MAINTENACE PLAN

FOR

MAINTAINING

NRW RATIO LOW

Kathmandu Upatyaka Khanepani Limited (KUKL)

JICA Expert Team

Kathmandu Upatyaka Khanepani Limited

Japan International Cooperation Agency

Following 2 figures shows the results of discussion between JICA Expert Team and KUKL during the “Project on Capacity Development of KUKL to Improve Overall Water Supply Service in Kathmandu Valley”.

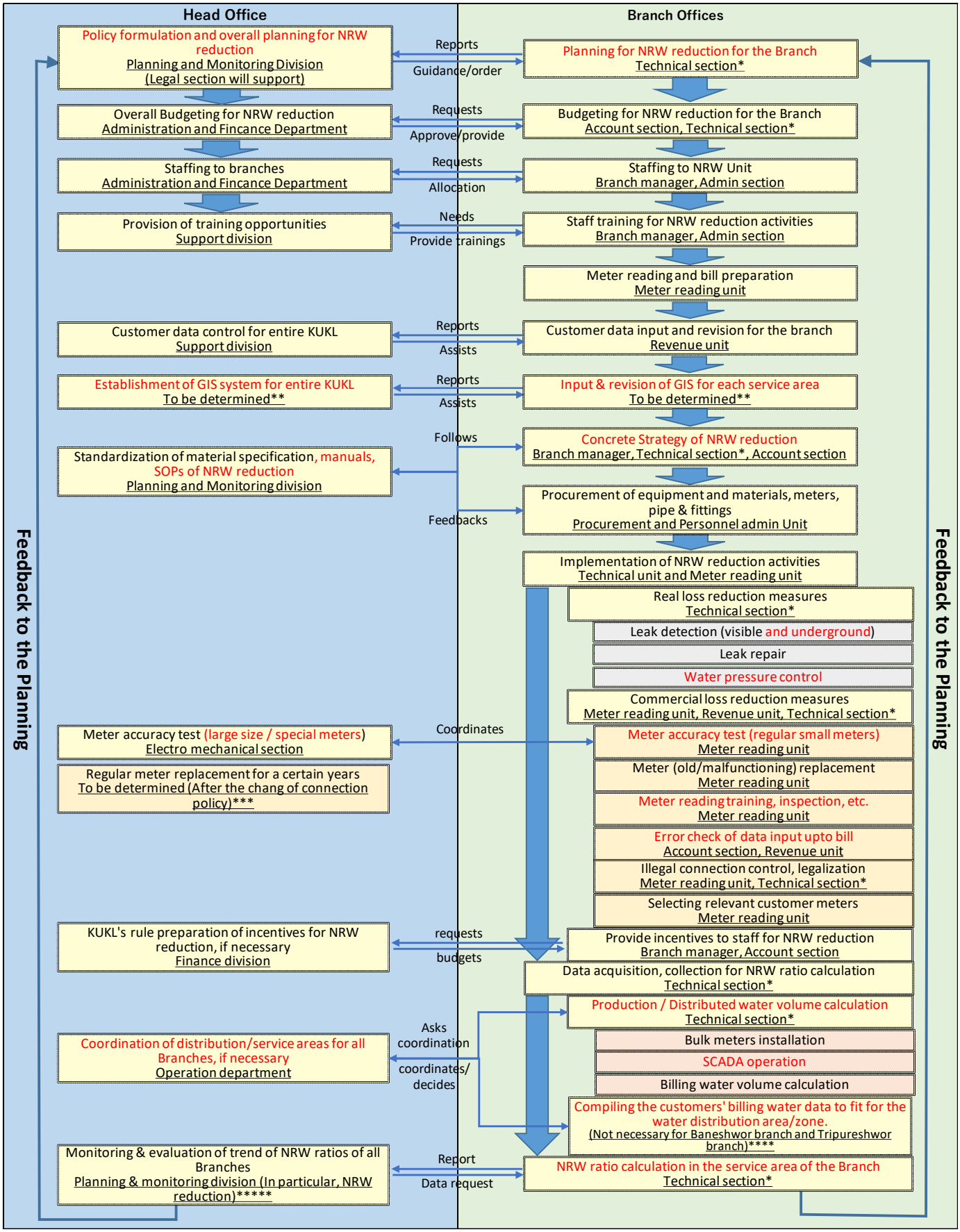
First fugre at next page shows “Roles / Responsibilities in Head Office and Branch Offices for NRW reduction activities”, in order to clarify the roles and responsibilities for NRW to tackle it efficiently and effectively. Red coloured parts are brand new or revised roles from present ones.

Second figure at 2 page later shows “Data Collection Process of NRW ratio”. Generally, branch offices collect distribution water volume data and billed water volume data of the DMAs or Sub DMAs in the Branch boundary and calculated NRW ratios of them. Branch offices report those results and data to Head Office. Head office compiles and store NRW related data of all Branches (6 branches inside Ring Road as of July 2025). Head office shall analyze the collected NRW data, give comments to branches as necessity arises, and reflect it on future NRW reduction planning, and so on.

Roles/Responsibilities in Head office and Branch Offices for NRW reduction activity

Red colour: Brand new or revised from present one.

Underline: responsible section or division for each procedures



*Technical section is consists of Production section, Distribution section and NRW section. These section chief is covered by one person in Baneshwor branch and Tripureshwor branch, so considering this situation, these sections can be considered as one section.

**Since the responsible person of GIS data will be decided in the future activity of output 1, the responsible section will be determined in future.

***Since the Connection policy should be revised to replace the customer meters regularly, responsible section will be decided later.

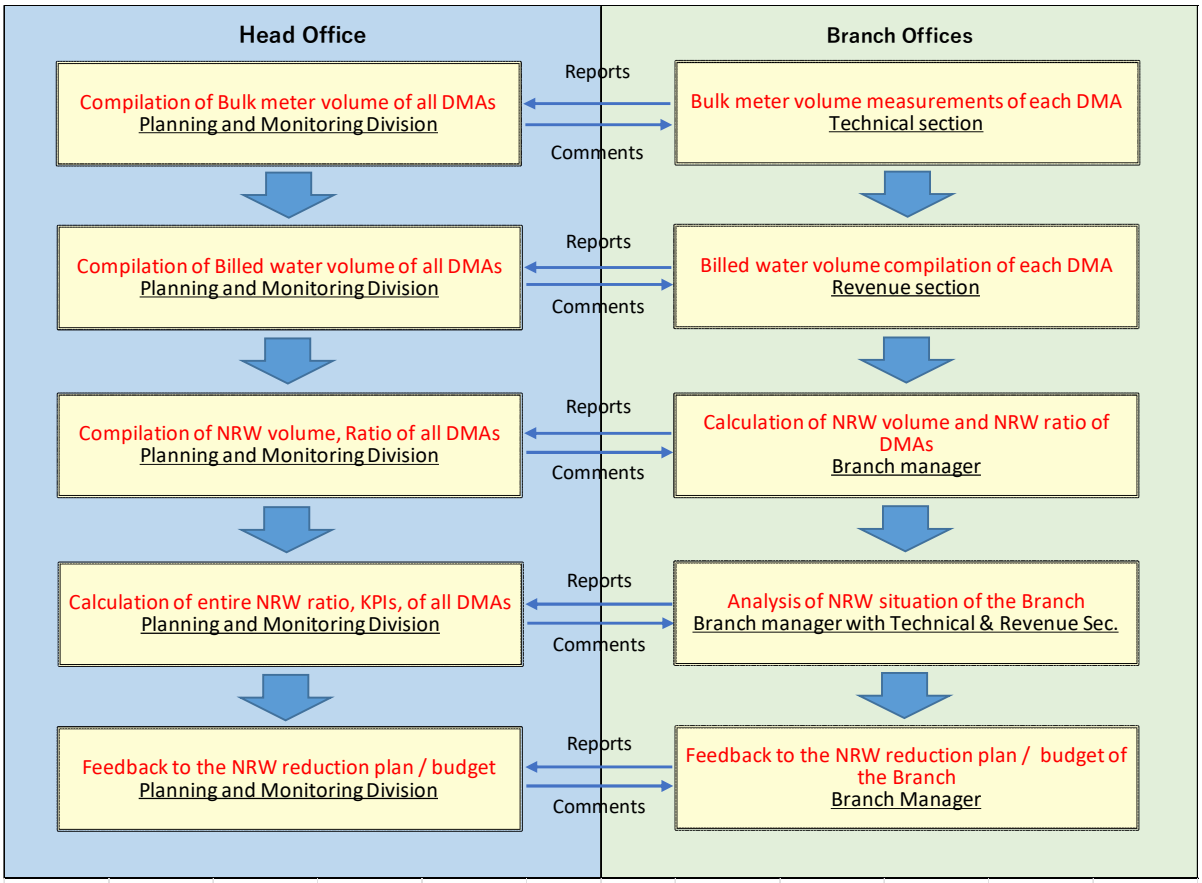
****Since the boundry of DNI No.4 corresponds to the boundary of cover area of Baneshwor branch and Tripureshwor branch, it is not necessary to change the cover area of each branch

*****Since NRW section in Head office doesn't have enough staff, it's covered by Planning & monitoring division for the time being.

Data collection process of NRW ratio

Red colour: Brand new or revised from present one.

Underline: responsible section or division for each procedures



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Full Version of Maintenance Plan for Maintaining NRW Ratio Low in the Medium & Long Term

Summary of Maintenance Plan for Maintaining NRW Ratio Low in the Medium & Long Term

1. What is commercial losses of NRW?

Following table shows the composition of NRW among System Input Volume.

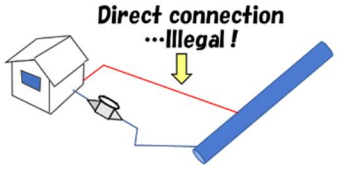
Table Sum.1-1 Water Balance

System Input Volume	Authorized consumption	Billed authorized consumption	Billed metered consumption (including water exported)	**Revenue water**
			Billed unmetered consumption	
		Unbilled authorized consumption	Unbilled metered consumption	**Non-revenue water (NRW)**
			Unbilled unmetered consumption	
	Water losses	**Apparent losses**	**Unauthorized consumption**	
			Customer metering inaccuracies	
			Data handling errors	
		Real losses	Leakage on transmission and-or distribution mains	
			Leakage and Overflows at utility's storage tanks	
			Leakage on service connections up to point of customer metering	

Source: IWA

Unauthorized consumption: Water company (e.g., KUKL) does not allow to use the supplied water but actually used. Illegal connections, water stealing, etc.

- By-passing the customer meter,
- Installing illegal pipe by the user,
- Meter tampering / manipulate a meter to count slower / re-connect a meter reversely.

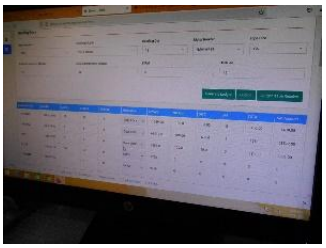


Customer metering inaccuracies: Customer water meter itself is not accurate. Water meter counts less water volume than that of actually consumed.

- Caused by wear and tear,
- Improper size meter,
- Manipulated one.
- For no meter or unread customers, wrong estimation of water consumption.

Data handling errors: Water consumption data, and so on, is not precisely reflected on the bill to the customer.

- Meter reading error: errors in meter readings. Meter reader doesn't go to the customer but assume it.
- Differences between estimated (e.g., average) vol. or minimum charge vol. and actual used vol. in case of no meter / no reading.
- Data posting staff makes mistakes in meter reading data input.
- Bill printing mistakes. Delivered to wrong customer.



Considering the above causes of NRW commercial losses, major targets of commercial losses reduction are shown in the following Figure. Therefore, NRW commercial losses countermeasures include following 4 major components;

- Measures to make customer water meters accurate,
- Measures to do meter reading works efficient and accurate,
- Measures to improve customer data input and check skill,
- Measures to find and legalize any illegal uses.

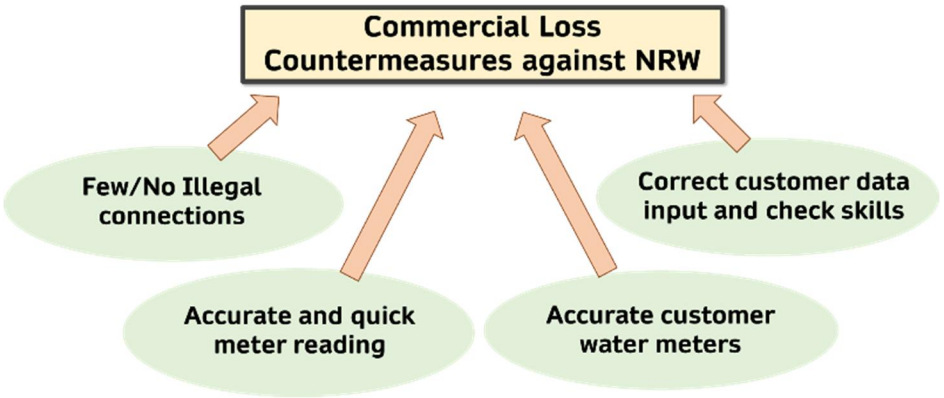


Figure Sum.1-1 Commercial Loss Countermeasures against NRW

2. Major reduction measures on NRW commercial losses

Expected activities of NRW maintenance plan for commercial loss are as follows;

(1) Few / no illegal connections

i. Regular illegal connection field inspection

ii. Revision of KUKL connection policy for new connection applicant not to require

a land ownership

iii. Public relation activities to ask cooperation of citizens to report illegal connections

iv. Meet and talk with community leader / member to ask cooperate to stop illegal connection

v. Give incentives to report the other illegal use and give exemption/discount of penalty for voluntary disclosure of illegal use

vi. Give incentive and/or award to meter readers and inspection team to find illegal connections

(2) Accurate customer water meters

i. Regular meter replacement

ii. Regular accuracy check of customer meters and necessary replacement other than to be replaced meters regularly

iii. Relevant installation of water meter

(3) Correct customer database

i. Regular checking of customer information by field investigation

ii. Improvement of the capacity of accurate data input and check skill

iii. At random internal inspection of meter reading and inputted data

(4) Accurate and quick meter reading

i. Reduction of meter unread billings

ii. Improvement of the capacity of meter reading skill

iii. At random internal inspection of meter reading and inputted data

iv. Give incentive and/or award (non money) to meter readers and inspection team to reduce unread billings

(5) The other measures to reduce NRW commercial losses

i. Regular trainings (meter reading, customer data input, meter accuracy test, illegal connection countermeasures)

ii. Make indicators (NRW ratio and the others) to be clear the billing and non-billing situation (e.g., average bill, average distributed water/case, ave. billed water, metered ratio, no reading ratio)

With the above measures, water supply hours/pressures and customer service level should also be improved.

