

Action Plan for Reduction of NRW

Ujjain Municipal Corporation
March, 2016

Contents

1	Introduction	2
1.1	Measurement of NRW	2
1.2	General theory of loss.....	3
2	Existing Situation Assessment.....	4
2.1	Review Assessment of Existing Losses	4
2.2	Causes of Water Losses and NRW	6
3	Action Plan to Reduce NRW.....	8
3.1	Identification of issues and Prioritization	8
3.2	Priority wise Actions required.....	9
3.2.1	Water Audit and Planning:.....	9
3.2.2	SCADA System:.....	9
3.2.3	Regular monitoring for Illegal Connections and Citizen Involvement	9
3.2.4	Metering of Consumer	10
3.2.5	Reduction of Authorized Unbilled Water.....	11
3.2.6	Increasing Coverage and Complete SCADA System.....	11
3.2.7	Funding Strategy	11

List of Tables

Table 1: Sources of Water Supply and their Capacity.....	4
Table 2: Capacity of Water Treatment Plants.....	4
Table 3: Water Demand in City and Simhasth	5
Table 4: Tax Rates for Water Supply.....	5
Table 5: Collection Statement of Water Tax.....	6
Table 6: Causes of NRW and its Segregation	7
Table 7: Priority Matrix for NRW Reduction	8
Table 8: Funding Strategy under AMRUT mission	11

List of Figures

Figure 1: Vicious Cycle of NRW	3
Figure 2: Causes of NRW and its Segregation.....	7
Figure 3: Architecture of SCADA System	10

Action Plan to Reduce Non-Revenue Water (NRW)

– A Concept Note

1 Introduction

The Urban population in India is growing at a rate faster than ever and the services in cities are crumbling to the increasing pressure. Along with other key services of the city, water supply is also struggling to maintain adequacy and quality of services provided to the citizens. Few of the major problem faced by Water Supply sector is the large proportion of water loss in distribution and poor collection of revenue for the supplied water. This situation is common in majority of Indian cities and has led to inefficient performance of water supply services.

To overcome the challenge the city needs to identify the losses and take necessary measures to reduce it. Non-Revenue Water (NRW) is a good indicators to measure the losses and high NRW typically indicate a poorly managed water utility.

Non-revenue water (NRW) is water which is supplied (produced and purchased) but not paid for, including technical losses (leakage), not billed water, illegal connections, poor water meter performance and inaccurate reading and accounting of metered flows. The impacts of NRW are the loss of scarce resources and financial revenue in a cash strapped water sector.

The central government under AMRUT mission has aimed to reduce the NRW in cities, and has included the same as a priority reform.

The extent of NRW in Ujjain city is not accurately measured, however it has been estimated approximately 60% i.e. 63.6 MLD. This is unacceptable and for that reason UMC has prepared a Concept Note on Plan of Action to reduce the NRW less than 20% in next 5 years.

1.1 Measurement of NRW

This indicator highlights the extent of water produced which does not earn the utility any revenue. This is computed as the difference between the total water produced (ex-treatment plant) and the total water sold expressed as a percentage of the total water produced.

NRW comprises of:

a) Unbilled Authorized Consumption: Consumption which is authorised but not billed, such as public stand posts water used by the utility for operational purposes, water used for firefighting, and water provided for free to certain consumer groups;

b) Commercial (or apparent) losses: Apparent losses such as illegal water connections, metering inaccuracies, customer meter under registration, data handling errors and theft of water in various forms;

c) Physical (or real) losses: Real losses which are leakages in the transmission and distribution networks from all parts of the system and overflows at the utility's reservoirs. They are caused by poor operations and maintenance, the lack of active leakage control, and poor quality of underground assets.

For the purpose of measurement of NRW following data is required:

1. **Total water produced and put into the transmission and distribution system (Million Litres per Day): a)**

Daily quantities should be measured through metering, and records on the transmission and distribution system should be maintained. The total supply for the month should be based on the aggregate of the daily quantum. Only treated water input into the distribution system should be measured. If water is distributed from multiple points, the aggregate of that quantity should be considered. This quantum should include water purchased directly from any other sources and put into the distribution system, if any. Water may have been purchased from neighbouring ULBs, Cantonment Boards, etc.

