized connections, unbilled connections etc., All these leaks lead to Non revenue of water(NRW). In the case of GVMC(Greater Visakhapatnam Municipal Corporation) the NRW is as much as 25 to 35% as reported. Study conducted on one of the trunk main namely 'Raiwada Source' which caters 28% of water demand of GVMC. Real losses are calculated on the system and at least 26% losses are found in the distribution system and 8% losses are found in supply side from trunk main to service reservoirs. If real losses restricted to the norms of CPHEEO, saving in water utility would be 9 MGD which is sufficient for the time being to supply water at 150 lpcd to the residents of Visakhapatnam.

KEYWORDS

Leak detection;
Unaccounted flow of water;
Real losses;
Apparent losses;
Non revenue of water;
Metering;
GIS.

Current Research Paper

INTRODUCTION

Though the water supply system is successfully laid, technically, the real problem is that the system is mismanaged and misused through un-metered and unaccounted water supply. Moreover, low tariff rates, the policy of subsidy and low recovery rate as well as metering errors and billing mistakes burden the system. People are yet to come out of the mindset that water is naturally available and hence, a free commodity. But, one has to pay for the transport of this commodity after refinement. Attending to contamination problems in the mains below the concrete roads is also difficult. It has also become very difficult to take action even after detecting cases of pilferage or theft work and attend to the problem. GVMC officials hope that the citizens become aware of these hardships in bringing water from 100km and distributing in complex environment so that they can lend a hand and fulfill their duty of paying for the services and conserve scarce water resources.

The Greater Visakhapatnam Municipal Corporation (GVMC) is responsible for supply of potable water including planning, design, construction Implementation, maintenance, operation& Management of water supply and sewerage system. The water supply pipelines have been laid in the city from early 20th century onwards. Though the city took up replacement of pipelines from time to time, due to financial constraints, it has not been possible to fully replace all the old pipelines. GVMC proposes to implement UFW reduction measures in all parts of the city as an immediate measure by conducting leak detection studies, metering, rehabilitation of old pipelines etc.,

The existing facilities have been critically assessed. Some have been found to be designed and/ or constructed that they have to be replaced and following deficiencies have been arrived at based on the SWOT (Strengths, Weaknesses, Opportunity, Threads) analysis.

- ❖ Insufficient distribution network
- ❖ Insufficient infrastructure
- ❖ Lack of water audits
- ❖ Lack of energy Audits
- ❖ Lack of reuse facilities
- ❖ Storm water drains and utilization

WATER DEMAND AND DEFICIT

GVMC's Current estimated demand @ 150 lpcd stands at 60 MGD for the present population of 1.8 million. Bulk demand for industrial use is 16 MGD and thus the total requirement of water is 76 MGD. The supply provided to domestic sector is 40 MGD with intermittent supply period of one hour a day in different parts of the city. The deficit in domestic supply is 20 MGD. The requirement of water for industrial use is 20 MGD and there is a deficit of 4 MGD; thus amounting to a total a deficit of 24 MGD. The installed capacity of Water treatment plants are 73 MGD.

Sources of water

The main surface sources of water for the city of Visakhapatnam are;

- Mudasaralova Reservoir
- Raiwada Reservoir
- Gosthani River
- Thatipudi Reservoir
- Mehadri Gedda Reservoir
- Gambheeram Gedda Reservoir
- Yeleru Left Bank Canal
- Godavari River

The City was initially receiving 0.4 mgd of water from the Mudasarlova reservoir(1902) with subsequent additions of 3.60 mgd from Gosthani, 9.00 mgd from Thatipudi, 9.00 mgd from Mehadrigedda reservoir and 16.00 mgd from Raiwada and Yeleru systems totaling 56.00 mgd of water. The other sources of supply are the reservoirs built on minor streams like Gambheeram and others All these sources are rain fed reservoirs. The Godavari filtration plant with 33 MGD capacity of was commissioned during the year 2006 with Yeleswaram (YLMC) reservoir source.

UNACCOUNTED FLOW OF WATER (UFW)

What is Unaccounted for Water?