Maintenance Plan to keep low NRW ratio in each DMA in the Short-Term

1. Purpose

This is an idea of Maintenance Plan in the short-term to keep low NRW ratio for OJT to be conducted in handed over DMA.

2. To be noted

The customer meters in the handed over DMA are considered new and basically accurate. So, regular meter replacements are not included in short-term plan in DNI areas. Main commercial losses' problems in handed over DMA are considered,

- Unregistered residents (water users),
- illegal connections,
- meter reading mistakes,
- data input mistakes,
- inaccurate meter (considered not so much),
- low meter reading ratio, and so on.

3. Contents of Maintenance Plan to be carried out in a certain DMA

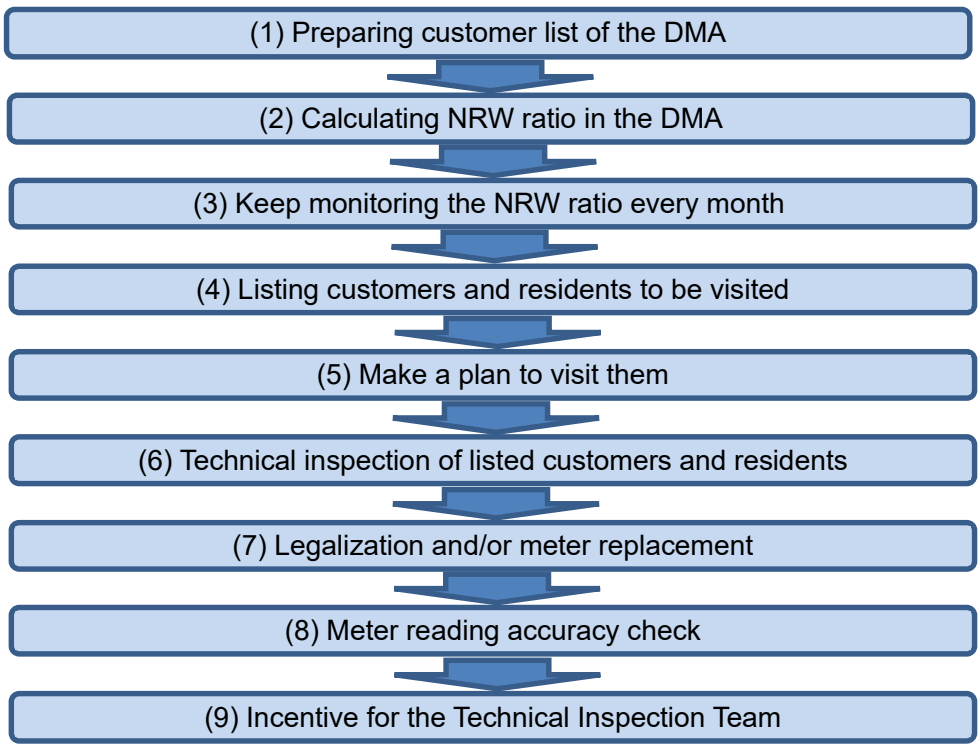


Figure Sh.3.0-1 Flow Chart of Maintenance Plan Activities

4. Details of Maintenance Plan to be carried out in a certain DMA

4.1 Preparing customer list of the DMA

(1) Decide a DMA to control illegal connections

- The target DMA shall be decided, considering meter reader's information, low water consumption customers, and complaints by customers.

(2) Prepare a customer list of the DMA

- First, prepare a customer list of the target DMA, covering all customers.
- Domestic, commercial, governmental and any categories of customers will be included.
- Bsmart (customer database) shall be used to pick up all the customers in the DMA.
- If possible, please refer to the GIS data, which can generate all customer ID numbers in a certain DMA.

4.2 Calculating NRW ratio in the DMA

(1) Read and record a bulk meter of the DMA

- To obtain a System Input (distribution water volume into the DMA), bulk meter(s) shall be read at least once a month, and record the figure to calculate the NRW ratio.

(2) Calculate a billed water volume for all the customers of the DMA

i. By using the customer list of the DMA, collect billed water volume data of all the customer in the list. Billed water volume data can be acquired from IT Section (head office) of KUKL.

ii. It is good to collect not only one month but past several months billed water volume. As a result, you can see the trend of change of billed water volume for the past several months.

iii. A billed water volume of the DMA shall be calculated by totaling billed water volumes of all the customers of the DMA.

iv. For unmetered bill and unread minimum charge, it is necessary to set relevant billed water volumes by transferring bill amount to water volume through tariff table or by minimum charge volume ($10m^3$/month).

(3) Calculate a NRW of the DMA

- You can calculate a NRW of the DMA by using system input volume (distribution water volume) and billed water volume of the target DMA. Following is a calculation formula of NRW;

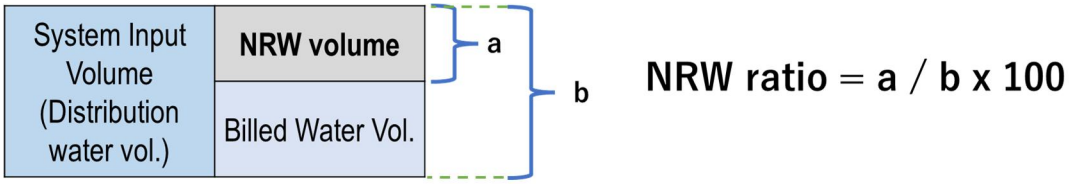


Figure Sh.4.2-1 Image of NRW Volume and Calculation Formula

NRW ratio = (System Input Volume – Billed Water Volume) / System Input Volume x 100

4.3 Keep monitoring the NRW ratio every month

- NRW ratio shall be calculated every month by referring procedures of "**4.2 Calculating NRW ratio in the DMA**".
- NRW ratios of all the month shall be stored to observe the trend of changes of them.

4.4 Listing customers and residents to be visited

(1) Pick up the suspects of illegal connections

- Collect information of illegal users from meter readers responsible for the area.
- The suspects can be picked up from billing data of the customers. Compare to the other customers, **if a certain customer uses much less water**, it will be selected as suspects.
- **Disconnected or suspended customers still residing** shall also be included.
- Non-domestic customers, commercial, industry, etc., should be included.
- Make a list of the suspects of the illegal connection
- You had better list up all the suspects of illegal users to visit.

Table Sh.4.4-1 List of Suspects of Illegal Users (Example)

No.	Customer number	Name	Address	Zone	Route	Condition	Previous Reading
1							
2							
3							
...							

4.5 Make a plan to visit the listed customers and residents

- Make a simple plan, such as who are included in the inspection team, when they visit, how many days it takes to finish them, what kind of material / equipment are necessary.
- Staff safety measures should be considered.

- To raise meter reading ratio, flyers to ask cooperation on meter reading are prepared and delivered to all houses in the DMA.

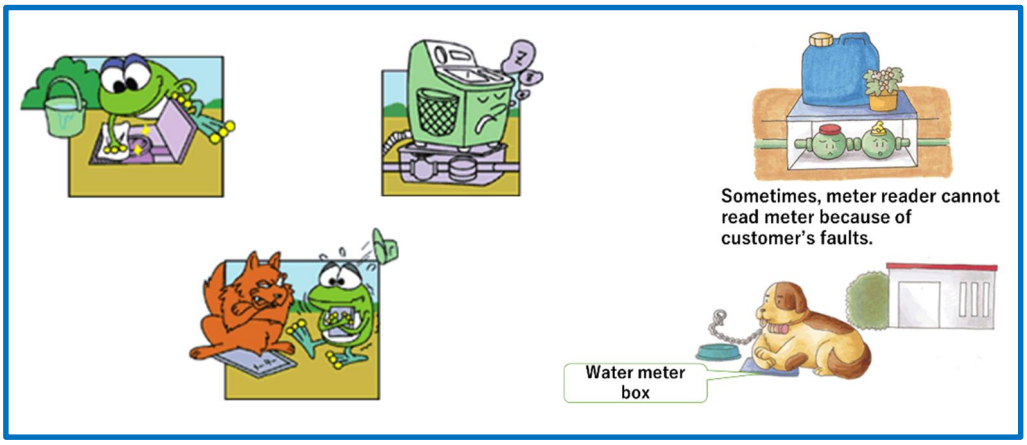


Figure Sh.4.5-1 Example of Public Relations to Improve Meter Reading Condition

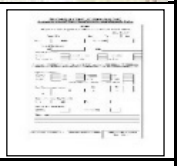
- Following table shows an example of member composition of technical inspection.

Table Sh.4.5-1 Member Composition of Technical Inspection

Member composition of Technical Inspection (Example);		
Technical Inspection Team Members (in one truck);	Supervisor x 1	Talks with customer, organizes overall inspection work, takes photos of the evidences of illegal connection, fills in the format and hand to illegal user
	Technician x 1 to 2	Supports supervisor, talks with customer, checks customer data, asks plumbers to do necessary work to search illegal connection, calibration test of customer meter, etc.
	Plumber x 1	Closes a valve, removes a meter, digs around a service pipe, digs around a house to find direct connection, etc.
	Chief of Meter reader x 1	Talks with customer, compares water consumption volume with the previous volume, asks the customer about any queries for the consumption vol., etc.
	Meter reader x 1 to 2	Checks the customer meter itself and inside the meter box, helps to do calibration test of customer meter, etc.

- Following shows an example of equipment and tools for technical inspection.

Figure Sh.4.5-2 Equipment and Tools for Technical Inspection

Equipment and tools for Technical Inspection (at least);					
1	Truck		2	List of customers (with customer information) to visit	
3	Plumbing tools		4	Shovel / iron bar / wrench / hammer	
5	Digital camera or smart phone to record		6	Format to fill-in and leave it to illegal user (proposed)	
7	Portable test meter (proposed)		8	Accurate water meter (normal new meter) (proposed)	
9	Plastic water tank (20 liter) (proposed)		10	Acoustic rod (proposed)	
11	Portable leak detector (proposed)		12	Metal pipe locator / Magnetic Locator (proposed)	

- Following shows an example of Report format on Field Inspection. It is recommended to leave this kind of letter to the customer who has no meters, malfunctioning meter, or illegal users. Branch office of KUKL shall also keep a copy of this for a record of the inspection.

Table Sh.4.5-2 Report format on Field Inspection (Example)

KUKL

Report on Technical Inspection of Meter & House Connection (draft)

Serial No.

Meter No. Day Month Year

Ward Route Connection Number

1 Cutomer information:

Name of the Customer: Tel: E-mail:

2 Type of the customer:

Domestic Shop Restaurant Hotel Industry Govt.

Temple Hospital School Apartment Large user (pool, car wash, etc.)

3 Size of house connection (inch):

1/2 3/4 1 1 1/2 2 Others (specify) inches

4 Number of persons living (domestic):

Adults: Children: Total:

5 Condition of customer meter: Is there a meter? Yes No meter If no, why?

Is the meter working? Yes No working If no, why?

6 Meter reading volume: Regular reading day

Reading -3 Reading -2 Previous Read Reading NOW

Consumption - 2 Consumption - 1 Consumption 0

7 Other meter observation: Invisible glass Old meter Leakage at meter Wrong direction

Is there a Meter Seal? Yes, there is. No seal.

8 Accuracy test of meter: Meter Error (%) Small flow rate 100L/h % Middle flow rate 200L/h %

9 Check of illegal use:

Stop valve and sound of water flow into tank	I heard a sound		No sound
Check the inside of the meter	Manipulated		No problem
Dig around the meter and service pipe	Found illegal pipe.		No illegal pipe
Metal pipe detector or Digital leak detector	Found illegal pipe.		No illegal pipe

In case you are confirmed as an illegal user of KUKL water, you must come to the responsible branch office of KUKL to pay penalty and to do the legalization <u>by the end of next working day.</u>

10 Observations:

Name and sign of the staff, KUKL	Name and sign of the customer	Name and sign of leader of Inspection Team, KUKL

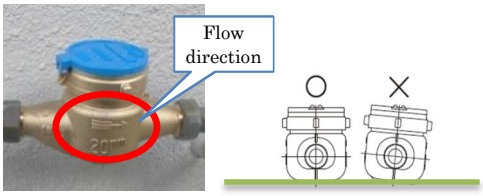
4.6 Technical inspection of listed customers and residents

- Team of staff goes to the listed customers / residents one by one.
- To be checked points (as follows).
  - ✓ Meter ID, customer ID, etc., in the list are the same as actual ones or not,
  - ✓ Record a meter read volume at that time (to compare with previous reading),
  - ✓ Ask customer the reasons of abnormal consumption volume,
  - ✓ Meter seal is there or not (if no, ask them why),

  - ✓ Meter is working correctly or not (roughly compare with last reading, movement of smallest digit during supply hour),
  - ✓ Meter is correctly installed or not (see a Box below),

Reference: Correct Installation of Water Meter

- A Velocity Type Propeller Water Meter must be installed horizontally.
- A Volumetric Water Meter keeps accuracy even installed horizontally, vertically or on an incline. To be easy to read.
- Flow direction is shown at the meter, the meter must be installed right direction.
- For Velocity Type Propeller Water Meter, reading glass side must be installed right upward.