2. **Total water sold (Million Litres per Day): b)**

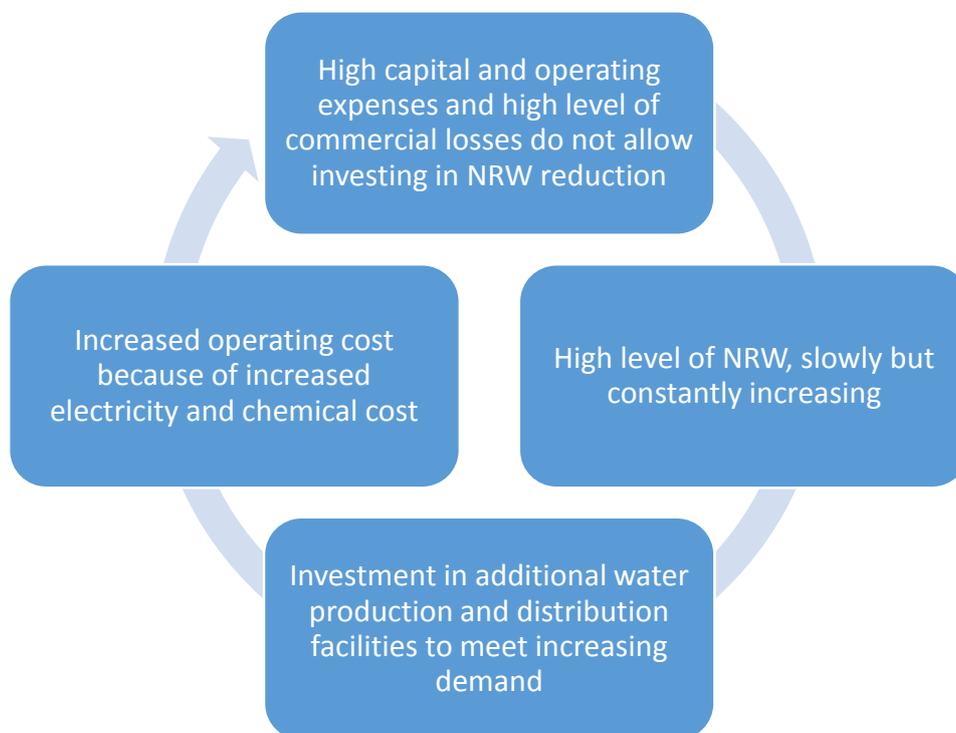
The actual volume of water supplied to customers who are billed for the water provided. Ideally, this should be the aggregate volume of water consumed as per which consumers have been billed. However, in the absence of a complete and functionally effective metering regimen, alternate methods of measurement need to be evolved, with lower but acceptable levels of reliability.

$$\text{NRW} = \left[\frac{(a - b)}{a} \right] * 100$$

1.2 General theory of loss

The majority of funds for management of water supply system comes through the revenue generated from collection of user charges. Because of a large share of NRW, the revenue generated is very less, thus reducing the scope for improvement in the system. This becomes a vicious circle that does not address the core problem.

Figure 1: Vicious Cycle of NRW



2 Existing Situation Assessment

The holy city of Ujjain has a total population of 5.15 lakhs with total Households 1.02 lakhs (as per census 2011). The total area of city municipal limits is 92.67 sq. km.

2.1 Review Assessment of Existing Losses

Sources of Water Supply

There are 5 sources for water supply in the city having total capacity of 5317.54 Million Cubic Feet. The capacity of existing sources ensure adequate water supply for the city.

Table 1: Sources of Water Supply and their Capacity

S.NO.	Location	Capacity	Capacity in Million Liter (ML)
1.	Gambhir Dam	2250 MCFT	63706.50 ML
2.	Gaughat barrage	41.61 MCFT	1178.15 ML
3.	Undasa Tank (irrigation tanks)	218 MCFT (30 MCFT for Water supply)	6172.45 ML (849.42 ML for Water Supply)
4	Saheb Khedi (irrigation tanks)	446 MCFT (30 MCFT reserve for Water supply)	12628.04 ML (1132.56 ML for Water Supply)
5	Power Pumps and Hand pumps	0.16 MCFT per day	4.53 MLD
		5317.54 MCFT	150560.83 ML

Water Treatment & Intake Capacity

The total intake and treatment capacity from 5 sources is 168.51 MLD. Existing intake as per the requirement of city residents is 106 MLD, however during the mega event 'Simhasth' the total demand is estimated to be 162.45 MLD, considering a reduced rate of water supply to the city residents i.e. 100 LPCD. Post 'Simhasth' the rate of water supplied to the citizens will be restored to 135 LPCD.