1. Unaccounted for water is the difference between the amount of water a utility purchases or produces and the amount of water it can account for in sales and other known uses for a given period.
2. Most unaccounted for water can be found in FIVE major areas.

Five Areas of Water Loss

1. Inaccurate or Incomplete record keeping.
2. Meter error;
3. Unmetered uses such as firefighting, line flushing, etc.
4. Leaks.
5. Water Theft and unauthorized use.

UNDERSTANDING WATER LOSS

Historically, in most part of the world, water was seen as an infinite resource, and it was believed that given sufficient capital investment, additional water sources could always be developed, when needed. Therefore, lost water was largely ignored by water utilities or simply accepted as a part of the operation of a water supply system.

With the increased rate of population growth that has occurred recently around the world; the migration of rural populations to urban centers; the need to access more distant and/or more costly sources of supply; and the increased cost to produce each unit of potable water, it is now unrealistic to allow water loss to be ignored or simply accepted.

Currently, around the world, different governmental organizations, professional institutions, consultants, and system operators are terminologies, define their use, and apply calculations in different ways in what they feel is toward the same end objective, to reduce water loss. This approach not only hinders any attempt to built a coherent and accountable historical database for a given water utility, but also makes it impractical to apply benchmarking techniques across an industry. As a result, it becomes very difficult to demonstrate responsible management and use of an important natural resource, the water. Standardization of terminology and, consequently, the calculations that follow, are important and essential to the water industry as much as they are in any other industry.

The problem of standardization of terminology and calculations in addressing water balance has begun to be resolved by the collective efforts of number of larger, national professional water association working in concert through the efforts of the International Water Association(IWA).

TABLE 1 : Unaccounted Flow – Types Of Revenue Losses

Losses	Components	Causes
Unbilled authorized consumption	Unbilled metered consumption	Water delivered to special customers that are not billed although they are metered. Water used for operational purposes.
	Unbilled metered consumption	Water delivered to special customers that are neither bill nor metered Different between actual and estimated consumption. Water used for operational purposes
Non Physical ('apparent') losses	Unauthorized Consumption	Illegal connections where there is no access Illegal connections to properties that have legal connections Illegal connections of vendors selling water
	Metering inaccuracies	Under-registration of customer meters Poor quality, inaccurate meters Inadequate meter maintenance or replacement policy stopped Meters Data handling errors
Physical (real) losses	Leakages on transmission and /or distribution mains	Burst pipes (sudden rupture of pipe) Leaking joints and fittings
	Leakage overflows at utility storage Tank	Seepage from old masonry or concrete walls Float-valves not working.
	Leakages on service connections	Burst pipes (Sudden rupture of pipe section or joint) Leaking joints and fittings.

Water loss occurs in two fundamental ways

1. Water lost from the distribution system through leaks, tank overflows, improperly open drains, or system blow-offs. This is water that never gets to

the point of end use. These losses are referred to as "real losses" or sometimes called technical losses.

2. Water that reaches a customer or other end user, including beneficial and unauthorized use, but is not properly or tabulated. These water losses are essentially "paper" losses and are referred to as "apparent losses" or sometimes called administrative losses.

Relative to real water losses, apparent water losses (TABLE 1) typically have a much greater short-run marginal cost effect, since they affect revenues of the water utility at the retail customer rate.

WATER LOSS AND WATER DEMAND MANAGEMENT

As the capital and operating costs of water supply continue to increase, per unit of capacity installed, or per unit of water produced, the water industry is becoming more aware of water demand management. This is often first addressed as a need for conservation efforts, which are efforts to reduce the use of water or to use it more efficiently.

However, high real losses require water suppliers to extract, treat, and transport greater volumes of water per day than their customers need or demand. This apparent need for additional water then creates an unnecessary demand to supply that water.

Real and Apparent Water Loss (UFW)

Both real water loss and apparent water loss were defined in the context of the aggregate water loss problem. In beginning to consider the problem of water loss, it is important to have a practical understanding of why water losses occur.