✓ Meter calibration test (by test meter, if the error is big, find by-passing pipe),

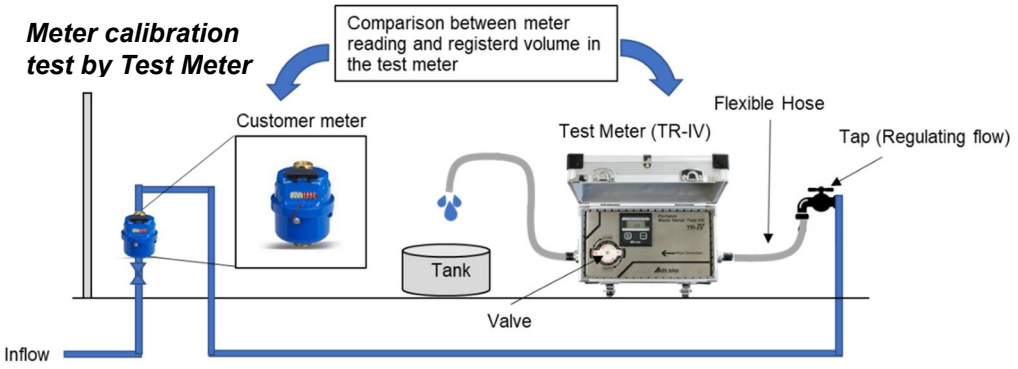
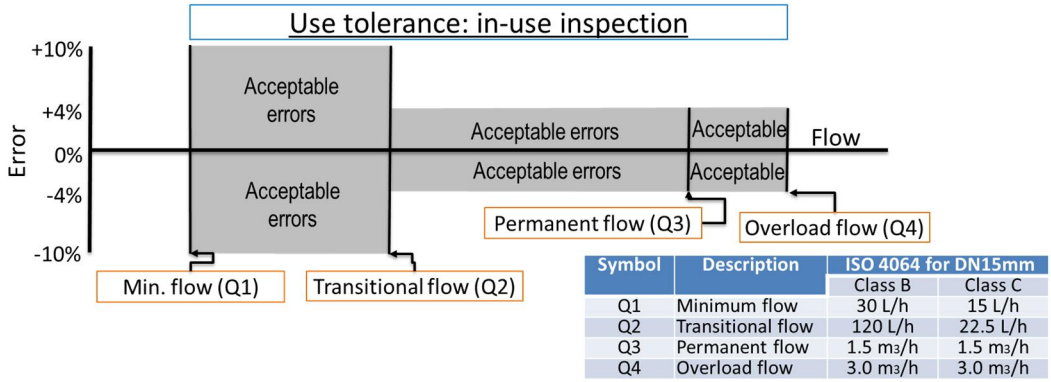


Figure Sh.4.6-1 Image of Meter Calibration by Test Meter



Symbol	Description	ISO 4064 for DN15mm	
		Class B	Class C
Q1	Minimum flow	30 L/h	15 L/h
Q2	Transitional flow	120 L/h	22.5 L/h
Q3	Permanent flow	1.5 m3/h	1.5 m3/h
Q4	Overload flow	3.0 m3/h	3.0 m3/h

Figure Sh.4.6-2 Judgement Standard of Meter Error

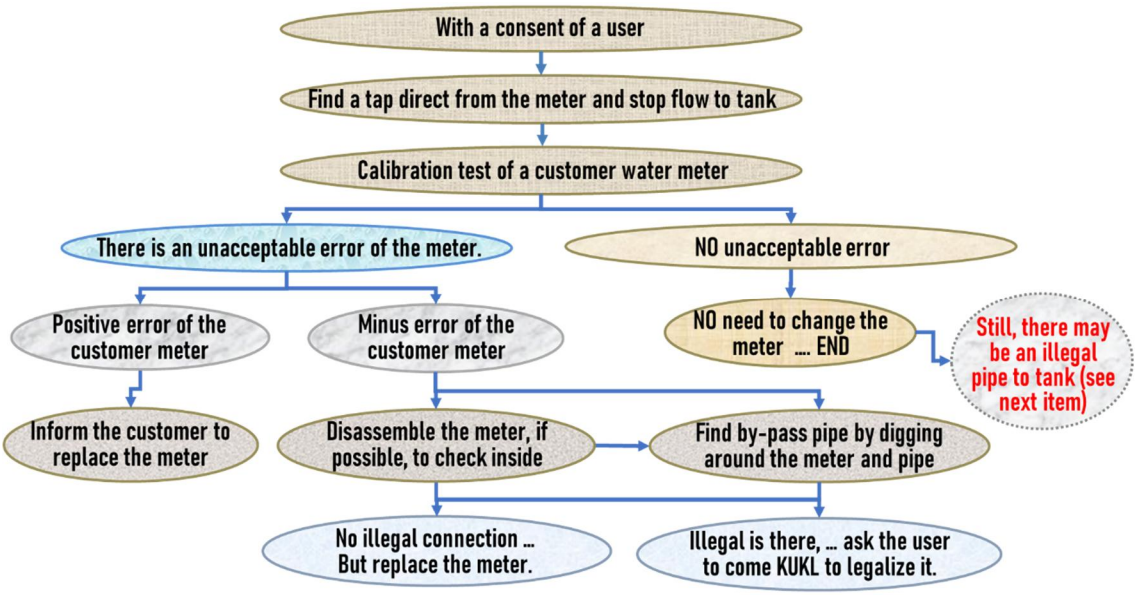


Figure Sh.4.6-3 Flow Chart of Calibration Test of Meter and Finding Meter By-Pass

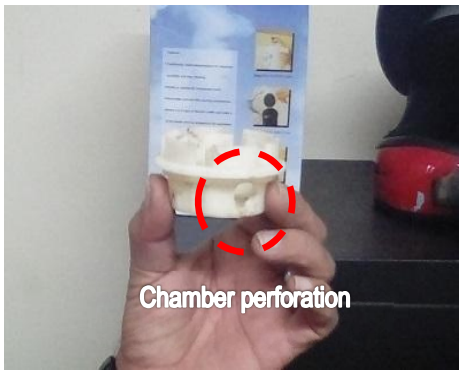
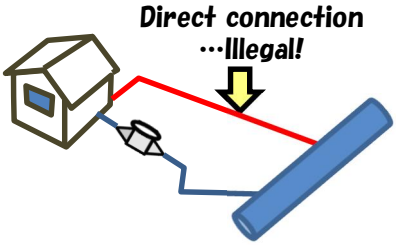
<table>
<tr><td>1. Bypass pipe
  </td><td>2. Direct connection (by removing a meter)
  </td></tr>
<tr><td>3. Bypass the meter (T connection)
 
</td><td>4. Manipulate inside the meter not to rotate rightly
 
</td></tr>
<tr><td>5. Direct connection from distribution pipe
 
</td><td>6. Install the meter reversely between reading days
  </td></tr>
</table>

Figure Sh.4.6-4 Typical Illegal Uses

✓ Stop valve and hear a sound of water flowing into a tank.

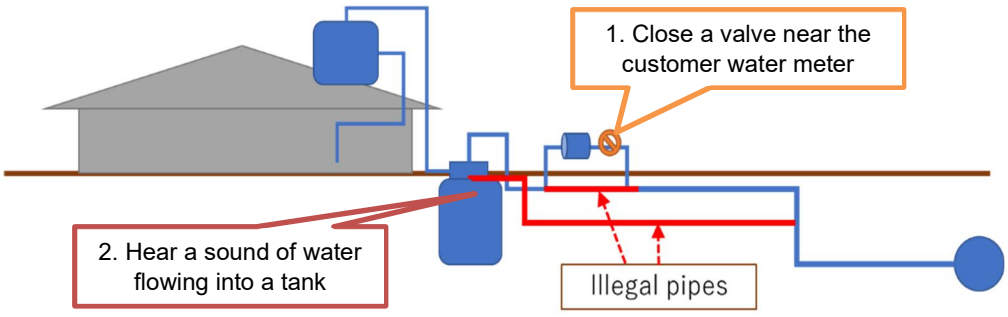


Figure Sh.4.6-5 How to Find Illegal Pipe toward Underground Tank

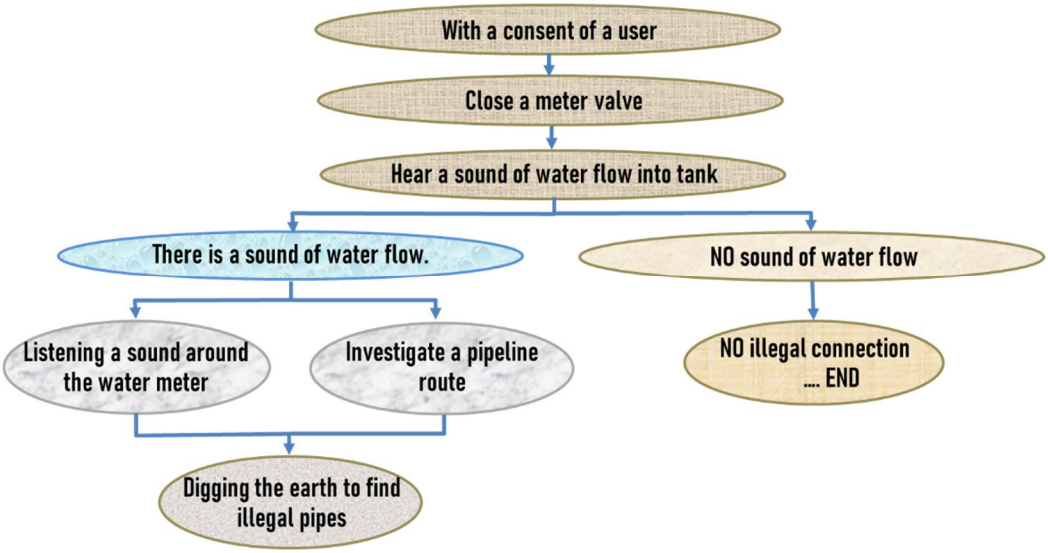


Figure Sh.4.6-6 Flow Chart to Find Illegal Pipe toward Underground Tank

- All the inspection results are recorded on memo format and be brought back to an office.

4.7 Legalization and/or meter replacement

- If you find an illegal connection, KUKL must warn the customer to come to branch office and to be legalized after paying punishment fee.
- It is recommended to leave a letter of warning to illegal users.
- It is expected that there are not so much defect meters as just after handover. But if the defect meters are found, KUKL must replace them or at least warn them to replace and monitor them after that.

4.8 Meter reading accuracy check

- Recorded meter read volumes at Technical Inspection shall be shared with data input staff after the inspection team comes back to the branch office.
- The data input staff should compare those data with previous read volume and check the relevancy of meter reading of the previous month.
- If the previous reading seems strange, the data input staff should talk to responsible meter reader. The meter reading data at the inspection shall be secured.
- The inspection data is used to check the relevancy of next month meter read volume of each customer. So, please keep the Technical Inspection record in the office.

4.9 Incentive for the Technical Inspection Team

- Field technical inspection is a tough work as it is facing suspects of illegal users every day.
- The team will receive a lot of complaints from users or citizens.
- Incentives should be provided to the team to conduct a field inspection continuously.
- A proposal is to provide a portion of punishment fee from illegal users found by inspection to all team members. Such as 10% of the fee paid by illegal users (e.g., 1,177.5 x 12 months x 1.5 x 10% = 2,119.5NPR. If the field inspection is conducted by 5 staff, 423 NPR/staff per case).

Full Version of Maintenance Plan for Maintaining NRW Ratio Low in the Medium & Long Term

1. Background

1.1 Background of the "Project on Capacity Development of KUKL to Improve Overall Water Supply Service in Kathmandu Valley"

In the Kathmandu Valley of Nepal, the water supply facilities are owned by the Kathmandu Valley Water Supply Management Board (KVWSMB), and Kathmandu Upatyaka Khanepani Limited (KUKL) is responsible for operating the water supply service under a license issued under a lease agreement.

The water demand of the 2.7 million people in the Kathmandu Valley is estimated to be 370 MLD, and the annual average water supply of KUKL is 126 MLD. Taking into account the estimated 26% leakage rate, the effective water supply volume is estimated to be 81MLD[1]. As a result, water services are unevenly distributed and many customers do not have access to water despite having a contract, and are forced to have a service every few days or limited water supply hours. The overall service provided by KUKL is not equitable, as the lack of sufficient water supply forces customers to use alternative sources of water, such as using water tankers with additional payments or using groundwater of poor quality.
While the fundamental reason for the lack of improvement in water supply services is the absolute shortage of water sources, KUKL has not been able to fully fulfil its role as a water utility in terms of water quality management, water treatment plant operation and maintenance, water distribution management, non-revenue water management and customer service, and has been slow to establish an internal human resource development system.