Table 2: Capacity of Water Treatment Plants

S.NO.	Location	Capacity
1	Gambhir Dam 12.50+6 MGD	56.75 MLD
2	Gaughat (Old W.T.P.)	22.50 MLD
3	Gaughat (New W.T.P.)	49.71 MLD
4	Undasa Irrigation Tank	4.50 MLD
5	Sahib khedi WTP (for Simhasth 2016)	7.80 MLD
6	Khipra Gaughat barrage WTP(for Simhasth 2016)	27.00 MLD
	Total	168.51 MLD

Table 3: Water Demand in City and Simhasth

S. No.	Particulars	Expected population		Rate of water supply		Requirement	
1	Ujjain City	5.65	Lakh	100	LPCD	56.50	MLD
2	Floating in city	1	Lakh	100	LPCD	10.00	MLD
3	Sadhus in 5 mela areas	3	Lakh	100	LPCD	30.00	MLD
4	Floating in camps	4	Lakh	70	LPCD	28.00	MLD
5	Other floating Not staying overnight	86.35	Lakh	3-5	LPCD	37.95	MLD
Total						162.45	MLD

Storage and Distribution

City has got 32 overhead water tanks of total capacity 46.5 MLD and 5 Nos. sump well of capacity 3.0 MLD. Summing up to a total storage capacity of 49.5 MLD. Considering the difference in elevation in different zones of water supply, water is supplied both through direct pumping and elevated reservoir to ensure proper pressure head at the consumer end. The water is distributed to the households from approx. 396 km pipe lines.

Rate of Water Supply

The present rate of water supply is 175 LPCD, which is much more than the required benchmark of 135 LPCD. At present the total water supply in the city area from source is 106 MLD and considering 25% transmission and distribution losses the supplied water is estimated to be 79.5 MLD. The population for the year 2016 has been estimated to be 5,64,907 (considering base population of 2011 census - 5,15,215) and coverage is approx. 80% thus the rate of water supply is 175 LPCD.

Water Supply Charges and Collection

Water tax is charged from 53,083 connections at following rates:

Table 4: Tax Rates for Water Supply

	Connection Size	Water Tax/Month (In Rs.)
Residential	8 mm	60
	15 mm	80
	20 mm	150
Non-Residential	8 mm	600
	15 mm	800
	20 mm	1000
Industrial	8 mm	750

	Connection Size	Water Tax/Month (In Rs.)
	15 mm	1000
	20 mm	1250

Collection of Water Tax:

Out of 54,482 formal connections 1,399 are exempted connection and billing is done for 53083 Connections. Assuming average bill of 120 Rs from 53083 connections, the Total Demand = 7,64,39,520 (Say 7.64 Cr). The Collection efficiency in 2014-15 is 86%.

Table 5: Collection Statement of Water Tax

Collection - Rs. Lakh	2011-12	2012-13	2013-14	2014-15
Arrears	25	64	19	50
Current	692	545	587	610
Total Collection	717	609	606	660

Connections

The total number of connections in the city is 54,482 and 53,083 are billed. Estimated number of Households in 2016 is 1,13,000 (considering base population of 2011 census - 1,02,401 HH) and approx. 10,000 is non-residential properties. Thus out of total 1,23,000 properties the total coverage can be estimated approx. 44% only. Out of the remaining 68,500 connection approx. 30,000 connections are illegal connections which is 24% and rest 31% do not have any water connection and depend on ground water or public hand pumps.

2.2 Causes of Water Losses and NRW

Transmission and Distribution Losses (Physical or Real Losses)

At present the actual transmission and distribution losses cannot be calculated as flow meters and check meters are not installed in the distribution network. However based upon the estimation and experience it is assumed that 25% of the total water supplied from water treatment plant is lost in transmission and distribution network. This includes leakages, overflow, supply line burst, water loss in maintenance etc. This accounts for **26.5 MLD**.