Why Real Water Losses Occur

The most common form of real losses in water supply systems is "leakage", which occurs for a number of reasons, to include:

1. Poor installation and workmanship in the distribution system
2. poor installation and workmanship in service connections
3. poor piping and connection materials
4. Mishandling of materials before installation
5. Improper backfilling procedures around pipes
6. Pressure fluctuations in the distribution system
7. Excessive system and/or/ zone pressures
8. Corrosion around connections
9. Vibration and traffic loading over buried pipelines.

In British leakage management terminology, a distinction is made between "reported leaks" versus "unreported leaks" or more literally, "reported bursts" and unreported leaks. When a pipe bursts, it is obvious that it will be recognized, reported and repaired within a fairly reasonable period of time. The same is not true for small leaks that are the result of a pipe burst, or actually never surface to become observed. These leaks are continuous and, although less dramatic, collectively account for a greater total amount of water loss in a water supply system.

A significant finding of more recent leakage correction efforts has been the large amount of water loss occurring on the customer service piping, which goes from the service main or, the property line shut-off valve, to a single or multiple user premise. It has been determined that in many systems the cumulative losses occurring in these small diameter pipes constitute the greatest total source of real loses. This problem is complicated by the fact that the service lines are often defined by utility policy to be owned and maintained by the customer. Since the loss is usually occurring before the customer meter, the customer is not motivated to repair it at his cost until it creates a problem on his property.

Due to water's relative inexpensive and readily available nature it has not been considered cost effective to reduce unaccounted for water in the past.

With today's increase in costs of producing potable water in sufficient supply, many water systems are changing their minds about water loss and finding it can pay for itself and increase revenue in a short time in many cases.

REAL WATER LOSSES IN GVMC

The major problem G.V.M.C. is facing at present is the high level of unaccounted-for water (UFW). UFW rate is estimated at approximately 25 to 35% of water supply.

Thatipudi Reservoir supplies about 9 MGD of water to Visakhapatnam city the pipeline was laid during

the year 1964. It is a PSC main. There is lot of leakages and bursts in the pipeline during last five years and the same is shown in the TABLE above. The approximate loss of quantity of water is about 3 MGD. Therefore it is proposed to replace line with BWS Pipes under JNNURM to save 3 MGD of water.

In distribution system also lot of leakages along with house service connections leakages being attended by the GVMC staff. And these leaks are attended within 24 hours time line. The data below on rectification of leaks from the GVMC office and tabulated as below:

Leaks/ Bursts Rectified in GVMC (Real Losses)

Information and data has been collected (TABLE 2) from the office of Water supply Section of GVMC. As per data collected about the number of major and Minor leaks in the distribution network along with domestic Service connections leaks which were noticed or reported up-on since last four years and is represented in Figure 1.

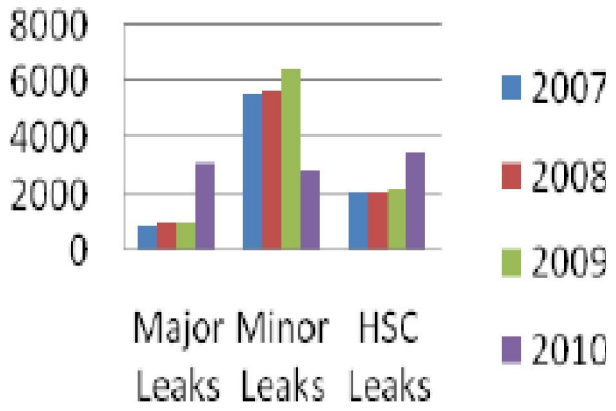

Figure 1 : LEAKS/BURSTS RECTIFIED IN GVMC (REAL LOSSES)

TABLE 2 : Leaks/ Bursts Rectified Identified In GVMC

S.No	Year	Major Leaks		Minor Leaks		House Service Connections Leaks	
		Identified	Rectified	Identified	Rectified	Identified	Rectified
1	2007	920	920	5599	5594	2121	2121
2	2008	958	958	5717	5717	2146	2146
3	2009	985	985	6419	6419	2256	2256
4	2010	3114	3114	2902	2902	3515	3515

CASE STUDY

Field test on raiwada trunk main and reservoirs

Real loss Analysis

Identification of unaccounted for water (UFW) in field test for existing water supply taken is of a very typical type. Because it involves:

1. Identification of all components of water supply scheme including source, raw water transmission system, treatment plants, treated water transmission network, service reservoirs, representative distribution zone with governing service reservoir.
2. Measurement of flow including 24-hour flow measurements at sources of water supply, simultaneous flow measurements at terminal locations of raw water transmission mains and treated water transmission network up to ELSRs and find out the difference in the readings to know the UFW.