To remedy this situation, the Melamchi Water Supply Project, with a capacity of 170MLD (170,000 m3/day), is being implemented under financial assistance and co-financing from the Asian Development Bank (ADB) and JICA. After the completion of this project, the water supply of KUKL will be doubled by the water conducted from the Melamchi River, and the water supply infrastructure in the Kathmandu Valley will be drastically improved by the Distribution Network Improvement (DNI) project supported by ADB.

Under the above DNI project, the development of the water distribution network including

[1] Report of Detailed Planning Survey 2017 (JICA)

installation of pipelines and customers meters is being carried out in three phases. The water pipeline network within the ring road surrounding Kathmandu and Lalitpur cities will be developed through DNI Phase 1 and Phase 2.

JICA decided to start the Project on Capacity Development of KUKL to Improve Overall Water Supply Service in Kathmandu Valley in March 2021.

1.2 Outline of the Project on Capacity Development of KUKL to Improve Overall Water Supply Service in Kathmandu Valley

1.2.1 Project Period

The project period is from March 2021 to March 2026.

1.2.2 Outline of the Project

An outline of the Project is given below.

Table 1.2-1 Outline of the Project

Item	Contents	
Overall Goal	The quality of KUKL's water supply services is improved	
Project Purpose	The KUKL's capacity of operation and maintenance of water supply is improved.	
Outputs	[Output 1]	The capacity of water distribution management utilizing GIS is enhanced.
	[Output 2]	**The capacity of NRW reduction is enhanced.**
	[Output 3]	The capacity of operation and maintenance of WTPs and water quality control is enhanced.
	[Output 4]	The capacity of customer service management is enhanced.
	[Output 5]	The capacity of managing KUKL's internal training is improved.
Project Site	Kathmandu Valley	
Activities to realize Output 2	[Activity 2-1]	Define the roles/responsibilities of Head Office and Branches for NRW reduction activities.
	[Activity 2-2]	Decide the data collection process of NRW ratio.
	[Activity 2-3]	Conduct trainings on NRW reduction measures.
	[Activity 2-4]	Prepare **maintenance plan for maintaining NRW ratio low**.
	[Activity 2-5]	Implement **maintenance plan (prepared by Activity 2-4) for maintaining NRW ratio low**.
	[Activity 2-6]	Calculate NRW ratio monthly.

This maintence plan was prepared based on the Activity 2-4 and Activity 2-5 of Output 2.

2. Introduction

2.1 Objective of this maintenance plan

Name of this maintenance plan is "MAINTENACE PLAN FOR MAINTAINING NRW RATIO LOW". The objective of this maintenance plan is to keep NRW ratio low by carrying out several measures of NRW commercial loss reduction. Physical loss reduction measures are not covered by this maintenance plan.

2.2 General outline of maintenance plan

By the completion of Distribution Network Improvement (DNI) project supported by ADB, NRW ratio will be measured and planned to be less than 15%. Based on this assumption, physical loss reduction measures are considered not necessary at the moment.

Therefore, the activities for NRW reduction of the "Project on Capacity Development of KUKL to Improve Overall Water Supply Service in Kathmandu Valley" are limited to the commercial loss reduction.

Also, it is supposed that a NRW ratio in DNI's first stage area (Target Area as shown below) would start from 15%. The maintenance plan is formulated to keep this NRW ratio low level through the continuous implementation of commercial losses reduction activities. The maintenance plan is composed of several NRW commercial losses reduction measures.

3. Target Area

Water service areas covered by DNI's first stage (target area of Output 2 of the Project on Capacity Development of KUKL to Improve Overall Water Supply Service, refer to Figure below), Kathmandu Valley.

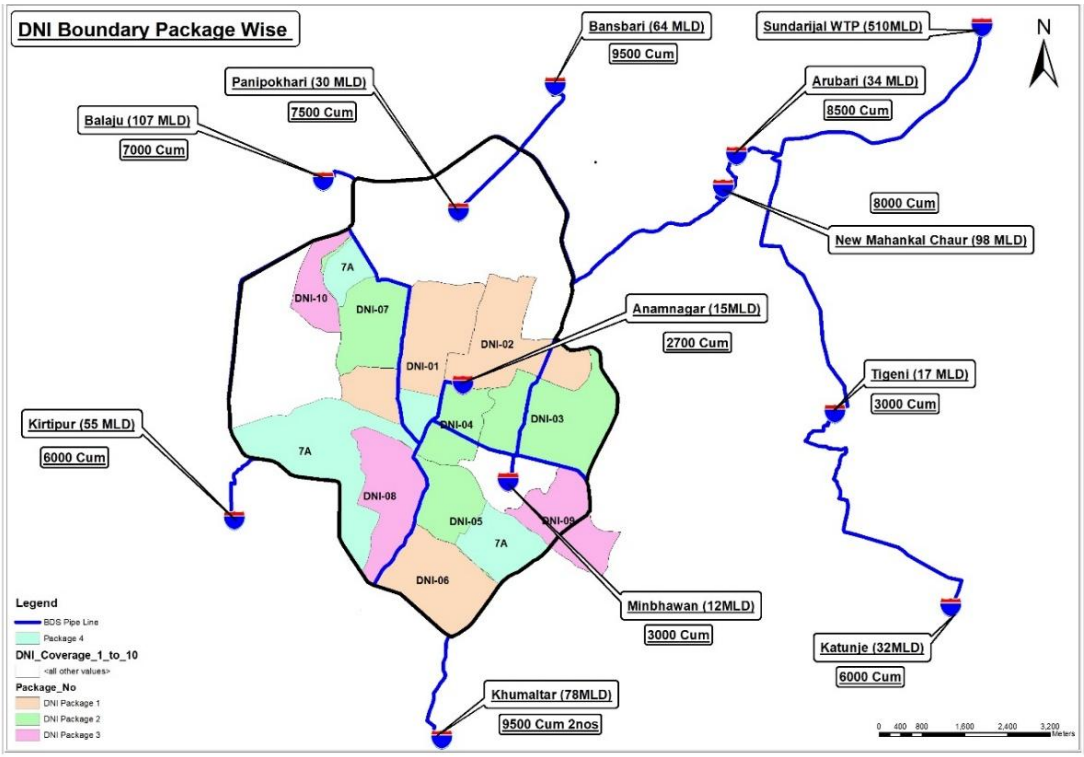


Figure 3.0-1 Water service areas covered by DNI

4. Components of NRW Commercial Losses

Following table shows the composition of NRW among System Input Volume.

Table 4.0-1 Water Balance

System Input Volume	Authorized consumption	Billed authorized consumption	Billed metered consumption (including water exported)	**Revenue water**
			Billed unmetered consumption	
		Unbilled authorized consumption	Unbilled metered consumption	**Non-revenue water (NRW)**
			Unbilled unmetered consumption	
	Water losses	**Apparent losses**	**Unauthorized consumption**	
			Customer metering inaccuracies	
			Data handling errors	
		Real losses	Leakage on transmission and-or distribution mains	
			Leakage and Overflows at utility's storage tanks	
			Leakage on service connections up to point of customer metering	

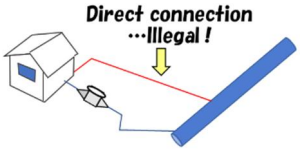
Source: IWA

As shown in the above Table, components of commercial losses (apparent losses) are major

three items; unauthorized consumption, customer metering inaccuracies, and data handling errors. Following sentences briefly explain the meaning and concrete examples of the 3 items.

Unauthorized consumption: Water company (e.g., KUKL) does not allow to use the supplied water. Illegal connections, water stealing, etc.

- By-passing the customer meter,
- Installing illegal pipe by the user,
- Meter tampering / manipulate a meter to count slower / re-connect a meter reversely.

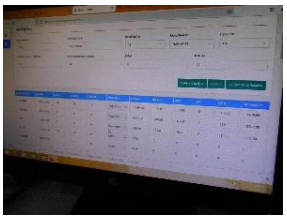


Customer metering inaccuracies: Customer water meter itself is not accurate. Water meter counts less water volume than that of actually consumed.

- Caused by wear and tear,
- Improper size meter,
- Manipulated one.
- For no metered customers, wrong estimation of water consumption.

Data handling errors: Water consumption data, and so on, is not precisely reflected on the bill to the customer.

- Meter reading error: errors in meter readings. Meter reader doesn't go to the customer but assume it.
- Differences between estimated (e.g., average) vol. or minimum charge vol. and actual used vol. in case of no meter / no reading.
- Data posting staff makes mistakes in meter reading data input.
- Bill printing mistakes. Delivered to wrong customer.



Considering the above causes of NRW commercial losses, major targets of commercial losses reduction are shown in the following Figure. Therefore, NRW commercial losses countermeasures include following 4 major components;

- Measures to make customer water meters accurate,
- Measures to do meter reading works efficient and accurate,
- Measures to improve customer data input and check skill,
- Measures to find and legalize any illegal uses of water supplied by KUKL.

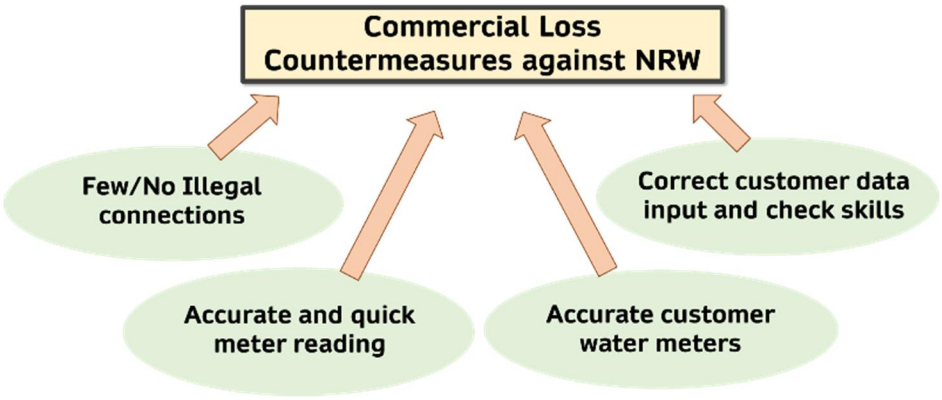


Figure 4.0-1 Commercial Loss Countermeasures against NRW

From the next section, each of the 4 major components are described in detailed.

5. Accurate customer water meters

5.1 Importance of accurate meter

Water and sewerage tariff revenue is a main source of budget for a general water company. Usually, and KUKL also, water and sewerage tariff is calculated and billed based on the monthly water consumption of each customer. Monthly water consumption is measured by each customer water meter. Therefore, a small customer water meter is an important player of water company which works every day for several years continuously.

Important player of water company, a water meter, is working under the hard conditions, such as;

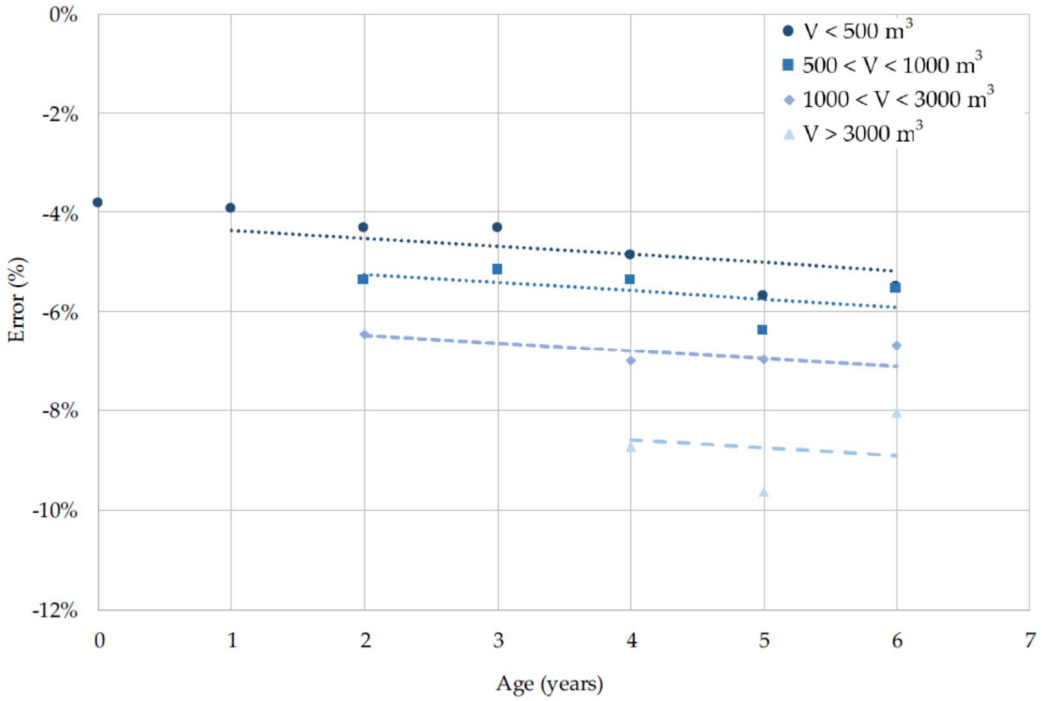
- Heavy rain, sometimes under the water,
- Under the strong sun light,
- High temperature,
- Large change of water pressure inside,
- No water, in some cases, and so on.