Illegal Connections (Commercial or apparent losses)

It has been estimated that there are approx. 30,000 illegal connections. These connections are not on record thus no bills are generated against these connections. This accounts for approximately **26.25 MLD**.

Unbilled Authorized Consumption

Total 1399 connections are unbilled and revenue from 14% of billed connections are not collected. This accounts for **6.5 MLD**. The unbilled connections includes public stand posts and institutional buildings.

Other Losses

This includes losses in water thefts and unaccounted leakages. This is estimated to be around 5% i.e. approx. **5 MLD**.

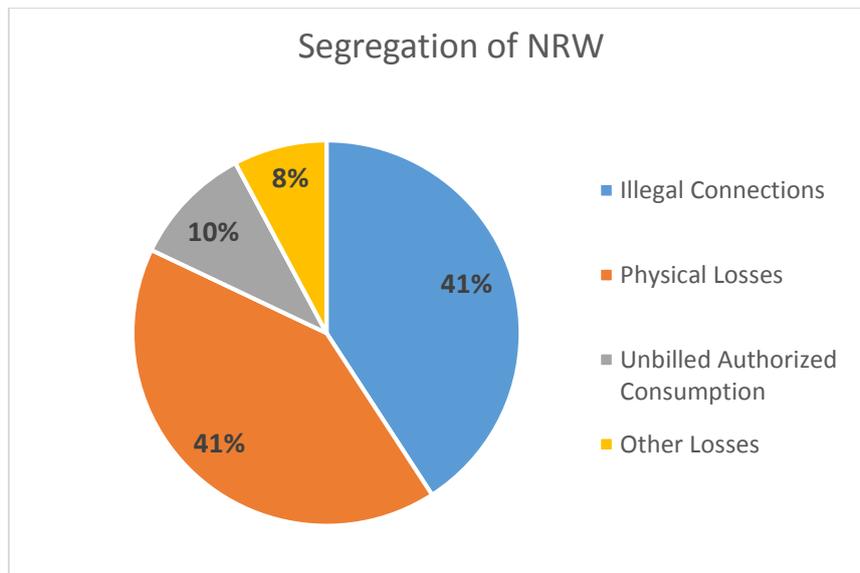
Total NRW

Total NRW accounts to be 64.25 MLD out of 104 MLD which is approximately 62%.

Table 6: Causes of NRW and its Segregation

Cause	NRW in MLD
Illegal Connections	26.25
Physical Losses	26.50
Unbilled Authorized Consumption	6.50
Other Losses	5.00
	64.25

Figure 2: Causes of NRW and its Segregation



3 Action Plan to Reduce NRW

3.1 Identification of issues and Prioritization

The key to developing a strategy for management of non-revenue water (NRW) is to gain a better understanding of the reasons for NRW, and the factors which influence its components. Then techniques and procedures can be developed and tailored to the specific characteristics of the network and local influencing factors, to tackle each of the components in order of priority. Causes of failure need to be investigated in depth at the stage of action planning and implementation and a more systematic approach needs to be developed.

Following are the components of NRW

1. Background and unavoidable leakage
2. Reported Leakage
3. Detectable Leakage
4. Water tank Overflow
5. Illegal Connections
6. Billing Errors
7. Authorized consumption free of charge
8. Discounts
9. Water for Municipal Services
10. Water Meter out of operation
11. Poorly calibrated water meters

For the purpose of prioritization of Action Plan a volume and cost analysis for NRW management has been done as per following:

Table 7: Priority Matrix for NRW Reduction

		Cost		
		High	Medium	Low
Volume	High	Leakage on mains (P) Illegal Connections (C)		Water for City Services and Urban Poor (U)
	Medium	Leakage on service connections (P)	Waste of water in non-metered connections (C)	Exempted Connections (U)
	Low	Non-metering of connections (C)	Inaccurate billing and Data handling errors (C)	Reservoir overflows (P)
NRW Type: U=Unbilled authorized consumption, C=Commercial losses, P=Physical losses				