Raiwada reservoir

Another main source of Reservoir was constructed by the Irrigation department at Devarapalli with a distance of about 60.00 KM during the year 1992 as open canal. This scheme was commenced during the year 1993 with 15 MGD treatment plant at Narava and subsequently the open canal was handed over to GVMC during the year 2003 by the Irrigation department.

Raiwada gravity main is 22 km long and it runs through the middle of the city along National Highway No.5. Gravity main feeds about 25 GLSR/ELSRs en route and terminates at TSR(Town service Reservoir).

Figure 2 Rai wada Reservoir

DETERMINATION OF UFW

1. The volume of water supplied to the distribution system, as measured by all master meters at points of entry, is totaled.
2. The volume of water SOLD and distributed as measured by customer meters and estimated unmetered uses.
3. Unaccounted-for water is obtained by subtracting known water uses from the total water supplied to the distribution system.
4. Age and materials of a water system as well as population density served can affect the amount of unaccounted-for water.
5. Qualities of construction and materials have a large impact on loss thru leaks.
6. Taking care of meter problems will immediately increase revenue and is generally the most cost effective action to take.

Analysis of the flow measurement

The flow measurements have been carried out for 24 hours or for the supply duration where supply is less than 24 hours. However the measurements have been continued at such location for sufficient duration beyond supply hours in order to identify night flow/ valve leaks etc., Simultaneous flow measurements have been carried out for many stretched by installing flow meters on either side of the concerned pipelines. In situations where it is not practically possible to take simultaneous flow measurements, measurements have been taken on either end for the same period of the day in order to get the realistic water quantity.

Figure 3 : Visakhapatnam City – Raiwada Water Supply Trunk Main

It has also been observed that major trunk transmission are operated for 24 hours where as the branches are often operated for lesser duration as per the zoning of the system. It would therefore be worthwhile to work out the equivalent hourly water rate in order to examine and estimate the UFW in the system, which can always be shown in percentage of total supply. The analysis made and the inferences drawn are presented in the following tables 3,4&5 as far as the " Supply side" and "Transmission system" are concerned.

Methodology adopted

- Reconnaissance survey of the area & collection of data
- Identify locations of each component of water supply scheme for field investigations / measurement
- 24 hours simultaneous flow measurements for each component / section up to storage reservoirs & find the difference
- Selected distribution zones for study as per water audit manual, study the sampled water connections & calibration and find the difference

Derive inferences & identify losses.

Demand side

The water from Raiwada Scheme is supplied to the distribution reservoirs serving wards divisions 9,10,11,13,32,33,35,36,37,38,39,42,67 and 68 details along with the reservoirs blocks of transmission system are detailed below.

Real losses in Transmission Side

Out of these divisions, the reservoirs in division no. 33.35.42.67 and 68 have been studied as representative zones for distribution system. The number of connections in these Divisions has been identified along with the water consumption. The overall supply duration in these Divisions has been observed to be varying; however 1.00 hrs daily supply has been considered for analysis. The detailed analysis and the summery is given in following TABLE 5

Case summary

As seen from the field study the losses occurring in the Trunk main, Reservoir network distribution system and Water Distribution System is as much as 8.36%, 23.13% & 26% respectively.

For comparison the allowable losses in a water utility are suggested by the CPHEEO are shown in the TABLE 6

In GVMC distribution systems the pipes and valves are much older and therefore there is every need to replace the defective valves and age old pipes as per CPHEEO allowable losses in the entire system is 15% only. It is estimated by an authorized source to UFW will be around 30% in the GVMC System.