So, it is natural that water meters are sometimes deteriorated and broken or unable to read.

Relationship between meter error and the age / volume registered

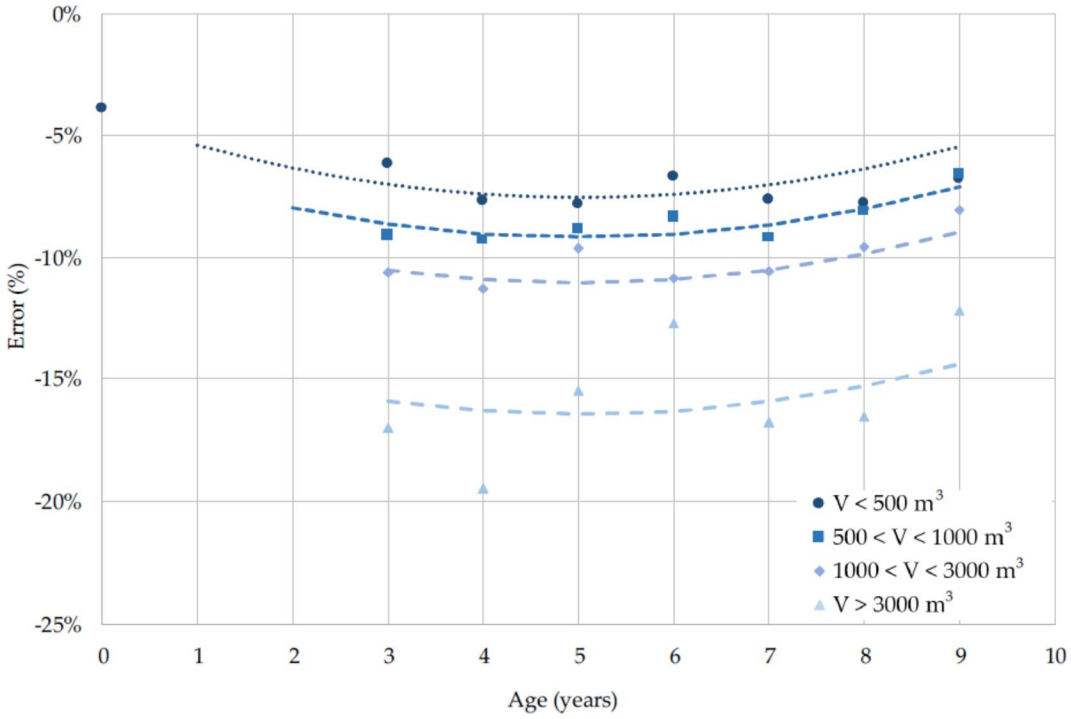
Following figures are extracts from “Performance Analysis of Ageing Single-Jet Water Meters for Measuring Residential Water Consumption, By Francisco J. Arregui”, results of Spanish study.

The author checked 2 types of water meters M_1 and M_2 (both are Single-Jet B ISO4064:1993). The sample sizes are; 1,474 for M_1 and 3,498 for M_2.



Source: Performance Analysis of Ageing Single-Jet Water Meters for Measuring Residential Water Consumption, By Francisco J. Arregui

Figure 5.1-1 The degradation rate of the weighted error with age and totalized volume (meter M_1).



Source: Performance Analysis of Ageing Single-Jet Water Meters for Measuring Residential Water Consumption, By Francisco J. Arregui

Figure 5.1-2 The degradation rate of the weighted error with age and totalized volume (meter M_2).

For M_1, "The overall tendency is that the meter error becomes more negative with both age and totalized volume."

For M_2, "Consequently, this particular single-jet meter type seems to have a tendency to slightly improve its overall performance as it becomes older. In any case, the weighted error is considerably larger, for any age and totalized volume range, than for meter type M_1."

Generally speaking, the more volume the meter counted, the larger the negative error is! The older the meter, the larger the negative error is!

Influences of meter errors

Negative error indicates less volume registered by the meter than actual water consumed. Fewer billing compared with that of actual consumption.

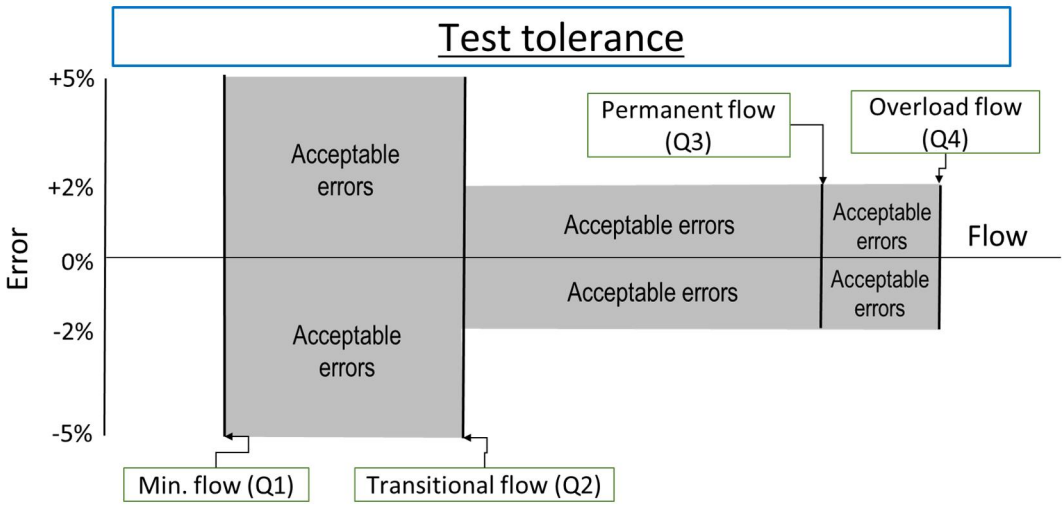
The difference is unbilled water, that is, Non-Revenue Water.

If the meter accuracies are unchecked, the NRW shall be continued. … Massive loss for water company!

In case that the meter error is positive (meter counted more than actual water consumed), a customer will complaint to water company. It is not fair for the customer and the company loses the customer confidence.

Acceptable and unacceptable errors of water meter

Following figure shows test tolerance (in laboratory) of water meter;



Source: Japan Water Works Association (JWWA), ISO4064 standard

Figure 5.1-3 Acceptable Errors of Water Meter (Test tolerance)

For the above figure, each of Q1, Q2, Q3, and Q4 are set as follows;

Table 5.1-1 Q1 to Q4 flows of Water Meter (ISO 4064)

Symbol	Description	ISO 4064 for DN15mm	
		Class B	Class C
Q1	Minimum flow	30 L/h	15 L/h
Q2	Transitional flow	120 L/h	22.5 L/h
Q3	Permanent flow	1.5 m^3/h	1.5 m^3/h
Q4	Overload flow	3.0 m^3/h	3.0 m^3/h

Use tolerance: in-use inspection, acceptable rates of test tolerance are doubled. So, the water

meter in-use is accepted, in case the error is within ±10% or ±4% for each small and large flow.

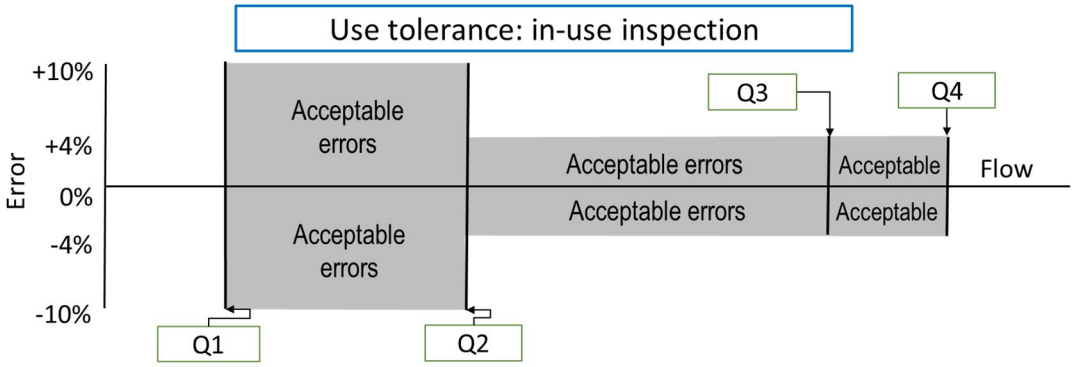


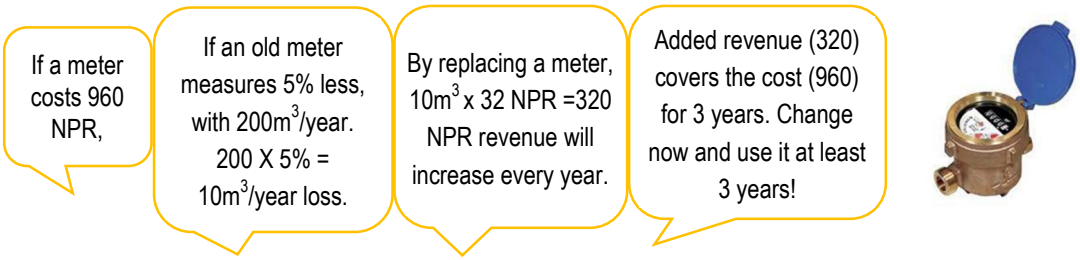
Figure 5.1-4 Acceptable Errors of Water Meter (Use tolerance)

5.2 Periodical replacement of customer water meters

In developed countries, customer meter used for a certain period is obliged to be replaced based on an Act. In Japan, it must be replaced to new one every 8 years by Measurement Act.

In other countries, there are often no system of periodical meter replacement. Regular replacement of water meter is a preventive measure to avoid meter errors and also an improvement measure of meter accuracy in case that old and malfunctioning meters are often seen.

Regular replacement can be done based on used year (e.g., over 10 years), or accumulated measured volume (e.g., over 3,000 m^3).



To replace a meter regularly for large non-domestic customers or high consumption customers is an economical measure, as its unit price of water tariff is higher than those of the small customers.

Therefore, it is recommended to replace meters regularly, prioritizing the customers using **older and/or more accumulated volume meters, and with a larger monthly consumption volume**.

It is better to use high accuracy, long life, good quality meters. Cheap or repaired ones are considered economical, but they cause short lifetime and faster decreasing tariff revenue, then they may not be economical.

Meter replacements are also a good time to check whether meters are manipulated or not and whether illegal connections are made or not.

Planning of regular replacement is briefly as follows;

(1) Listing up meters to be replaced, total/annual cost estimates, annual number of replacements, procurement and replacement plan, etc.
(2) Budget approval for the procurement and installation of them.
(3) Procurement of relevant meters (based on procurement criteria).
(4) Sample check of the quality of procured maters.
(5) Installation (by staff or by outsourcing, how many per month)
(6) Staff recruitment, if necessary (permanent or contracted staff)
(7) Update the customer data (meter brand, ID number, installation date, etc.)

Regular meter replacement shall necessitate a certain amount of money. Also, the approval procedures of the budget may take several months if it is first to do an extensive replacement. Therefore, it is better to prepare the plan and obtain approval for the plan and budget, as earlier as possible.

5.3 Check and replacement of customer water meters

(1) Survey by visiting each house

The causes of meter error include broken down of the meter, bad meter location, or unfit diameter meter. These conditions are checked at the same time of illegal connection survey. In case that too large or too small diameter meter is installed compared with size of building or size of family, ask the customer to change to proper diameter. How to find and repair the defective meters are as follows;

(2) Field survey of defective meter

Field survey of defective meter is carried out at the time of visiting each house to find illegal

connection. From customer database, prepare "to be checked" list whose water consumption volumes are too small for the family size or whose consumption decreased suddenly. Obviously broken down and aged meters shall be selected. Not obvious but suspected meters shall also be selected.

If a water company has a meter replacement plan with a customer list to be replaced, the list for field survey should not include these customers of the replacement list. This is because they will be replaced their meters anyway. No need for accuracy test.

Against the listed meters, calibration test is conducted at field. As a result of calibration test, meters with large error (more than 10% or 4% for each small and large flow) are said to be defective meters. They should be replaced.

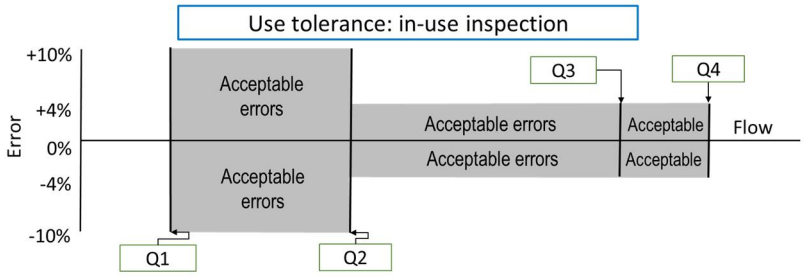


Figure 5.3-1 Acceptable Errors of Water Meter (Use tolerance)

(3) Meter calibration test

First, a portable test meter is connected to flowing-out side of a customer meter or a tap of the house. If a portable test meter is not available, it is OK to use 20 liters' tank. Close all the taps of the house. Flowing the water from a tap and received by 20 liters' tank, and measure a flowing out volume. By comparing meter indicated volume and tank filled volume, you can calculate the error.

