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Water Audit and Reduction Strategies for Nrw of Nashik City

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ABSTRACT

Water is the origin of life on earth. Every living organism is somehow dependent on water to sustain their life. There is no Life without Water. Thus, Water is Life! And now, thousands of years after that first living cell was originated, we have evolved, we have developed and we have created such a scenario that this Life is in danger now as we have been ignorant towards this inexpensive and plentiful utility.

As a human being, our needs never end, thus, the usage of water everywhere is way greater than the resources that we have. Now, with increase in population, the demand for water consumption has hiked up exponentially. To streamline this problem, Measurement of Water or Audit of Water is must. Water Audit gives you the scientific, rational information of your system, its purpose is to do actual calculation of the water use by the concerned body.

International Water Association (IWA)/ American Water Work Association (AWWA) initiating to assess the issues to do water audit effectively.

KEY WORDS: IWA, AWWA, Water Audit.

I INTRODUCTION

Water Audit determines the shortage, leakages, losses of Water and it helps to maintain the water balance of the city/ organization/ system etc. Through water audit we can calculate the non revenue water, it is a fantastic tool to regenerate the system and for water management.

Effective management of non-revenue water (NRW) could be one of the possible solutions for improving the finances of ULBs. NRW management is very beneficial for concerned organization, city, system etc, due to its effective resource utilization, effective utility management, consumer satisfaction and postponement of capital, intensive addition to capacity.()

As per the current scenario in developing countries, the water losses in systems are 40 to 60%, due to the leakage and NRW issues. But as prescribed by MOUD/CPHEEO, it should be below 15%.

Water is a basic necessity but the ability to pay for it in India is very limited. If the water losses in distribution. Transmission, Supply systems is reduced then only it is possible the areas which not receiving the water supply properly are getting the water and it results improve the revenue of the organization with competitive lesser investment.

EXISTING WATER SUPPLY SYSTEM AT NASHIK CITY

Nashik is a city in Maharashtra, situated at a short distance from both Mumbai and pune, having mythological importance because of Lord Rama. It has a population of about 19-20 lakhs, thus, a high water demand. Nashik gets it water supply from two main resources, one is the Gangapur Dam and other is Darna river weir total supply of 415 MLD. Water supply system of Nashik has 6 WTP of capacity 412.5 MLD. The network of 100 reservoirs, transmission and distribution routes is of nearly 2100km.

Geographically Nashik is blessed with two natural sources of water, Godavari River and Darna River weir is also called Chehedi barrage. The city is traditionally dependent on Godavari river. There are three dams upstream of the city, viz. Gangapur, Kashypi and Gautami .Nashik's head work is at submergence of the Gangapur Dam another one at Darna river weir or Chehedi barrage, to fulfill the need of potable Water of the Nashik city, Raw Water main is laid up to six WTPs where Nashik city gets treated water and are located at different locations of the Nashik city.

Gangapur Dam was constructed in 1954 with a storage capacity of 7200 mcft (204.07 MCum) but now it has reduced down to 5620 mcft (159.42 MCum) due to siltation.

There is reservation of water dam up to 4606 mcft (136 MCum) and it includes the Nashik Municipal Corporation and MIDC Nashik and

Eklaharu thermal station. This Eklaharu thermal station is downstream to the Nashik City.

Darna Dam was constructed in 1934 with a storage capacity of 203.43 MCum (7149 mcft) and it is 28 km away from the Nashik City. Nashik Municipal Corporation (NMC) has 528 mcfc (14.98 MCum) quota of water reserved. NMC constructed a pick up weir with sluice gate on Darna river near Chehedi village. It is known as Chehedi Barrage and head work is located at submergence of weir. Water is released from the dam as per demand. Capacity of Chehedi Barrage is 137 mcft (3.88 MCum) along with that 400 MIL capacity of Mukane water supply scheme is under process. NMC gets additional supply of 137 MLD up to 2019.

