Reducing Non-Revenue Water for Multi-Village Water Supply Schemes:

A Case Study of Hururta-Hetosa-Dera Utility, Oromia Region, Ethiopia

SCRSWaSH
Technical Assistance Project

In Ethiopia, many piped water supply schemes are affected by high levels of Non-Revenue Water (NRW), which limits both the adequacy and sustainability of service provision. This note highlights the experience of a UK-funded project which, while strengthening the management of selected rural multi-village water supply schemes, implemented a pilot project to reduce NRW at one large rural utility.

About TAP

The 'Strengthening Climate Resilient Systems for Water, Sanitation and Hygiene Services' (SCRS-WaSH) Programme, funded by the UK government since 2019, supports the implementation of the Climate Resilient (CR) pillar of the Government of Ethiopia's One WaSH National Programme. NIRAS, in consortium with WaterAid, has implemented the accompanying technical assistance project known as 'TAP', helping to strengthen the management of selected rural multi-village water supply schemes in CR-WaSH areas of 12 regions. In addition, TAP has supported the establishment of 30 micro- and small enterprises to support water supply maintenance; developed a WaSH Sector Finance Strategy; and improved the supply of menstrual hygiene products to 150 schools in programme areas, to the benefit of 35,000 adolescent girls.

1. INTRODUCTION

As part of a broader effort to strengthen the management of selected rural multi-village water supply schemes (MVS), TAP implemented a pilot project to reduce NRW in one part of the Hururta-Hetosa-Dera (HHD) scheme in Oromia Region. The intention was to develop and test a model approach to NRW reduction that could subsequently be scaled and replicated by other utilities. The pilot operated for ten months from March to December 2024.

1.1 The importance of reducing NRW

Non-Revenue Water is defined as the difference between the volume of water put into a distribution system and the volume that is billed to customers. It typically comprises both physical losses (e.g. from leaks) and commercial losses (e.g. from unauthorised consumption, unbilled authorised consumption and billing inaccuracies). The reduction of NRW is critical for improving the financial sustainability of water utilities, conserving water resources and ensuring that the supply is adequate for all intended users – a vital consideration in locations facing water scarcity. Furthermore, with fewer losses and a more reliable supply, customer satisfaction will likely improve.

1.2 Hururta-Hetosa-Dera Utility

HHD was one of 30 MVS utilities which received technical assistance from TAP to strengthen its management systems. It was selected for the NRW pilot because the management had already shown some initiative in this area by allocating a budget and human resources for NRW reduction and expressing a willingness to scale up successful practices.

The utility was formed in 2022 by clustering the administration of five long established, independent schemes:

Dera-Awash, Huruta, Hetossa, Gonde and Boru Jawi. The combined scheme covered 76 kebeles (sub-districts) of which 10 were urban and 66 rural, in six woredas (districts) across two regional zones. The total population served was estimated at just over 800,000 people. The combined scheme drew on 12 sources: 11 springs and one borehole, and the total length of pipelines was just over 700 km.

1.3 The pilot location

The NRW pilot focused on Dera branch, which was selected for the following reasons:

- It had some ageing infrastructure that was known to experience losses, although there were also some new pipelines due to population growth;
- This branch of the utility had relatively good operational capacity, with skilled personnel and access to essential tools; and
- The location was easily accessible and the piped network had a regular layout which would make the practicalities of project implementation and monitoring more straightforward than in other parts of the scheme with a complicated layout.

There were four urban and three rural kebeles (sub-districts) under the branch's administration, served by 102 public taps (71% of them functional) and 7,480 private connections, of which 96% were domestic. The total number of domestic users was estimated at roughly 31,329, although the actual figure was unknown since users of public taps were not registered with the utility. Water was supplied from springs 27km from the branch centre, via a gravity flow system. Climatic conditions in the area were characterised by seasonal rainfall and high temperatures which could exacerbate pipe bursts and leakage due to the expansion and contraction of pipe materials. The region also experienced periodic dry spells.

For the purposes of the pilot, a sub-section of the branch with no public taps but approximately 466 private, 57 commercial and two institutional connections was identified and established as a 'District Metering Area' (DMA). A DMA is a defined area within a water distribution network where inflows and outflows can be closely monitored using meters. This targeted approach allowed for implementation that was intensive, but on a manageable scale.