A: By 20 liters water tank

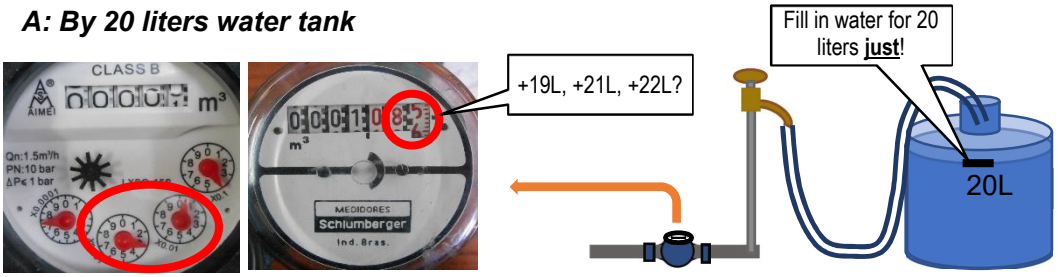


Figure 5.3-2 Meter Calibration by 20 liters Water Tank

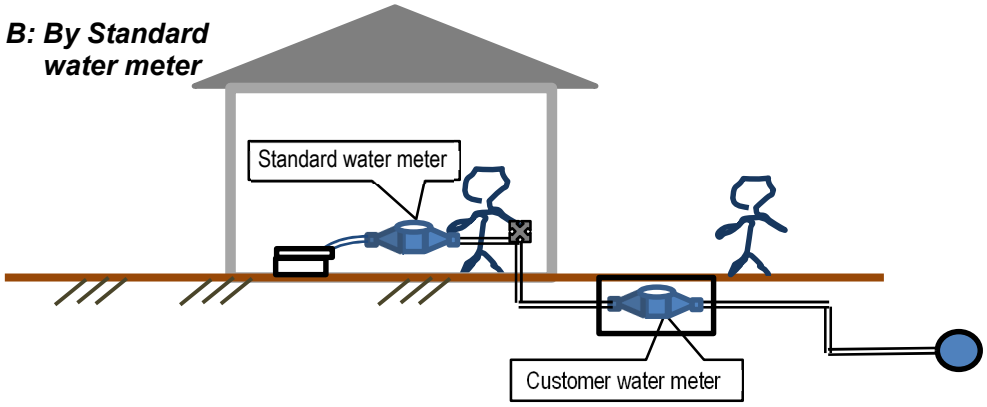


Figure 5.3-3 Meter Calibration by Standard Water Meter

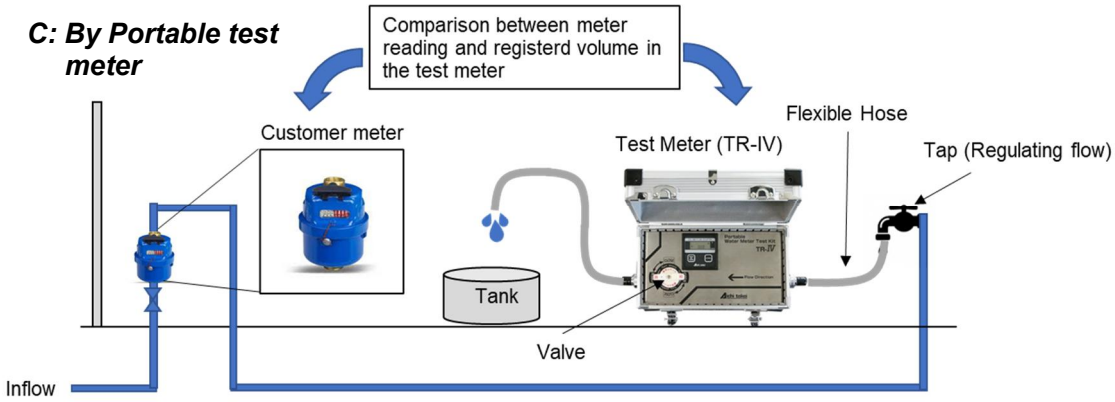


Figure 5.3-4 Meter Calibration by Portable Test Meter

Meter error is calculated by filling in the information into the following format.

Measure and fill in the right side table from up

Customer Meter ID			
Step	1 (Low flow rate)	2 (Middle flow rate)	3 (High flow rate)
Target test flow rate	100 L/h (1.7 L/min)	200 L/h (3.3 L/min)	1000 L/h (16.7 L/min)
Total test volume	10 L	10 L	20 L
Initial reading of customer meter			
Final reading of customer meter			
"A": Registered volume of customer meter (L)	= Final reading of customer meter – Initial reading		
"B": Registered volume of Test meter (L)	or tank or bucket filled volume		
Test time (min)	time of flowing water or fill in tank or bucket		
Actual test flow rate of test meter (L/min)	= "B" (Liter) / Test time (min)		
Difference of volume between "A" and "B" (A – B)			
"C": Instrumental error of test meter (%)	see below. Estimated by error report for each test meter.		
Error ((A-B) / B) x 100 + C			

Figure 5.3-5 Calculation format of meter errors (3 flow rates)

Calculation formula of a meter error is shown as follow.

$$\text{Error (\%)} = \frac{\text{Water volume measured by customer meter} - \text{Water volume registered by test meter}}{\text{Water volume registered by test meter} + \text{Instrumental Error of Test Meter}} \times 100$$

Example of Instrumental error achievement table		
Product name	TR-IV	
Serial No.	151	
Official approval term of validity	Dec-2029	
Example of Instrumental error		
High flow rate	Middle flow rate	Low flow rate
1,000 L/h (16.7 L/min)	200 L/h (3.3 L/min)	100 L/h (1.7L/min)
-0.4%	+1.5%	+1.2%

Figure 5.3-6 Calculation formula of meter error and Instrumental error of test meter

The above table shows an example of Instrumental error achievement table attached to all the test meter. Example of instrumental errors are used to calculate the meter error by filling in the previous format.

5.4 Improvement of meter installation condition

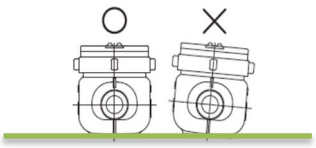
Correct Installation of Water Meter (basically, please follow the instruction of each maker)

Followings are the important points to install/replace a water meter;

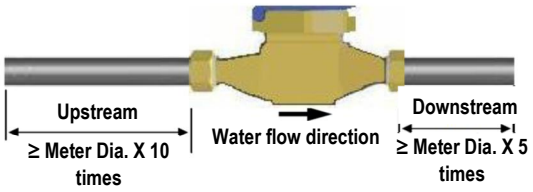
Velocity Type Propeller Water Meter	Volumetric Water Meter
	

- A Velocity Type Propeller Water Meter must be installed horizontally.
- A Volumetric Water Meter keeps accuracy even installed horizontally, vertically or on an incline. You shall install it easy to read.
- Flow direction is decided and shown at the meter, the meter must be installed right direction.

- For Velocity Type Propeller Water Meter, reading glass side must be installed right upward.



- Installation of straight pipes and valves before and after the meter, in order to prevent the influence of turbulent flow that causes inaccurate measurement. The upstream side of the meter must be at least 10 times straight pipe of the diameter of the meter (Japanese standard, JIS). On the downstream side, it is required to provide a straight pipe five times longer.



- Direct sunlight, high temperature, humidity, vibrations, very low temperatures should be avoided.
- Make some spaces around a meter for future replacement.
- Installation inside a house had better be avoided not to be made tampering.

6. Accurate meter reading

6.1 Reduction of meter unread billings

Following table shows meter ratio and a ratio of read meters among total customers for entire KUKL.

Table 6.1-1 A Ratio of Read Meters: Entire KUKL (including all branches)

Year Month	Total Customer	Metered ratio	Reading + self-reading	% of reading + self-reading
2079 Jestha	242,373	94.8%	85,560	35.3%
2079 Asadh	243,448	94.9%	83,345	34.2%
2079 Shrawan	244,126	94.9%	87,239	35.7%

Source: IT Section, KUKL

According to the data, a metered ratio is high at around 95%. But only 35% of all customer meters were read (measured) or self-read. The other 65% of customer meters were not read (not measured). The other 65% of unread customers were categorized into; “no reading”, “temporary hole block”, “unmetered”, “dog presence”, “door lock”, “dual record”, “meter buried”, “meter damaged”, “meter removed”, “house not found”, “PID”, “service line disconnected”, etc.

Under “unmetered” and “no reading” etc. in KUKL, bill shall be prepared based on minimum charge (150 NPR) or estimated volume or punishment fee (1,177.5 NPR). If the customer is

illegal (e.g., removed meter by him), a punishment is relevant to charge. Estimated volume or minimum charge is sometimes lower than actual usages of water. Also, existence of many "no reading" customers will make it impossible to calculate the NRW ratio precisely.

The ratio of read (measured) customers should be raised. If no, the water company cannot bill to the customer properly based on how much they consume, either calculate the precise NRW ratio. The presence of massive percentages of unread customers becomes one of the causes of NRW commercial losses as their actual consumptions may be more than the estimations.

KUKL continuously challenges to raise the number of read (measured) customers.

6.2 Improvement of meter reading skill

6.2.1 Why meters must be read?

By meter reading, water consumption of each customer becomes clear. The more the customer consumes, the more he/she must pay. That is reasonable as he/she pays based on the volume of service received (same as any services). Costs to supply water also increase, as consumption volume increases.

KUKL uses volumetric rate with minimum charge. Under the volumetric rate, it is good to measure all the customer meters to bill equally based on the consumption vol. To reduce the number of meter unread customers is important for KUKL to service to all customers equally as was already written in previous section 6.1.

The other aspect of the answer is to reduce NRW (water produced but not billed). Meter reading mistakes are one of the major parts of commercial losses of NRW. Precise meter reading will contribute to reduce NRW. Reducing NRW will increase a revenue of KUKL.

Table 6.2-1 Components of Water Losses and Commercial Losses

Water losses	Apparent losses	Unauthorized consumption
		Customer metering inaccuracies and data handling errors
	Real losses	Leakage on transmission and-or distribution mains
		Leakage and Overflows at utility's storage tanks
		Leakage on service connections up to point of customer metering

If the water meters are correct but if a meter reader records wrong volume, it will become wrong bill and customer will complain it. Those complaints will go to meter reader. All complaints will not disappear, but they can be reduced.

6.2.2 Major tasks of a meter reader

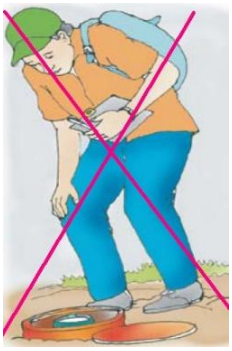
Tasks of a meter reader include the followings;

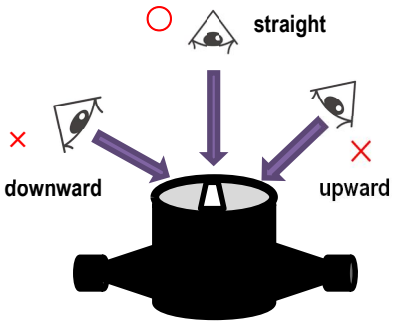
- Visit and read water meters of your responsible customers.
- Record the water volume of each customer and hand it to responsible branch office staff.
- Later, reconfirm the water volume or any other information when the office staff asks to do so.
- Check the condition of water meter and service pipe (e.g., no leakages, no illegal use, with seal)
- Record and inform to office the change of customers' information (e.g., movement, suspects of illegal use)
- Inform to office about unregistered new houses/family (Try to ask them about water usage).
- Communicate with customers (condition, complaints, answer to it at that time or later)
- Ask customers to pay past arrears, if any.
- Deliver the bills to his/her responsible customers, and so on.

6.2.3 Necessary skills or ability

- Good physical (walking, under any weather)
- Patience (not angry to customers, have to talk gently against any customers)
- Wiseness (answer to complaints rightly)
- A certain level of courage (to meet and talk with all types of many customers)
- Honest, sincerity (not to do bad thing, not corrupt)
- Basic knowledge about water supply, and so on.

6.2.4 How to read a meter

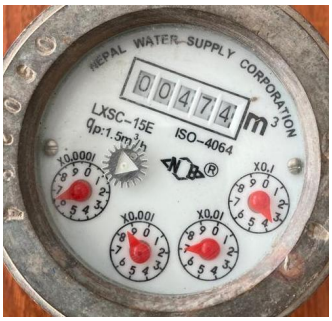




- Be located in front of the meter at a distance that allows you to see well.
- If you look sideways, from upward, or from downward, you can see a wrong number.
- At the end of a reading, you had better review the written numbers to avoid mistakes.
- When there are no conditions to perform the reading properly, write down the strangeness or anomaly for which the meter has not been read.

6.2.5 Try to read actual meters!

Following 2 photos are displays of two used water meters. The numbers under of each photo are meter indicated volumes. These two photos are easy ones for reading.



4 7 4 m³

2 9 9 m³

6.2.6 Cases that are easy to make mistakes

How do you read the following four photos? Answers are written under each photo.

6 3 4 m³

It looks like 635. But the 1st digit partially shows 4. Smaller volume than 1st digit are 8-2-3-0. That means 634.8230m³ precisely. A little smaller than 635m³. 634m³ is correct.

2 8 3 6 m³

In black part (m³), we cannot see 3rd digit (hundreds m³). We must guess what are 2 numbers shown partially in 3rd digit. They are 8 and 9, which have round parts.

3 2 1 6 m³

Fourth digit in black color is not clear. We must guess what it is. It looks like 0 or 3. But the left side is missed. So, it is 3.