Remedial measures to reduce real losses by GVMC

The greater Visakhapatnam municipal corporation has taken up refurbishment of water supply distribution system under the funds of JNNURM. Some important measures to adopt to curtail non revenue of water are

- Replacement of pipe length & Valves
- Alternate route for system improvement
- Alert metering & billing Installation of bulk meters at control points on supply side (Preventive measure)
- Construction of service reservoirs,
- Erection of New pumps and motors
- Metering at production and service points.
- Repairs of leaking pipes
- Repairs of leaking valves

According to Hand book on Indian water Utilities prepared by ADB, Manila, un-accounted flow of water in various urban local bodies in India are between 25% to 45%. The precious treated water is wasted through leakages, pilferages, un-accounting, un- metering, etc.,

Main Action to be taken to control UFW (Both real & apparent losses):

1. Implementation of a new commercial system for better accounting of all water of all water uses and users.
2. Less billing errors.
3. Intensive searches for unauthorized users.
4. Replacement of family meters and extension of metering to all users.
5. Metering of all production sources and installation of meters at key points in the distribution system.
6. Pressure zoning in distribution system to avoid extreme low and high pressures.
7. Leak detection survey and intensive repair of pipe leaks.

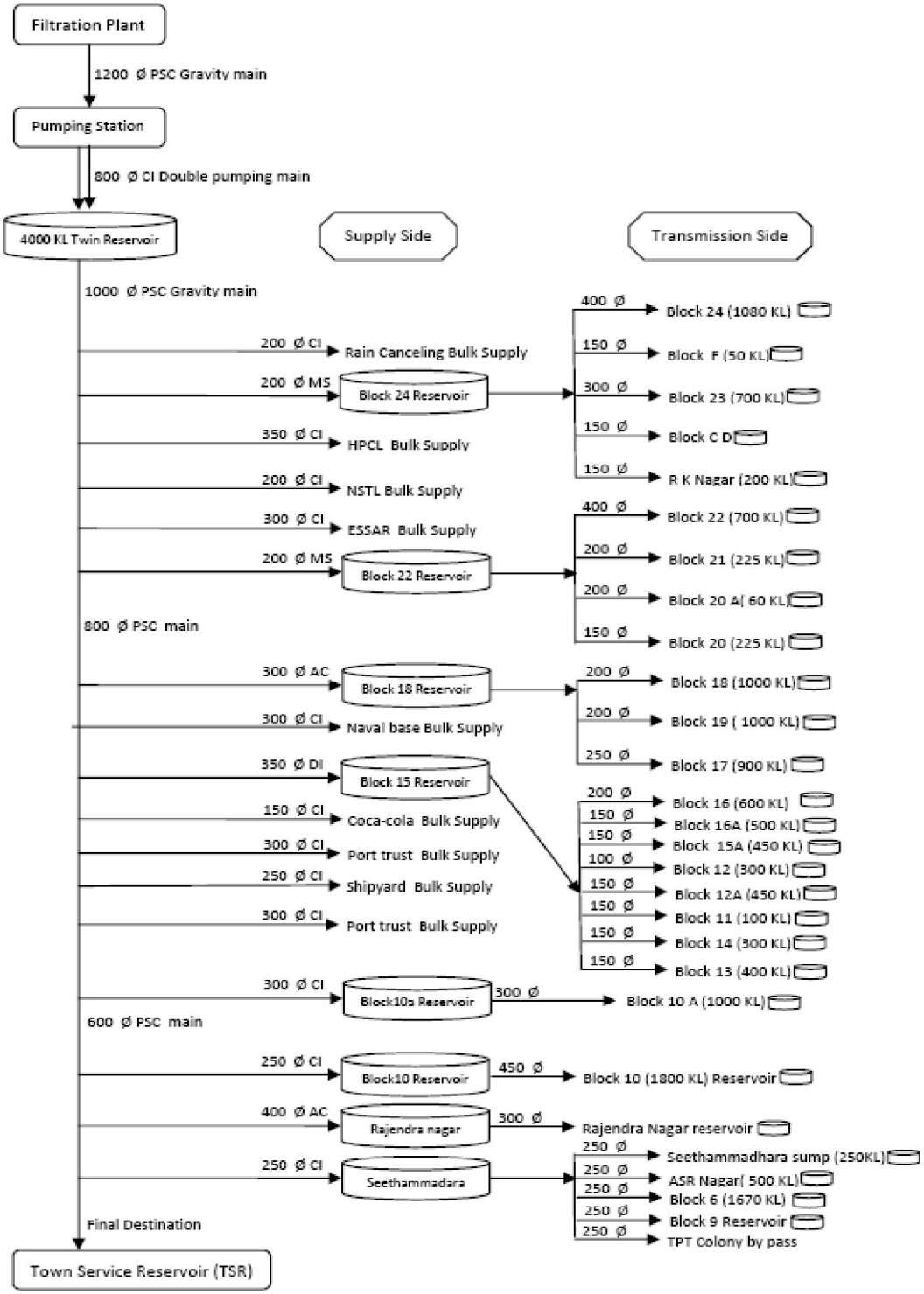

Figure 4 : LINE DIAGRAM OF RAIWADA TRUNK MAIN IN VISAKHAPATNAM WATER SUPPLY

8. Water districts can be fully isolated to monitor for leaks.