When the pilot began there were no bulk meters at critical points in the DMA, therefore the volume of water entering and leaving the area was unknown. It was nevertheless evident that significant physical losses occurred at various points in the network due to ageing components, pressure fluctuations and inadequate leak detection systems. The distribution network in the pilot DMA was installed in 1977, while housing construction at scale did not begin until 1998. Many of the pipes now ran under people's homes, creating significant challenges to leak detection and repair. Occasionally pipes burst and leaked inside homes, causing substantial damage.

Aerial photos of the pilot area in 2012 and 2024 are shown below; these also indicate the location of inlet and outlet bulk meters installed for the pilot.

Figure 1: Aerial photos of the selected DMA showing settlement changes between 2012 and 2024

Figure 2: Consultative meeting at HHD head office, Iteya town

2. IMPLEMENTATION OF THE PILOT

2.1 Planning and Preparation

TAP produced a strategy document which provided an overall framework for the pilot. At the outset, TAP held a consultation meeting with HHD management to raise awareness of NRW and its impact; define the pilot's objectives; clarify stakeholder roles; and discuss potential scale-up strategies. It was agreed that TAP would oversee and technically assist the pilot implementation by visiting the utility for branch 3-4 days on average every month, starting in April 2024. Two water engineers were deployed with close follow-up support from the task lead, while utility staff undertook work on the ground.

A NRW implementation task force was then established at Dera Branch, comprising a team leader, NRW expert from the head office in Iteya town and nine members from various departments within the Dera branch: three from Production and Distribution, four from Revenue and Billing (including two meter readers) and two from Customer Services. This team was actively involved in every stage of the pilot.

2.2 Baseline assessment

To inform the way forward for NRW, a detailed assessment was undertaken of the distribution network within Dera branch, covering not only its physical condition, but also utility operation and maintenance practices, institutional arrangements, and commercial operations. Key findings included the following:

Maintenance and monitoring

1. **Monitoring pressure, consumption and losses.** Neither bulk meters nor pressure gauges were in place, hence it was not possible to measure losses within the DMA. Pressure gauges are crucial in a DMA for detecting pressure variations that may signal leaks or system inefficiencies. They also help to maintain optimal pressure levels, preventing damage to infrastructure and improving water distribution management. The utility had attempted to calculate water losses in the system overall, but the accuracy of these calculations was limited by the insufficient number of bulk meters.
2. **Leakage detection and control.** The utility had no leakage detection equipment and therefore repaired visible leaks only, with the average repair time reported as less than 1.5 days. Repairs were recorded but in an ad hoc manner, making it difficult to review data and monitor trends.

Commercial operations

3. **Customer meters.** Within the DMA, all private and public connections were metered, enabling volumetric charges to be applied. However, the utility had no reliable information on the age of the meters. It had an 'in principle' policy of replacing them every ten years, but it was evident that some were long overdue for this. The utility was also unaware of the quality and reliability of the meters installed.

4. **Customer data and billing software.** The utility used DAFTEC software to handle customer data and periodically updated the database via door-to-door surveys. It used the same software to prepare monthly bills, with smart phones used for meter reading.
5. **Asset management.** The utility did not have an up-to-date asset inventory for the network; only office equipment was recorded. An accurate inventory is essential for managing NRW because it helps track the condition and functionality of key infrastructure components like water meters, valves and pipes. Without an accurate record of assets, utilities cannot identify where losses occur or prioritise maintenance and repairs.

Institutional arrangements

6. **Staffing for NRW reduction.** The Dera branch office did not have its own NRW reduction team; there was only one expert at the utility head office. This limited the ability to tackle NRW comprehensively within the branch.
7. **Capacity building.** The utility had a capacity building programme but for senior personnel only; the training and coaching needs of other personnel were not being addressed. In particular, operational staff needed the knowledge and skills to implement targeted measures for NRW reduction.
8. **Stakeholder involvement.** When the pilot began, there was no involvement of service users in efforts to reduce NRW. The involvement of users is crucial in the effort to reduce NRW as their engagement directly impacts water conservation practices, meter accuracy, the identification of leaks and the control of illegal connections.