2 1 2 1 m³

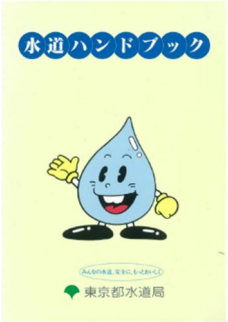
1st digit in black color looks like 0 or 1. Smaller volume show 0-0-9. 1st digit in black color is just turned to 1 from 0.

Meter readers should be the experts of reading any types and conditions of water meters. Following figure shows major two types of water meters being used in Kathmandu.

Velocity Type Propeller Water Meter	Volumetric Water Meter
	
It consists of a blade wheel or turbine with a vertical axis, located inside a chamber provided with an inlet hole through which the water enters the turbine. It also has a water outlet hole.	Volumetric water meter measures the volume of the actual fluid passing through the water meter. An example is the kind of revolving door in front of a large supermarket or hotel.

Source: https://www.sh-meters.com/products

6.2.7 Basic attitude to face a customer



Followings are the extracts of the contents of handbook, Tokyo Waterworks Bureau, mainly related to customer response. It is used by Waterworks Bureau staff for effective and smooth implementation of daily routine work. In KUKL, it is recommended to use this material not as a rule but as reference, considering the local situation of Kathmandu.

Response in the field

- The field is the place where you directly face a customer.
- Differ from office counter, you will be only the representative of water company.
- You have to respond to any matters related to water supply.

Source: https://moppy-baito.com/list1/1400788/

Preparation before visiting

- Customer will watch you, so you must be careful about your appearance, check materials, and visit after taking every possible preparation.
- Better to make an appointment, if you have an important task or complicated business.

Response at the time of visiting

- First impression is decided by greeting.
- Tell the water company name, your name, and purpose, in a polite way, in good faith.

- If you cannot answer the customer's queries in the field, you had better answer them soon after going back to the office and after consulting your boss.
- In case that water company made a mistake, you must apologize to the customer humbly, and do in good faith.

Source: https://www.azbil.com/jp/case/other/nou_479/index.html

6.2.8 How to check whether it is illegal or not?

A meter reader may see the suspect of meter by-pass or illegal connection. It is one of the important tasks for meter reader to inform these situations to KUKL branch office. The following is a way to check whether there is an illegal pipe or not in a usual residence.

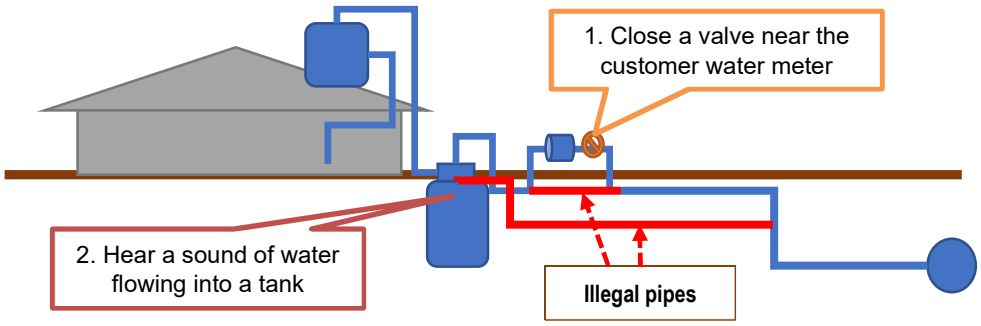


Figure 6.2-1 How to Find Illegal Pipe toward Underground Tank

- During water supply hours, close a valve near water meter. Then, if water still flow into underground tank, it may be an illegal use.
- During no supply hour, removing customer water meter and flowing water to service pipe by hose towards distribution pipe. If water flow into the underground tank, it may be an illegal use.

6.3 Incentive/management of meter readers

Incentive to meter readers

In the future, it is recommended that KUKL shall introduce incentive for meter readers. The incentive for better performance will raise the motivation of the meter readers and it will lead to higher meter reading ratio and efficient working.

One of the criteria of incentives is high reading ratio (low unmeasured ratio) in the responsible reading area. The other criteria is a less customer complaints regarding meter reading mistakes or bill delivery mistakes. One of the other criterion is a less number of unconfirmed customers with dubious consumption volume.

Management of meter readers

Concerning the management of meter readers, it should be considered that meter readers shall be rotated his responsible area periodically to avoid a corruption.

Trainings for meter readers should be carried out regularly. The trainings shall include lectures to let them understand the importance of accurate meter reading, how to read a meter accurately, structure of water meter, correct installation methods of a meter, possible illegal water uses, and so on. The trainings shall also include a paper test and a contest like meter reading competition to raise a motivation to improve their reading skill.

A manager of the meter reading section had better talk with meter readers as often as possible, in order to check and understand the condition of their work, customer's conditions, problems faced at reading, meter malfunctions or suspects of illegal water use, and so on.

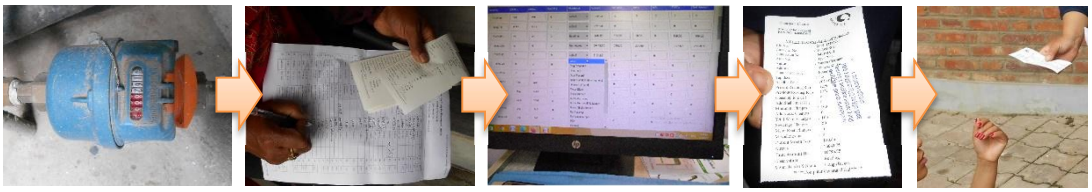
Necessary reactions to the request by meter readers (such as illegal use suspect, leakage) should be taken earlier, as it will affect the mind of meter readers to inform any problems in the field.

7. Updated Customer Database

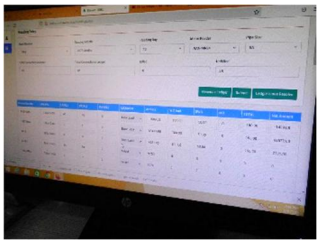
7.1 Check and correction of meter reading data, data input, and bill preparation

7.1.1 Role and responsibilities of data input staff

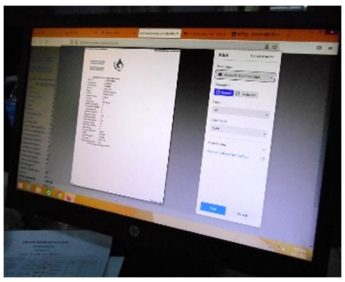
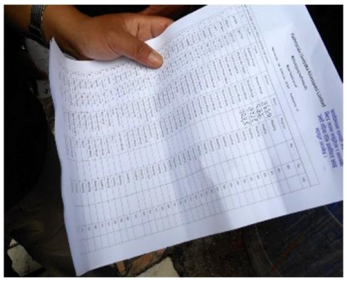
The typical method of billing requires a meter reader to visit each house and read the customer meter. The data is then recorded by hand on a form, taken back to the office, given to the billing section, and typed into the billing system. A bill is then printed and delivered to the customer.



Data input staff (data posting staff), KUKL, has an important role of inputting the meter reading data into the billing system (Bsmart). Data input staff also checks the relevancy of meter reading data. If the data is dubious even after confirming the meter reader, data input staff goes to customer's house to check the meter.



Data input staff closes the bills at the end of each month. Data input staff prints the bills after close (confirmed). Data input staff also prints meter reading lists (customer lists). The above documents are handed to responsible meter reading staff.


In this, a variety of errors may occur at different stages:

- Meter reader doesn't check a meter,
- Meter reader writes down incorrect data,
- Data input staff (data posting staff) inputs incorrect data into the billing system,
- The system may make some errors,
- A bill is sent to wrong address.

7.1.2 Importance of precise and quick data input

First data input is very important, as it can minimize the mistakes in the system. On the other hand, it is also important to input a lot of data as quick as possible. Because the staff and time are usually limited. Data input staff shall try to input the data as fast as possible with fewer mistakes as far as possible. The above skill will be improved through daily routine work in addition to training.

7.1.3 Importance of checking the inputted data

Nevertheless, a certain number of mistakes are somehow unavoidable, as it is human. The checking will help to reduce the mistakes. Then, it will reduce complaints from customers and reduce your work to solve the complaints after that. There are some customers who care staff's mistakes so much and complaints strongly. It will take much time to respond them.

Reducing the data input mistakes may reduce the NRW volume. As wrongly less inputted consumption (billing) shall be corrected by the checking. The decreasing complaints lead to improve the company's service level, customer satisfaction and company's reliance. Checking the inputted data is very important from the above reasons.

7.1.4 Causes of data input mistakes in general

There are 2 major causes of data input mistakes;

- Human errors
- Deficiency of working structure and system

Human errors

Majority of errors come from human errors.

- Low concentration
- Messy on the desk and workplace
- Wrong guess of dubious number/word (no confirm)
- Input a data in a wrong cell / place
- Did not check the inputted data
- Less trainings and experiences, knowledges.

Deficiency of working structure and system

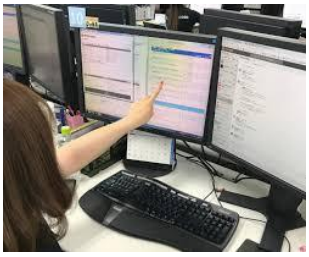
An organization must try to reduce the number of human errors but cannot do it enough, because…

- E.g., one staff is doing all the work from input to checking.
- The workload is too heavy because of shortages of staff.
- No manual nor checklist, but oral teaching only
- No relevant and enough PC, programs, internet, etc.

7.1.5 How to keep the accuracy of data input

Against human errors:

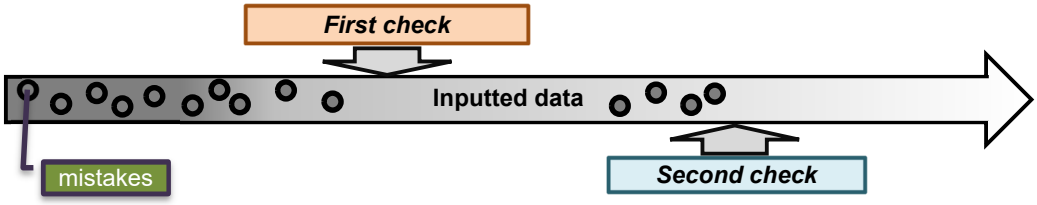
- Appropriate break time between data input works.
- Asking anytime to meter readers, if you find difficult-to-read number/word.
- Voice or point the numbers and words when you input data



- Use the Excel reading function (checking by ear)
- Take memo of your number of mistakes, and try to reduce it
- Understand what you often make mistakes (consumption? category? etc.)
- Sometimes change your tasks in a day (e.g., data input, field survey, then checking other's input data)

Against Deficiency of working structure and system:

- Proper working conditions (proper staff number, enough skills)
- Continuous staff training for data input / check skill
- Preparation of manual and checklist
- Proper PC, program, internet, and so on.



In order to prevent mistakes, to check the working results twice are called double checks. Double check is done by one, two, or several persons. Followings are the major 7 methods of double check;

Table 7.1-1 Major 7 methods of double check

No.	Name	How to check
1	2-person sequential check	Two-people check once in a row
2	2-person continuous interactive type	After the first person checks, the second person checks from the opposite direction
3	1-person continuous type	Check twice in a row by one person
4	1-person time difference check	Check twice by one person. Set an interval between the first and second check.
5	1-person double direction check	Check by one person, second check from the opposite direction
6	Triple check	3 people check once
7	Cross check	Check with two people. The second time uses a different method from the first time.

- Double check can be done by data input staff by themselves.
- After finishing a certain amount of inputs, the same person will see whether the inputted data are same as ones in documents (1st check).
- Even a quick look is effective to find mistakes.
- It is better to do it after a while, as your mind/brain becomes fresh.
- Double check by another staff (team member) is also good.
- The double check is good to be a habit every time.
- Cross check: e.g., compare with this month consumption and last several months' consumptions of the same customer.
- An inspection, sometimes, is also effective.
- Another person (other section or supervisor) shall check the inputted data.
- It can be checked not all data but a part of the inputted data (if there is no enough time to check all).
- It is better to make it routine too, by setting inspection day (e.g., once in 1 month).

7.2 Customer visiting / hearing investigation to update the database

7.2.1 Check of customer information (name, address, ID, and so on)

The above "7.1 Check and correction of meter reading data, data input, and bill preparation" refers to the preciseness of water volume and billing amount. In many cases, there are also a lot of mistakes on the other information of a customer database / ledger. We have to be careful about updating and optimization of these information (name, address, phone number, customer ID, meter installed year, etc.).

Always to keep customer database / ledger new and optimum is one of the important bases of water supply management. Furthermore, concerning NRW reduction, the optimization of customer database / ledger is a very important factor.

More concretely, it is necessary to establish a check system by KUKL for preciseness of the information in the customer database / ledger.

Table 7.2-1 Major Customer Information secured by KUKL

Customer Information	1. Name 2. Address 3. Customer ID number 4. Water supply and/or sewerage 5. Type of customer (domestic, commercial, and so on) 6. Meter reading cycle 7. Order of meter reading 8. Number of water meter, size, brand, model 9. Number of house connection, diameter, material, water consumption volume 10. Amount of arrears 11. Note of meter reader, delivery staff of bills, etc. (total 97 items)

Major two methods of preciseness check of customer information;

- Implement a customer visiting survey regularly for zone-wise or for a group of some zones
- Internal meeting of related staff to share customer information (residing or not, reasons of small water consumption customer, or customers with exactly constant consumption volumer for a long period)

(1) Customer visiting survey:

For zone-wise or integrating several zones in one group, targeting on number of customers which can be surveyed efficiently, a customer visiting survey shall be conducted referring a purpose, survey methods, and survey items as shown in **Table 7.2-2**.