9. In house repair and installations are done by certified plumbers.
10. Replacement of residential meters every 7th year. These losses inflate the water utility's production costs and put undue stress on water resources, because they represent water that is extracted and treated but never reaches customers for beneficial use.. Major elements of proposed UFW project include the following:

1. Perform annual water audits using the IWA/AWWA methodology

TABLE 3 : Summary of Observations - Supply Side

S No	From	To	Intermediate connections	Dia (mm)	In Flow (cum/hr)	Out Flow (cum/hr)	Difference %
1	PWD Pump house (Line 1)	4000 KL twin GLSR	Nil	800 CI	1513	1495	01.19
	PWD Pump house (Line 2)	4000 KL twin GLSR	Nil	800 CI	1698	1677	01.24
	Narava WTP (new) outlet	4000 KL twin GLSR	Nil	1200 PSC	2433	2375	02.38
2	Raiwada line						
	4000 KL twin GLSR	D/S of booster for block 22		1000 PSC	3309	2300	
			RCL	250 CI		214	
			Block 24	200 MS		157.30	
			HPCL	350 CI		350.84	
			NTSL	200 CI		10.8	
			ESSAR	300 CI		8.678	
			Booster for block 22	250 MS		116.2	
						3157.81	4.57(%)
	D/S of booster for block 22	Akkayyapalem		800 PSC	2300	925	
			Block 18	300 AC		238.57	
			GE Naval base	300 CI		410.80	
			Block 15GLSR	350 DI		336.72	
			Block 15	300 CI		101.19	
			Coca cola	150 CI		5.36	
			SMN Port	300 CI		4.54	
			Ship building	250 CI		31.05	
			Shaligrampuram Port	300 CI		3.74	
			Thatichettalapalem	300 AC		50.84	
						2107.81	8.36(%)
	Akkayyapalem	TSR		800 PSC–600 AC	925	214.88	
			Booster for Bl 10	250 CI		133.35	
			Sitamdhara PH	400 AC		513.26	
			Rajendranagar GLSR	300 MS		14.65	
						876.14	5.28(%)
	Summary for Raiwada supply				3309	2916.76	11.85(%)