2.3 Preliminary actions

An early pilot intervention was to install bulk meters at the DMA's inlet and outlet points so that the volume of water entering and exiting the area daily could be monitored.

The next step was to make an inventory of the assets within the DMA, including customer meters, pipes and the reservoir feeding the system. This was done using the *mWater* tool, with training provided by TAP to the NRW task force. Asset data was recorded using mobile phones and the *mWater* app. Identifying customers in the DMA was challenging as details held by the utility proved to be incomplete and some houses were unoccupied.

The utility somewhat followed good practices in meter reading and billing, using software. Despite their efforts, challenges persist due to understaffing and the unavailability of customers during reading times. Based on data from the new bulk meters, the asset inventory and billing system, the baseline NRW value for the DMA was calculated to be approximately 58% as of June 2024. This indicated that over half of the water supplied to the area 4,770 cubic meters was lost or unaccounted for. This translated to a monthly loss of approximately 90,916.2 ETB from the DMA alone. There was evidently a need to reduce losses, improve operational performance and enhance the utility's financial sustainability.

To enhance awareness of NRW challenges and potential solutions, TAP organised an exposure visit to the nearby Adama Water and Sewerage Authority which had a good track record of reducing NRW. The visit provided valuable insights on how HHD utility could do the same. The visit strengthened the relationship between the two utilities, creating prospects for further collaboration in terms of sharing equipment, materials and experts.

Figure 3: Bulk water meter installation at the inlet and outlet of the DMA

Figure 4: Exposure visit to Adama Water and Sewerage Authority

Figure 5: On-site coaching on listening rod for leak detection utilization

2.4 Implementation of NRW reduction plan

Based on the assessment findings and in discussion with the NRW task force, a detailed intervention plan was developed addressing both physical and commercial losses. The key components are outlined below.

2.4.1 Reducing physical losses

Strategy 1: Maintaining meter effectiveness

Following the installation of bulk meters, frequent blockage of the inlet meter occurred due to suspended particles in the water. It was therefore necessary to clean the meters regularly.

Strategy 2: Proactive maintenance and reduce response times

TAP proposed that the utility start using Ministry of Water and Energy (MoWE) templates to record repairs and other maintenance. In addition, TAP introduced a simple format for recording daily flows at the inlet and outlet bulk water meters of the DMA.

Strategy 3: Improved leakage detection and control

With TAP support, the utility began recording maintenance activities and using this information to identify gaps in equipment and human resources. TAP also provided electro-mechanical and plumbing tools plus a welding machine with generator and on-site training in machine operation for technical staff.

TAP was not funded to provide advanced leakage detection equipment but showed utility staff how to make a “listening rod” from local materials and use it as a simple leak detection tool.

Strategy 4: Preventive maintenance including pipeline replacement

In addition to mapping the DMA network using mWater, TAP advised the utility to update the asset inventory beyond the DMA. In addition, to resolve the problem of transmission lines running under houses, the utility made a decision to re-install some parts of the network to enable easier access for maintenance. By late 2024, discussions were underway with the city administration on how to take this forward.

TAP encouraged the utility to use MoWE’s operation and maintenance manual as a guide. The technical team subsequently adopted some preventive maintenance practices such as cleaning storage tanks twice a year and fencing off water sources and public taps to reduce the risk of contamination. In addition, TAP provided standard operating procedures on chlorination and provided on-job training for its use when cleaning storage tanks.

2.4.2 Reducing commercial losses

Strategy 5: Replacement of defective customer meters, installation of new bulk meters

The informal policy of replacing meters after ten years was not being implemented; in fact only a few branch managers were aware of it. The utility did at least record meter installation dates and based on these, 33 water meters were replaced by November 2024. TAP provided the utility with 150 new domestic meters. The remaining meters are planned for future use to replace non-functioning meters as part of the ongoing NRW reduction measures. Normally these were sold to users, but TAP encouraged the utility to provide them free or at a subsidised rate for low-income households that were unable to pay.