Nashik city is fragmented in 6 divisions for over-all operation i.e. Satpur, New Nashik, Panchvati, Nashik East, Nashik West and Nashik Road. Division wise population forecasting is as given below (available from NMC data)

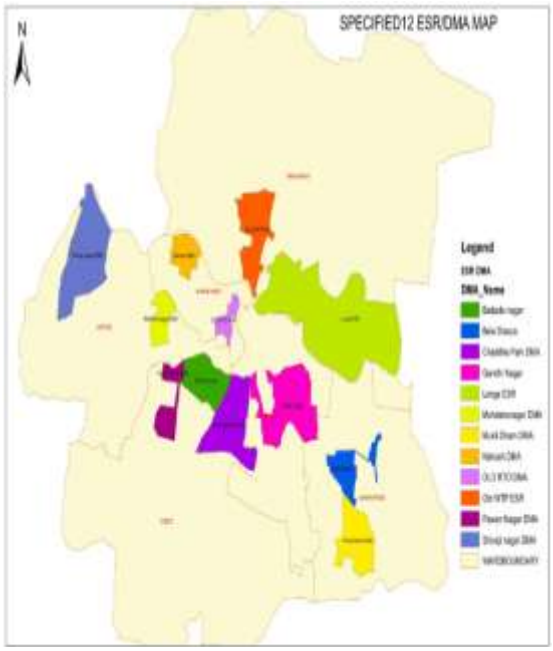
DIVISION-WISE POPULATION

Sr. No.	Division	Projected Population				
		2011	**2017**	**2026**	**2036**	**2049**
1	Nashik East	223491	277108	321746	443614	631422
2	Nashik West	147483	237533	242064	319618	463389
3	New Nashik	353899	402718	602171	823449	1235456
4	Nashik Road	264126	358689	413539	576149	821854
5	Panchavati	316517	402824	517857	719777	1069477
6	Satpur	180537	215275	321640	521571	749215
Total		**1486053**	**1894147**	**2419017**	**3404178**	**4970813**

In NMC area, majority household are covered by municipal water connections but few people are located on periphery of the boundary or outside the corporation boundary limit of Nashik, these households are a result of urban outgrowth of the city and yet to be covered by municipal water supply.

NMC is also facing issues like theft of water and illegal connections of water supply which create major effect on NRW of the NMC.

For accounting the water balance, approaching to do proper management and to reduce the NRW, NMC is taking tremendous efforts to manage them. To accomplish the same, NMC has initiated the Water audit of the Nashik city from 2016 with the help of a consulting firm NJS Engineer India Pvt. Ltd., Mumbai. The consultant did that study and survey with site examination, flow measurement, consumer survey, hydraulic modeling and GIS mapping, etc. and finalized some water balance analysis by using the standard IWA sheet in consultation with the staff of water supply department of NMC. Consultant carried out this assignment of water audit at 12 ESR zones out of which 2 ESR zones are solely for 24/7 supply purpose. These 12 ESR zones represent the picture of water audit study for overall Nashik city.



2.3 Detailed profile of the selected 12 ESR zones.

Sr. No.	Name of ESR	No. of ESRs	ESR capacity in ML	Area of command of ESR in Hectare	Present Population of ESR	Water Demand for ESR @ 150 lpcd + 15 % UFW in ML	NMC Properties water consumption in KL*
1	Chadda Park	1	2.8	472.49	76289	13.48	34.95
2	Gandhi Nagar ESR-1	3	1.5, 2 X 2.25	473.98	56050	9.89	56.01
3	Bella D'Souza	2	2.0, 1.5	248.56	34581	6.10	34.86
4	MuktiDham&Durga Nagar	2	2.0, 0.6	311.18	52069	9.19	125.10
5	Nahush	1	1.5	127.75	19341	3.42	3.93
6	Old RTO	1	2.2	70.95	21124	3.73	2.91
7	Badade Nagar	2	2 X 2.0	215.73	25301	4.47	17.61
8	Pawan Nagar	2	3.0, 1.0	192.65	66512	11.74	36.48
9	Lunge	2	2.275, 2.0	1239.89	51350	9.06	37.40
10	Panchavati	2	3.0, 1.35	303.02	64257	11.34	98.02
11	Mahatma Nagar	1	1.5	98.87	18007	3.18	15.44
12	Shivaji Nagar GSR	1	1.5	454.19	30427	5.37	26.56