Based upon the above matrix the priority actions for reduction of NRW has been distributed in 3 levels and considering the available resources and time, actions required are phased in 3 stages:

Priority 1

- Check of physical losses (leakages on Mains, leakages on Service connections, losses because of overflow in ESR and GSR)
- Reduction of illegal connections
- Awareness program

Priority 2

- Metering of connections
- Reduction in Water for City Services
- Restructuring of billing system

Priority 3

- Restructuring of Exempted connections
- Check on Reservoir flow and non-detectable losses
- Check on losses of service connections up to the customer's meter

3.2 Priority wise Actions required

3.2.1 Water Audit and Planning:

For the purpose of accurately calculation of losses and NRW a Water Audit is proposed to be conducted. The scope of work will involve Assessment of existing water supply system, conducting water audit proposal for coverage of gap and detail project report (DPR) for SCADA system (supervisory control and data acquisition).

The assessment of existing situation will help in mapping the existing distribution network, identify the physical coverage and gap in the system. The detail project report for SCADA system will help in implementing the SCADA system for first phase.

3.2.2 SCADA System:

The SCADA system in first phase will be installed for monitoring and water at water Source, intake wells, Treatment Plants, Water distribution Rising Mains, Elevated Service Reservoirs, Ground Service Reservoirs and Feeder Mains.

The system will monitor the water consumption, flow rate pressure etc. on a live basis. This will help identify the location of water loss and area of high demand. Further based upon location, consumption status and revenue collected from that location, NRW from illegal connections, water theft, waste of water and exempted connections can be focused to a location.

The system will also help estimates the location wise losses so that the supply can be planned accordingly.

3.2.3 Regular monitoring for Illegal Connections and Citizen Involvement

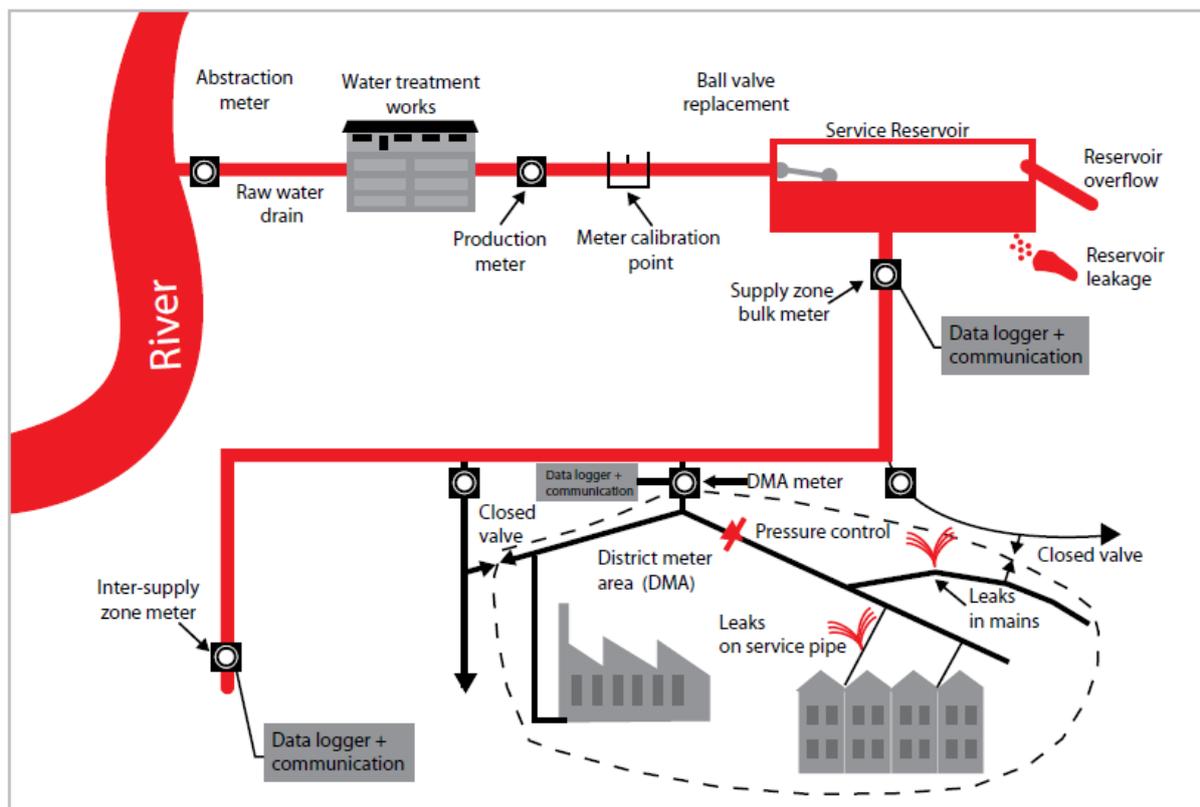
Illegal connections involve the physical installation of a connection to water distribution pipelines without the knowledge and approval of the UMC. Illegal connections can occur during the installation of a new supply connection, or sometimes the customer's supply is cut off after non-payment and the customer cannot afford, or does not want to pay, to be reconnected. During customer awareness