Figure 6: Sample defective customer water meters found in the DMA

Strategy 6: Improved commercial operations and customer relations

The utility already had a system in place for responding to customer complaints and a Customer Service Head was in place. Complaints were documented using standard formats, passed to the relevant technical personnel for action and tracked until resolved. Each branch also held an annual customer forum to obtain feedback from customers and share utility news. There was, however, no toll-free number for reporting leaks or other concerns with the service. During the pilot, the utility began discussions with Ethio-telecom with a view to introducing this facility.

Strategy 7: Improved efficiency of meter reading and billing

The branch had an insufficient number of meter readers. Each was expected to read approximately 2,000 meters per month and this was unrealistic, given also that repeat visits were sometimes needed where properties were empty when first visited. The utility was advised to increase the number of meter readers and explore the possibility of outsourcing this task to private agents. The utility directed its team to prioritise meter reading for customers within the DMA to address discrepancies and support the pilot NRW reduction effort. Additionally, the utility is in the process of hiring additional meter readers to enhance billing efficiency.

3. RESULTS

Over six months, NRW within the designated DMA was reduced by 50%, from an initial 58% in June to 29% in October, before encountering an increase to 56% in November due to the increase in customers from 525 to 563 who are yet to be registered in the billing system. Once these customers are registered, NRW will be considerably reduced. This decline in NRW value reflects the concerted efforts of management and technical staff in addressing both physical and commercial losses, despite resource limitations.

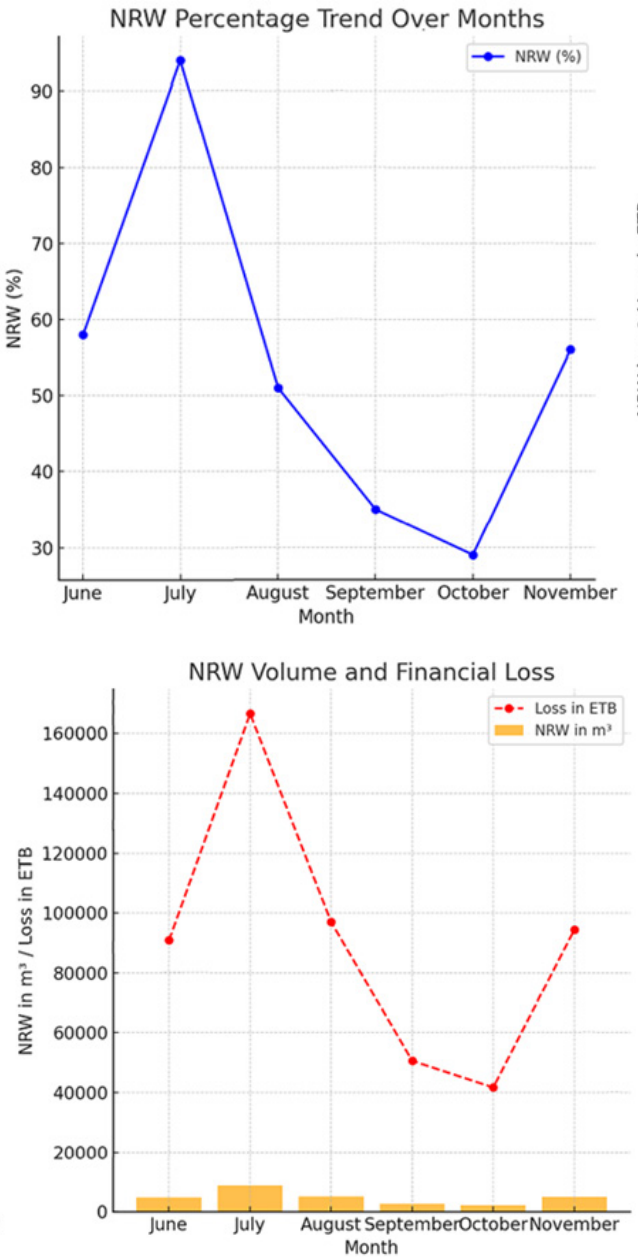

Figure 7: Summary of NRW percentage and financial loss(June-November 2024)

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For domestic consumption, the utility uses an increasing block tariff with the lowest block charged at 19.06 ETB per cubic metre (for consumption of 0 to 5 m^3 per month) and the highest at 30.71 ETB per cubic metre (for consumption above 25 m^3 per month). For illustrative purposes, losses are estimated in the table using the lowest tariff only.