OBJECTIVES

- To review the existing scenario of the Water supply system in Nashik.
- To calculate the Non-Revenue Water of the 12 DMAs (ESR zones), which represents the overall Nashik city.
- Calculation of Water balance analysis of the Nashik city for the proper Water management purpose.
- The water balance analysis suggest the NRW reduction strategy to the NMC.

Non Revenue Water

Non-Revenue Water (NRW) is defined as the difference between the amount of water put into the distribution system and the amount of water billed to consumers (ADB 2010).

Accounting for the rapid urbanization in India there are severe resource constraints seen, especially in water. In several policy discussions, Water demand management is the core subject but the issue of NRW is rarely brought up in such discussions.

NRW is a good indicator for water utility performance, high level of NRW indicates a poor management of water utility. In addition, published NRW data are often problematic, suspicious and inaccurate or provide only partial information. Some utilities invent 'creative' definitions of NRW, use wrong or misleading performance indicator, and fail to quote important information such as average pressure and supply time.

Conventionally, successful utility activity addresses the NRW by controlling physical losses, ensuring consumer meter activity and making all reports to keep the number of illegal connections within a limit. Taking these measures can boost revenue by increasing the amount of water that can be billed while reducing wastage of product, increases the profitability and improve the returns on investment with a larger profit. The Utility can then re-invest retained earnings and improve its productivity (ADB manual).

In NMC, reducing the NRW should be the first option to pursue when addressing low service coverage levels and increase demand for the piped water supply. Expanding water networks without addressing the water losses will only lead to a cycle of waste and inefficiency. Therefore, it is very important to reduce the NRW to increase the overall efficiency and financial sustainability, since it provides additional revenues and reduces the cost of water.

Water Audit Methodology & Reports of Nashik City:

Consumer Survey- Total of 20% of the total live water connections at 1,85,000 numbers out of which, 36,000 numbers consumer survey is carried out for all six divisions of the Nashik city.
Division wise Consumer Survey Findings and Estimated Values on basis of consumer survey data.

Sr. No	Item	Satpur Division	Panchavati Division	Nashik West Division	Nashik East Division	New Nashik Division	Nashik Road Division	Total / Average
A	**Performance Indicators**							
1	Average daily water supply in LPCD	100	90	88	122	101	103	**100.47**
2	Duration of supply	1.50 to 2.00 Hrs	1.50 to 2.00 Hrs	1.50 to 2.00 Hrs	1.50 to 2.00 Hrs	1.50 to 2.00 Hrs	1.50 to 2.00 Hrs	**1.50 to 2.00 Hrs**
3	Average population per connection	7.74	10.67	19.58	8.61	6.84	11.29	**10.79**

4	Average length of service pipe (M)	11	15	12	8	6	9.5	**10.25**
5	Average monthly water charges per connection (Rs.)	111.02	119.87	181.50	129.01	114.18	116.93	**128.75**
6	Average monthly water charges per person (Rs.)	14.34	11.23	9.27	14.98	16.69	10.36	**12.81**
7	Total estimated consumption (MLD)	21.46	36.11	20.81	33.77	40.80	36.85	**189.79**
8	ESR capacity (ML)	19.35	35.15	21.60	18.55	45	22.1	**161.75**
9	Total estimated supply (MLD)	50.395	105.45	43.2	55.65	95	71.3	**421.00**
B	**Consumer perception satisfaction level**							
1	Quantity (Adequate)	63.56%	93.32%	98.22%	96.13%	84.12%	18.90%	**75.71%**
2	Quality (Satisfactory)	83.00%	82.00%	84.00%	89.00%	78.00%	79.00%	**82.50%**
3	Pressure (Medium)	74.15%	87.85%	97.24%	92.34%	80.50%	45.75%	**79.64%**
C	**Others**							
1	Break-up of connection sizes							
	15 mm	2570	6707	1738	1059	692	4247	**17013**
	20 mm	8	0	0	20	71	42	**141**
	25 mm	102	0	0	155	146	161	**564**
	40 mm	1	0	0	6	2	0	**9**
	50 mm	0	0		0	2	0	**2**
	50 mm and above	0	0	0	0	0	0	**0**
2	Break-up of category of houses							
	Building / Apartment	181	718	507	346	255	665	**2672**
	Bungalow	152	478	393	434	267	1158	**2882**
	House/Row House/Chawl	2124	5511	836	412	376	2379	**11638**
	Slum Tenement	221	0	0	37	0	194	**452**
	Others	0	0	2	11	15	54	**82**