TABLE 4 : Summary of Observations- Demand side

S.No	Reservoir	Meter location (Division)	Inlet size (mm)	Equip flow (cum/hr)	Total water reached (Cum)	Outlet size (mm)	Equi flow (cum/hr)	Total water released (cum)	Difference (%)
1	Block 24(1080 KL)	68	200	157.3	3775.2	400	24.33	583.92	
2	Block F (50 KL)	68				150	7.21	173.04	
6	Block 23 (700 KL)	69				300	46.24	1109.76	
3	Block C D	62				150	14.83	355.92	
4	Indiranagar Block (50 KL)	48				leak	11.14	267.36	
	Ganesh nagar bypass	59				100	4.53	108.72	
5	R K nagar (200 KL)	65				150, leak	12.59	302.16	
								2900.88	23.15%
7	Block 22 (700 KL)	39	250	116.2	2788.8	400	35.12	842.88	
	Tanker supply @B 18	(@ 25 at 8000 lit)					35	840	
	Block 21 (225 KL)	38				200	6.782	162.768	
	Block 20A (60 KL)	38				200	15	360	
	Block 20 (225 KL)	17,16				150	4.24	101.76	
						150	8.19	196.56	
								2503.96	10.21%
	Block 15 (700 KL	Branch 1	350	336.72	8081.28	200			
	Sump (2270 KL)	Branch 2	300	101.19	2428.56	100 to 250	409.27		
					10509.84			9822.40	6.54%
	Block 10A(1000 KL)	34	300	50.24	1205.76	300	48.08	1153.92	4.29%
	Block 10 (1800 KL)	33	250	133.35	3200.4	450	18.42	442.08	
						400 leak	110.95	2662.8	
								3104.88	2.98%
	Rajendranagar	13 outlet	300	14.65	351.6	300 leak	14.61	350.64	< 1(%)
	Sethammadhara sump (250 KL)	12	400	513.26	12318.24				
	ASR nagar (500 KL)	11				250 leak	13.79	330.96	
	Block 6 (1670 KL)	17					110	2640	
	Block 9						125	3000	
	TPT colony bypass	12					135	3240	
								9210.96	25.22%

TABLE 5 : Transmission service connection losses

S.No	Division No	No. of Domestic Connections	Water released in ward(cum)	Water consumed (cum)	Difference (%)
1	68	1962	1034.20	798.07	22.83%
2	67	1212	1866.70	1177.20	36.93%
3	42	892	658.32	535.57	18.65%
4	35	2691	677.28	510.79	24.58%
5	33	827	1153.90	877.23	23.98%
	Average	7584	5388.48	3898.76	26.00%

TABLE 6 : Allowable Losses as per CPHEEO

Component	Allowable Losses(%)
Raw water Transmission	1
Treatment plant	2.5
Pure work Transmission	1
Reservoirs	0.5
Distribution	10
Total	15

2. Improve maintenance, replacement, and rehabilitation of piping infrastructure:
3. Pilot pressure management in selected areas at low demand periods
4. Track overall loss reduction effectiveness with time
5. Perform comparative accuracy testing on supply Venturi meters from water treatment plants
6. Perform comparative accuracy testing on wholesale customer supply venturi meters
7. Conduct wholesale customer unmetered connection investigation
8. Develop and implement a leakage reduction plan
9. Conduct sample parallel turbine/positive displacement meter change out program. Replace with compound meters. Compare billing results for the same month of the previous year.
10. Characterize residential water demand to determine average use at low flow, medium flow and high flow.
11. Utilize demand characterization and meter accuracy testing results to determine the economic optimum for residential meter replacement
12. Evaluate commercial and industrial meted water use to identify potential existing over-sized meter installations. Develop a plan to systematically replace wrong-sized meters with the correct size. Tract metered water use change for re-sized accounts.
13. Reduce total annual apparent water

Removal of public taps and legitimizing illegal connections

By removing public stand posts and legitimizing illegal connections, GVMC can achieve a reduction in revenue loss to the extent of 5 – 10 percent in a short term. Taking this into consideration, GVMC made a proposal to remove public stand posts and legitimize illegal connections within 3 years. There by the apparent losses in the system is marginally reduced.

Metering: Present status in GVMC

At present accountability of water produced and supplied is not there to the domestic water supply system. Water meters are existing to the semi-bulk connections, bulk connections, commercial connections and few meters for the domestic connections. For measurement of Un- accounted flow of water in domestic, metering is to be provided to the entire house service connection for domestic water supply system. A lot of water is being wasted through house service connections due to intermittent and erratic supply hours.

Figure 5 : Public Tap

To avoid the un balance water supply and accountability of water to domestic consumers in the water supply system and to avoid wastage of water, metering system is to be implemented to the all domestic consumers in water supply. The mains advantage is accountability of water, improvement of revenue, reducing leakages and effective maintenance of water supply system. Hence the Greater Visakhapatnam Municipal Corporation is proposing for the metering system to the house service connections (domestic purpose). So that every house is metered and accounted for and there by apparent losses can be reduced.