In total, the utility lost more than 540,000 ETB from June to November in the DMA alone, which had just 563 customers. Although TAP's scope did not extend to the entire multi-village scheme, if the same level of NRW applied across the whole scheme which had 8,000 customers the losses would be very high.

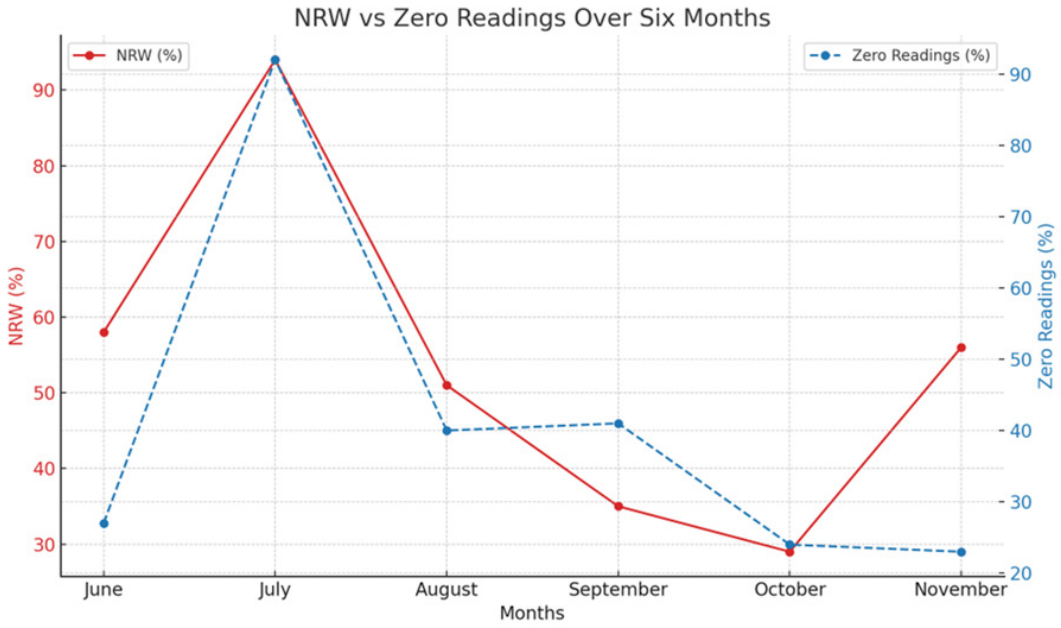

Figure 8: Summary of NRW percentage and unread meters(June-November 2024)

In July, the NRW value surged significantly to 94%, largely due to the fact that 92% of meters in the DMA were not read. Despite efforts to prioritise customers within the DMA, the meter readers faced challenges, as many properties were unoccupied when visited. This issue was especially prevalent in July, when most farmers were away working in more remote farming areas during the day.

The replacement of 33 defective meters in December resulted in an immediate increase in recorded consumption by 38 m^3 in just three weeks, validating the strategy's effectiveness in reducing unrecorded water usage. TAP's support to the provision of 150 additional customer meters also enabled scalability for further reduction. Additionally, the technical team successfully reduced downtime from 12 hours at baseline to six hours. Maintenance activities are now carried out with improved efficiency, ensuring water supply is temporarily shut off during repairs to minimise losses.

Key achievements from the pilot implementation were:

- **Enhanced awareness:** Significant awareness was created around NRW. Initially viewed as an additional task, NRW management is now fully integrated into the daily responsibilities of utility management and staff.
- **NRW reduction:** Despite the limited resource allocated, the NRW task force was able to reduce water loss by half from June to October.
- **Utility management buy-In:** Strong commitment and acceptance from utility management to scale up successful practices to the remaining four branches.
- **Capacity building:** The NRW task force has been trained and capacitated to independently manage all aspects of NRW reduction, supporting scalability and sustainability.
- **Improved data utilisation:** Task force members now recognise the critical importance of recording and analysing data on production, consumption, and maintenance to inform planning and improve system performance.