Water Audit:

Water Audit i.e. water loss study, is carried out at 12 ESR zones which represents the overall picture of the Nashik city.

It is carried out by the finding out water loss study of two main sources i.e. Gangapur Dam and Chehedi Barrage to 6 WTPs and further WTP to 100 ESR located at different locations of the Nashik city as well as by taking the bulk meter measurements at pumping main, Raw order gravity main, Treated water pumping main, Gravity main and ESR inlet, etc. Also, drop test are carried out at ESR, GSR, sumps, CLF, swimming tank, structure related WTP, etc.

By applying the above procedures, NJS Engineers India Pvt. Ltd, consultant for water audit to Nashik Municipal Corporation has prepared the final water balance analysis for the Nashik city.

Abstract of Water Balance Sheet for Nashik City

IWA Water Balance Sheet Abstract	Description	In KLD	In %
	System Input (%)	414587.53	100
	Authorized consumption (%)	204211.41	49.26
	Water Losses (%)	223196.12	53.84
	Billed water Consumption (%)	191391.41	46.16
	Unbilled Authorized Consumption (%)	12820.00	3.09
	Apparent Losses (%)	121093.36	29.21
	Real Losses (%)	55043.83	13.28
	Error and Uncertainty Component (%)	34238.93	8.26
	Revenue Water (%)	191391.41	46.16
	Non-Revenue Water (%)	175361.84	42.29
	Process Water Losses (%)	13595.35	3.27

Water Balance Sheet for Nashik City

<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
<tr><td rowspan="12">System Input Volume (KL) 414587.53 (100%)</td><td rowspan="2">Authorized Consumption (KL) 204211.41 (49.26%)</td><td>Billed Consumption (KL) 191391.41 (46.16%)</td><td>Billed Metered Consumption (Including Water Exported)</td><td rowspan="2">Revenue Water 191391.41 (46.16%)</td></tr>
<tr><td>Billed Un-Metered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption (KL) 12820 (3.09%)</td><td>Unbilled Metered Consumption (KL)</td><td rowspan="10">Non Revenue Water 175361.84 (42.29%)</td></tr>
<tr><td>Unbilled Un-Metered Consumption (Slum) (KL)</td></tr>
<tr><td rowspan="10">Water Losses (KL)</td><td rowspan="4">Apparent Losses (KL) 121093.36 (29.21 %)</td><td>Low rate of flow – Not recorded on meter (KL) 14672.31 (3.53 %)</td></tr>
<tr><td>Metering Inaccuracies (KL) 52756.27 (12.72 %)</td></tr>
<tr><td>Data handling error (KL) 40195.70 (9.69 %)</td></tr>
<tr><td>Unauthorized and Unbilled (KL) 13,469.08 (3.24%)</td></tr>
<tr><td rowspan="6">Real Losses (KL) 55043.83 (13.28 %)</td><td>Leakage on RW Transmission (KL) 6660.00 (1.60 %)</td></tr>
<tr><td>Leakage on PW Transmission+ Distribution Losses (KL) 36789.23 (8.87 %)</td></tr>
<tr><td>WTP Losses 4867.10 (1.17 %)</td></tr>
<tr><td>ESR / GSR Losses (KL) 6727.50 (1.62%)</td></tr>
<tr><td></td><td></td><td>Process Water Loss</td><td></td><td>WTP Process Loss (KL) 13595.35 (3.27 %)</td></tr>
<tr><td></td><td></td><td>Error and</td><td>Not measured and not derived</td><td></td></tr>
</table>