Transmission water loss control and GIS

Water utility engineers are tasked with ensuring the safe and efficient supply of drinking water. The role of a GIS in the analysis of a distribution system is to provide accurate data for which an engineering analysis is to be carried out. The current GIS software solutions are adequately addressed the requirements of the engineering community and they were designed to perform the necessary network management functionalities, from hydraulic and water quality analyses to fire flow computation, pump scheduling, and selective scenario management. As a result, engineers have relied on exporting data from GIS data sets into third party software to model, analyze, plan, and design water distribution systems. While efforts to date have proven successful in allowing very basic engineering analyses from a GIS, engineers are ready to embrace and utilize this technology.

- GIS systematic integration with computer to ana-

lyzed.

- Displays network layout in the city
- Efficient planning and optimization
- Detection of wastages and leakages
- Easy determination of opening and closing and closing a valve
- Overcoming delays in operation
- Monitory/ taxes analyses / metering
- Information about manpower management

➢ GIS enables information and management system for water supply and can prove to be good facility management.

CONCLUSIONS

Potable water is becoming scarcer and often making it more energy intensive to procure. More energy is required to pump water to greater distances and from deeper depth in the ground. It is predicted that in 2025, one third of the global population is expected to live in chronic water shortage areas and the total electricity consumption of water sector will grow globally by about 33% in the next 20 years. This alarming situation and ever increasing population has cautioned everybody to conserve the available water resources and adapt oneself to optimum use of available water. The water supply, as an essential commodity, has to be looked upon form demand side as well as supply side

The Sources for GVMC are as far as 25 Kms to 156 kms away from the Center of the city. Conveyance of water from distance places is a major task. A lot of amount being spent in brining of water through canal system from Yeleru & Raiwada Schemes. Lot of water is wasted through pilferages, thefts, evaporation, structure leaks and so on. Moreover all the impounding reservoirs are rain water fed and it is becoming difficult for GVMC to run the water supply utility in adverse seasonal conditions as the storage levels in the reservoirs has gone down to 10 to 15% during the year 2010.

The other major drawback in GVMC water supply system is leakages in the distribution system and domestic supply system. There are apparent losses and real losses which combindly reported to the 30% of the produced quantity of water on an average.

As seen from the case study that real losses in the Raiwada water system that the losses are 26%, which is commissioned just 15 years back. If we think about the age old system, the system functioning from the source of Mudasaralova source which was commissioned during the year 1902, the losses would be much higher.

Review of the potable water supply schemes revealed unsatisfactory operation & maintenance of the same resulting in heavy water losses due to water leakage, illegal connections, theft of water and huge energy consumption. Moreover, GVMC also lack requisite expertise in Operation and Maintenance of Water Supply schemes. In many cases, the major cause in revenue loss of ULB is believed to be unaccounted for water/energy losses in entire water supply system.

Urgent steps are required to be thought of to improve the efficiency of the water supply services in GVMC as well as the quality of water supplied so as to bring down the water losses in water supply system within permissible limits.

Need for creating awareness amongst residents is necessary to give feedback on leaks and pay water taxes promptly so that the drinking water supply systems and make the system economically viable.

GLOSSARY

Real losses: Physical loss of water visible, such as leakages of transmission, distribution mains, burst of pipes, over flow of service reservoirs and leakages on service connections.

Apparent losses : Non physical losses due to mismanagement of system with unmetered, un billed, un authorized, in accurate metered connections.

Non Revenue water : water is produced, but no income is generated due to the apparent losses and real losses in the water distribution system by the local body.

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ABBREVIATIONS

AWWA-American Water works Association
CPHEEO-Central Public Health & Environmental Engineering organization.
ELSR-Elevated level service reservoir
GIS-Geo-graphical Information system
GLSR-Ground level service reservoir
GVMC-Greater Visakhapatnam Municipal Corporation
IWA-International Water Association
KL-Kilo liter
JNNURM-Jawaharlal Nehru National Urban Renewal Mission
LPCD-Liters per capita per day
MLD(mld)- Million liters a day
NRW-Non Revenue of water
ULB-Urban Local Body
UFW-Unaccounted flow of water
YLMC-Yeleru Left main canal.

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