4. IMPLEMENTATION CHALLENGES AND MITIGATION MEASURES

The pilot achieved progress in raising awareness and building capacity for NRW reduction but it ultimately did not succeed in implementing all components of the strategic plan and significantly reducing NRW levels during the implementation period. The primary challenges and mitigations taken during implementation are as follows:

- Customer meters often went unread due to customer unavailability and an insufficient number of meter readers. The limited timeframe for readings further exacerbated the issue. Despite management directing meter readers to prioritise DMA customers during the pilot, the number of zero-reading meters remained high.
- Lack of awareness on NRW reduction measures which lead to focusing on daily operating activities rather than planned measures. To address this, TAP identified and extracted a series of preventative maintenance activities from MoWE's operation and maintenance manual, recommending their incorporation into the utility's regular practices.
- While an annual asset inventory was conducted, it was limited to office equipment, leaving the majority of the supply network unmapped. So, for the purpose of the pilot implementation and future efforts, the utility was trained on asset inventory, data collection and mapping.
- Although NRW reduction is included in the utility's plan, it has not been adequately budgeted for. The utility has made efforts to allocate additional resources for implementation, but these remain insufficient.
- The absence of leakage detection equipment, fittings, and other spare parts has hindered progress in addressing physical losses.
- The lack of an NRW team at branch offices, coupled with limited awareness, undermined ownership and accountability for planned activities. However, frequent discussions, regular site visits by TAP and awareness-raising and refresher training sessions have significantly improved the situation. While progress has been substantial, it cannot yet be said that all staff are fully aligned on these efforts.
- The absence of a proper, pre-existing production recording system made it difficult to establish a baseline NRW value.
- During asset inventory and mapping efforts using the mWater tool, the unavailability of customers in the DMA (e.g., vacant houses, absentee owners) delayed the completion of mapping. To address this, phone calls and colour-coding of gates were used to prevent duplication and encourage customers to visit the branch office for reporting and follow-up actions.

5. SUMMARY OF LESSONS

- Poor customer and water supply service distribution data management system can hinder effective planning and monitoring. Therefore, utilities need to conduct asset inventory and mapping of the entire water supply system to establish a strong foundation for data-driven decision-making.
- Establishing a dedicated NRW expert role within the utility's branch office organisational structure ensures consistent focus and accountability in addressing water losses. This specialisation can significantly enhance the utility's capacity to implement and sustain NRW reduction efforts.
- Securing the utility management's buy-in early in the process is crucial as it ensures organisational support and resources, making it easier to engage staff and scale up the NRW reduction strategy across the entire system. When management is aligned, the rest of the team follows suit more effectively. Management has prioritised NRW reduction activities, resulting in the allocation of human, equipment, and financial resources to support intervention plans. Technical teams now recognise that water loss translates directly into financial loss.
- Improved data management mechanisms are needed for production, meter reading and operation and maintenance activities.
- Some communities have become aware of the importance of paying their monthly water bills on time.
- To avoid ambiguity in future town expansions, water system designs should align with the town's master plan and involve discussions with the land administration authority or other key stakeholder.

6. RECOMMENDATIONS FOR FUTURE NRW REDUCTION INITIATIVES

6.1 Short-term actions for HHD utility

- Enhance regular meter reading by either increasing the number of readers or find alternative means to include local private enterprises to improve reading and collection efficiency.
- Accelerate replacement of the remaining old and defective customer meters within the DMA.
- Expand the implementation of DMAs across the entire distribution network of the branch.
- Focus on repairing visible leaks in the distribution network to minimise water loss.
- Establish NRW task forces in all branch offices to strengthen implementation efforts.
- Regularly calibrate and replace faulty customer and bulk meters to ensure accurate measurements.
- Provide continuous training for staff on NRW reduction strategies and tools.
- Enhance public awareness campaigns on water conservation and implications of NRW.
- Construct a local water meter testing bench to evaluate the accuracy and performance of customer meters at the utility level.

6.2 Long-Term Strategies

- Align the distribution network with the city master plan by rerouting pipelines that currently pass through customer properties.
- Allocate a dedicated budget for procuring leak detection equipment.
- Secure funding for long-term NRW reduction programs through strategic partnerships or grant opportunities.

6.3 Policy Recommendations

- Establish and implement a policy and guidelines for systematic meter replacement.
- Review and revise the organisational structure on the legal framework to include NRW team at the head office and branch offices.