		Uncertainty component (KL) 34238.93 (8.26%)		

III. CONCLUSION

The overall condition of revenue and non-revenue water in Nashik water distribution system is provided by the measured and calculated values for completion of standard IWA water balance table. The projected Non – revenue water, based on measurements and calculations of 12 ESR's, is approximately 42.29 (175.36 ML) percent of water produced from Nashik Water treatment plants and supplied to elevated service reservoirs from there to consumers. Out of the total daily water supply of 414.58 ML, the Apparent losses are approximately 29.21 (121.09 ML) percent and real losses of about 13.28 (55.04 ML) percent.

The assessment of various performance indicators for Nashik city are tabulated above gives the following interpretation.

Based upon the recommended WBI for present operating band D, NMC requires following steps for controlling water loss:

Apparent and Real loss

- Water audit of water supply system at regular intervals.
- Meter testing and repair/replacement, improving billing procedure – Bulk meter, consumer water meters testing on sample basis yearly or biyearly for assessing the accuracy of the domestic meters. Upgrading the domestic and commercial metering system to either AMR or AMI metering system considering the cost benefit analysis of the both options
- Leak detection and control program – upgradation and more efficient system for detection of leakages and reduction in response time in repair of leakages

- network evaluation
- leak detection in the field and repairing it
- detection of the Valves and provision of valve chambers or road box for less

than 200 mm dia., valves identification of valve operating condition,

- Rehabilitation and replacement program – for pipelines, damaged / leaking valve, installation of DMA's boundary limit valves and house service connections.
- Corrosion control – for metallic pipes
- Pressure reduction – in distribution network of ESR's where OHSR located on higher level or there is variation of elevation is more than 5 meters in ESR's
- Public education program; Legal provisions
- Water pricing policies encouraging conservation
- Human resources development – trainings for registered plumbers, operating staff, line mains, plant operations staffs, water supply department engineers
- Information system development – regular updating of Water supply assets on GIS maps, Details of Consumer connection data base, repair and replacement data updating on GIS.

Recommendations for Nashik city for controlling water loss- apparent and real loss

Apparent Water Loss	Real Water Loss
• **Improvisation in tariff structure** • **Regular water audit** • **Meter testing program- Repair & replacement of meter, Install AMR meter for DMA's which are isolated with other DMA** • **Regularize unauthorized connections with penalty**	• Improve leak detection and achieve leakage control • Formation of DMA & sub DMA • Human Resource Development • Awareness program • Information system like SCADA and Automation

NRW Reduction Strategy and Action Plan General

NRW reduction is one of the prime objectives of the assignment. Hence, the strategy for NRW reduction and action plan from crucial part of the recommendations under this exercise. While making recommendations in this regard, attention must be provided for ease of implementation, user friendliness, cost-effectiveness as well as sustainability.

Water loss reduction should take all stakeholders in to account for ensuring sustainability.

As per the benchmarks set by the Ministry of Urban Development, Government of India, the extent of "non-revenue water shall not be more than 20% in the entire system which includes 15% distribution losses and hence concerted efforts should be taken by the NMC as well as the consumers for achieving this.

Current leakage status:

The current water losses must be understood and assessed using diagnostic approach before an appropriate water loss reduction strategy is

developed. This can be understood with the help of check list given below:

Content	Available Method
Understanding the system	Network register (GIS)
Water loss	Water balance
Where it is lost?	Water balance, metering and location of visible leakage
How to determine the losses?	Loss assessment method
Why it is lost?	Poor infra-structure, operation practice and improper network design

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