programmes, customers should be encouraged to report illegal connections, and regulations should be in place to penalise the water thieves.

Because large customers tend to steal large volumes of water, the discrepancy will show up when the UMC conducts a flow balance analysis through SCADA system. UMC should then undertake a focused customer surveys and leakage step tests to determine where the missing flow occurs.

The ward wise usage or location wise usage shall be displayed in public forum which will encourage the citizens to go for a legal connection. Local public representatives shall also be persuaded to reduce the illegal connections.

Figure 3: Architecture of SCADA System



3.2.4 Metering of Consumer

At present the Industrial, Non-Residential and Residential Connections are charged at a fix rate based upon the size of connection. This results in overdraw of water and thus increased NRW.

Since metering of water supply is discouraged by citizens, at first only the Industrial and non-residential connections will be metered. Later the area selected for Smart City Mission will be completely metered. This shall create acceptability for metering among the citizens and thus 100% metering of water connections shall be persuaded.

The rates of water charges should be fixed at such rates so that it is not greater than respective present water tax, considering the standard supply of approx. 135 LPCD. This will ensure that the users consuming more water will pay more and hence reducing the NRW.

The connections which are exempted from water tax i.e. religious buildings, govt. buildings etc should also be metered. Based upon their usage a cap for unbilled water shall be fixed. Consuming more than the limited amount should be charged.

3.2.5 Reduction of Authorized Unbilled Water

Water for city services such and urban poor are unaccounted and unbilled these results in misuse of water and thus increasing NRW. It is proposed that water used for City Services such as gardening and cleaning shall be metered. Though the usage is not billed however an account of used water will create a conscience for misuse. Reuse of water has also been proposed for city services. Decentralized treatment plant can be used to provide water for gardening purpose and other city services.

3.2.6 Increasing Coverage and Complete SCADA System

The present physical coverage is approx. 80% which has been planned to increase to 100%. The new connections will be completely metered and will be covered under SCADA system. A complete SCADA system for old connections is also proposed with monitoring till individual connections. This system will further reduce the NRW as the revenue from new connections will be 100% and from old connections will tend to increase more than 90%.

3.2.7 Funding Strategy

Various sources identified for funding of proposed activities are AMRUT mission, Smart City Mission and Internal sources. Under AMRUT mission 132 Cr has been approved for water supply sector in next 5 years.

Table 8: Funding Strategy under AMRUT mission

Sr. No.	Name of Project	Total Project Cost in Crores	Share (in Crores)				
			GOI (50%)	State (40%)	ULB (10%)	Others	Total
1	RCC overhead Tank 6 Nos	12	6	5	1		12
2	Laying of pumping and distribution mains in newly	70	35	28	7		30
3	System Control and Data Acquisition)	50	25	20	5		50
	Total	132	66	53	13		132

Under Smart City Mission approx. 1,000 Cr is proposed to be funded from Central and State Government. Part of this will be utilized for development of water supply infrastructure in Smart City Area and part of it will be utilized for funding of Pan City Proposal which will include SCADA system for entire City.

The revenue from user charges collection is assumed to improve in next five years and shall be utilized for maintenance and upgradation of water Supply System.

Further, PPP model can also be explored for Viability Gap Funding if required.