Table 7.2-2 Purpose and Method of Customer Visiting Survey

1.	Purpose	To obtain correct customer information to update customer database / ledger
2.	Method	i. Prepare a questionnaire, ii. Several KUKL staff shall bring the printed questionnaire or a tablet installed it, iii. The above staff visit hundreds of customers and neighboring residents in a certain target zone or ward for a certain period to make hearing from them to get answers to the questionnaire, iv. After the survey, analyze all the answers of the survey and reflect on the customer database / ledger.
3.	Survey	Name of a head of the resident,

	contents	Address, Telephone (Mobile phone) number, Customer ID number, Type of customer (household, commercial, industry, government, etc.), Number of persons living in the resident, Active or inactive on water supply, Diameter and ID number of water meter, Condition of the meter, Diameter and number of house connections, Route and zone of meter reading, Major usages of water supply.
4.	Others	Visit residents with referring GIS information. Confirm the actual location of the building or the land is the same as customer information in the database.

(2) Customer Information Sharing Meeting

This is to have monthly meeting to share informations regarding customer data and to discuss necessary actions afterward. The meeting consists of representatives of sections which responsible for bill preparation, customer database, meter readings, and bill delivery. The meeting shall be chaired by assigned person by Commercial department head. The responsible staff will list up the customers / residents who need to be clarified before the meeting. The meeting will share the information of each participants one by one for customers / residents listed up and discuss how to make actions to them.

Responsible staff shall be decided for each of unclear or problematic customers. A progress of clarification or actions will be confirmed at the next meeting. Shared information and/or actions to be done shall be inputted briefly into the customer database.

8. Illegal Connection Countermeasures

For the details of illegal connection countermeasure, please see “Manual for Illegal Connection Countermeasures”, which intends to find and to legalize illegal connection in the field.

The “Manual for Illegal Connection Countermeasures” handles how to do ‘1. Inspection planning’, ‘2. Technical Inspection’, ‘3. Legalization Procedure’, and ‘4. Q&A, and Communications with Users’.

The other illegal connection countermeasures are as follows;

8.1 Incentive to the Staff of KUKL based on Their Performance

8.1.1 PPWSA: Incentive or Penalty to the staff for NRW Reduction

Following table shows performances before and after a reformation of the PPWSA.

Table 8.1-1 Phnom Penh Water Supply Authority (Before and After)

Indicators	1993	2009
Staff per 1,000/connections	22	3.2
Production Capacity	65,000 m^3/day	246,864 m^3/day
Non Revenue Water Ratio	**72%**	**5.9%**
Coverage area	25%	90%
Total connections	26,881	191,092
Metered coverage	13%	100%
Supply Duration	10 hours/day	24 hours/day
Collection Ratio	48%	99.9%
Total revenue	0.7 billion Riels	106 billion Riels
Operating profit	-0.7 billion Riels	33 billion Riels

One of the causes of drastic improvement of NRW ratio of PPWSA is an incentive to the staff working for NRW reduction (see below).

PPWSA: Incentive or Penalty to the staff

Fix NRW rate in all zones at year beginning, and following incentive or penalty was imposed on the staff responsible for each zone.

Table 8.1-2 PPWSA: Incentive or Penalty to the staff

Incentive	
Reduced < 1%	15% of saved amount
Reduced between 1-2%	20%
Reduced between 2-3%	30%
Reduced > 3%	40%
Penalty	
Increased < 1%	15% of loss amount
Increased between 1-3%	20%
Increased > 3%	30%

8.1.2 KIWACO: Incentive or Penalty to the staff for Tariff Collection

Kien Giang Water Supply & Drainage Company (KIWACO), Vietnam

Followings show incentive and penalty on staff working for tariff collection for the change of tariff collection rate of his/her responsible area.

- Incentive and Penalty on tariff collection staff of KIWACO
- All collection staff were set a target. If the staff achieves the target in responsible area, he/she gets incentive. If not achieved, he/she must pay penalty.
- Target rate:

Table 8.1-3 Target rate of tariff collection, KIWACO

City area	97%	Other than city	88%

- In other than city: incentive or penalty is calculated as;

Table 8.1-4 Incentive or penalty for tariff collection, KIWACO

Improvement	
89-91%	+10,000VND/1%
92-94%	25,000VND/1%
95-97%	45,000VND/1%
98-100%	75,000VND/1%
Reduction	
Any % ranges	-30,000VND/1%

E.g., in case of 98%, 3x10,000+3x25,000+3x45,000+1x75,000 =315,000VND (around 15USD)

Table 8.1-5 Result: Performance of KIWACO regarding Tariff Collection

Year	2009	2010
Tariff Collection Rate (Actual)	99.45%	99.55%

8.2 Voluntary Disclosure (e.g., Tax Amnesty)

One of the other measures for illegal connection reduction is a "Voluntary Disclosure". This method is widely seen in the field of tax collection around the world (see below). It is better to start considering to introduce this measure in KUKL as a pilot project to control the illegal use of water.

- *Indonesia, 2008, Sunset Policy*. If a person revises declared amount for income tax upward, overdue tax (2% of the tax) is exempted. … New tax registration = 5.6 million cases, Additional tax revenue = 675 million USD
- *USA, 2003 Offshore Voluntary Compliance Initiative (2003 OVCI)*. Govt obtained the list of tax payers who may hide their assets in offshore. Govt allowed persons who voluntary disclose to exempt some civil or criminal punishment. ... 1,300 new applicants and 107 million USD additional tax revenue.
- *UK, 2007 Offshore Disclosure Facility*. Govt agency obtained offshore account information of UK citizens. The agency's human resource is limited, so introduced voluntary disclosure. If a citizen voluntary applies for registration with paying all taxes and overdue taxes, deficit tax of maximum 100% will be reduced to 10%. Criminal accusation may be unlikely (not confirmed). … 109 thousands new citizens paid tax penalties. Total penalty tax revenue; 830 million to 1,036 million USD. The agency started investigation for the other suspects.

The above Tax Amnesty is a system to promote tax payment voluntarily against arrears and tax evaders. **There is a philosophy under this that it would be more effective to raise autonomy than to expose or to punish**.

It showed some clear positive results to increase tax revenues in developing and developed countries. The similar system can be applicable to water supply field to reduce illegal connections.

One of the ideas is to notice to citizens before carrying out extensive field inspection for illegal connection. The notice says, for example, "If you voluntarily turn yourself in KUKL if you have illegal use of water before KUKL find it, you will have some exemption of penalty for illegal use".

It is worth doing that for KUKL economically too, since voluntary disclosure saves the cost to find them to visit their houses and to search for the illegal pipes.

It may also help to expose illegal connections efficiently if an incentive such as to give bounty to reporter of neighboring illegal user.

8.3 Ask Cooperation to Community Leaders

Generally, community leaders have strong relationships with community residents and have a certain influence on the people living there. As far as possible, KUKL staff had better meet a community leader of each area, explain the situation well, ask cooperation to visit houses of illegal users together to persuade stop illegal use and legalize them.

8.4 Legal Arrangements (delivery of reminder letter, accompany with policeman, etc.)

Some illegal users shall respond to the "Voluntary Disclosure" or to persuading by community leader. However, the others may not follow these measures. KUKL has to consider applying some legal arrangements to these illegal users.

Even if an illegal connection is found and is told to repair by himself and to pay penalty, in case that the illegal user doesn't follow these, the illegal use of water shall be continued for a long period. The person may become considering that it is no problem for not to follow the procedure of KUKL.

In order to complete the process from exposing illegal use to legalize it soon, it is recommended to prepare and deliver reminder letter to illegal users which writes possible legal enforcement in case he/she doesn't follow the legalization procedure. Furthermore, in case that an illegal user strongly resists to KUKL, you can have a meeting with illegal users together with a policeman or a lawyer.

It is indispensable to consult with legal section of KUKL to consider establishing the above measures.

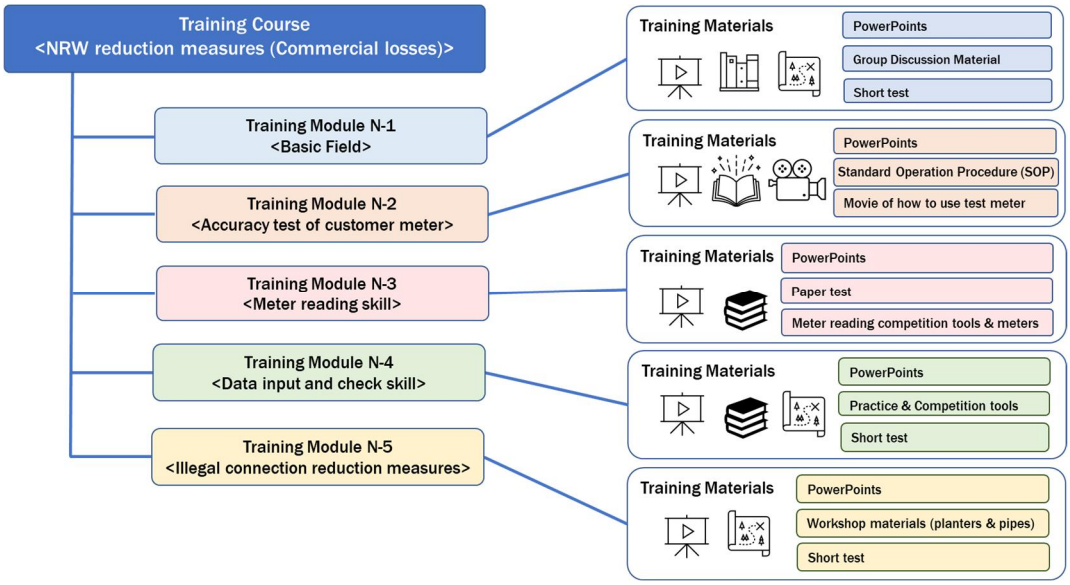
9. Continuous trainings for the staff related to commercial loss reduction

It is very important for KUKL to continuously train the staff and raise their capacity to relevantly handle the commercial losses of NRW.

Through the JICA Technical Cooperation Project on Capacity Development of KUKL to Improve Overall Water Supply Service in Kathmandu Valley, 5 training courses were established for capacity raising concerning NRW reduction for commercial losses (see the table below).

Table 9.0-1 Training Courses of NRW Commercial Loss Reduction

No.	Course name	Purpose	Contents of training	expected trainees
1	Basic Training	To know commercial losses and reduction measures to raise theoretical background.	Lecture, group discussion, short test	Branch Managers & Engineers, HO Management (Commercial, IT, E&M, etc.), about 20 trainees.
2	Accuracy test of customer water meters	To know the importance of accuracy check and regular replacement, to obtain the skills	Lecture and practice, field trainings	Technical sec. and Meter reading sec., about 12 trainees.
3	Meter reading skill	To know the importance of precise and quick reading, to obtain the skills	Lecture, test, meter reading competition	Meter readers (2 from each branch), about 20 trainees.
4	Customer data input and check skills	To know the importance of precise and quick data input and checking, to obtain the skills	Lecture, practice, test, data input competition	Data posting sec., about 9 trainees.
5	Illegal connections reduction measures	To know the importance of controlling illegal connections, to obtain the reduction measures	Lecture, Q&A, group work	Illegal connection reduction responsible staff (Meter reading sec., Technical sec., etc., 2 from each branch), about 20 trainees.



Followings are photos of Training of Trainers (TOT) of 5 courses carried out in 2022 and 2023.

Basic Training (11th December, 2022)

		
Lecture	Opening remark	Group discussion
		
Awarding certificate	Basic training by Tripureshwor Branch	Basic training by Mahankalchaur Branch

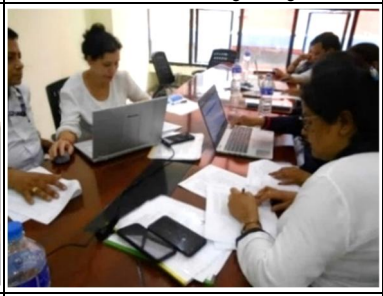
Accuracy test of customer meter (23rd May, 2023)

		
Lecture	Field practice, test meter setting	Field practice, meter error measurement
		
Field practice, meter error measurement	Short test	Closing remarks

Meter reading skill (5th June 2023)

		
Paper test of meter reading	Field contest of meter reading	Evaluation staff of test & field competition
		
Field competition, start, goal, and waiting seats	Field competition, players	Closing ceremony, awarding medal

Data input and check skill (20th June 2023)

		
Lecture	Question and answer regarding Bsmart	Data input and check practice
		
Data input and check practice	Data input and check competition	Data input and check competition

Illegal connection reduction measures (5th July 2023)

		
Lecture	Group workshop, meter disassemble to understand the structure	Group workshop, operation experience of leak detector
		
Group workshop, operation experience of leak detector	Group workshop, operation experience of magnetic locator	Closing ceremony, awarding certificate

Hopefully, all the related staff of KUKL shall attend a part or some of the above 5 training courses in the short-term. It is recommended to hold the 2 to 3 training courses for 1 year, to be completed all 5 courses for 2 years.

Contents or materials for the lecture (PowerPoints), short test, group discussion, group work,

or competition, shall be revised by KUKL, reflecting on the change of circumstances, feedback from trainees, introduction of new technology, and so on.