Reducing Non-Revenue Water

Leakage Survey after World War II
Source: Nagoya City Waterworks and Sewerage Bureau

No. T5 Ver. 1

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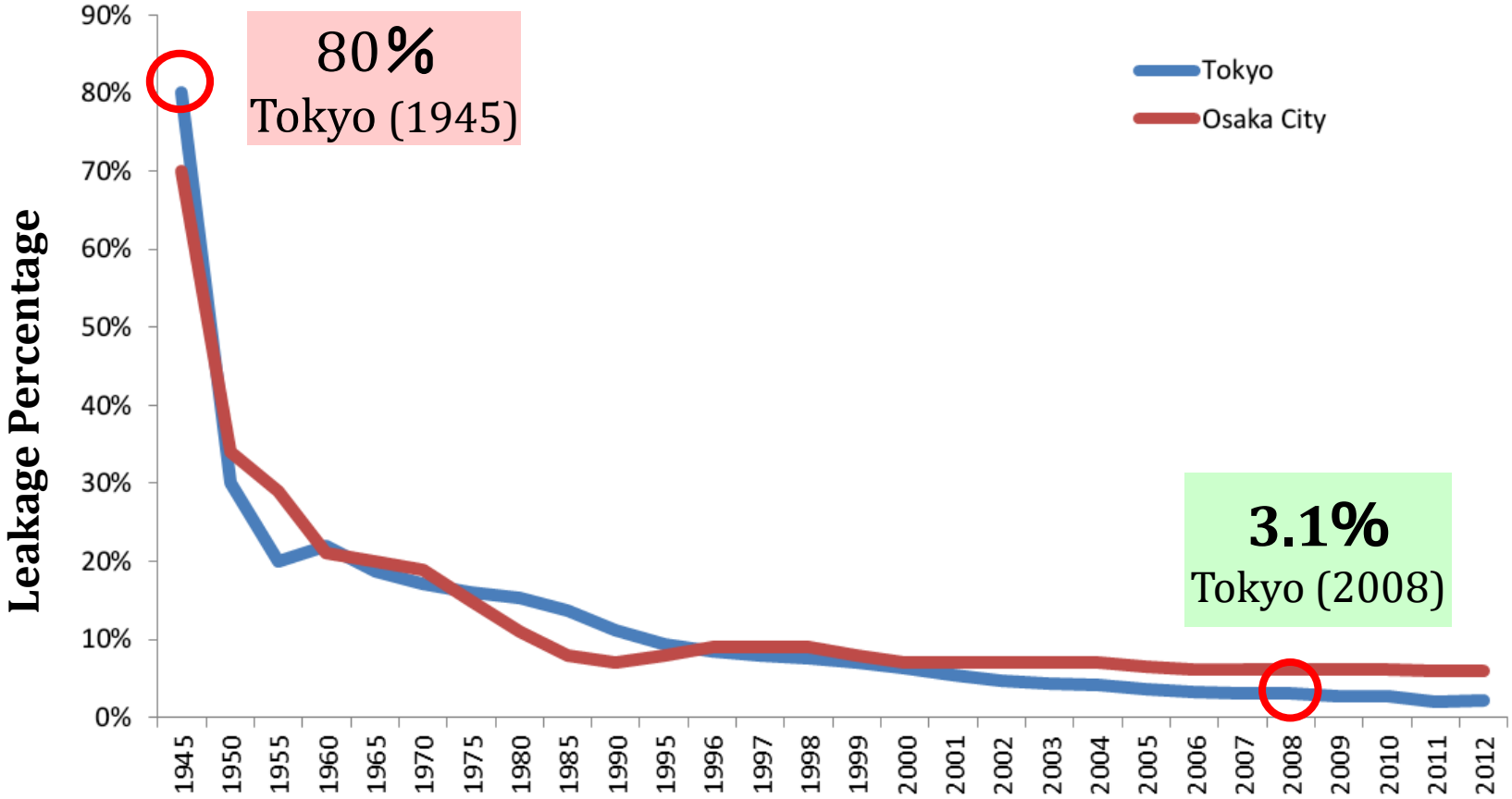
1. Introduction

Drastic reduction in leakage in Japan



Source: Created from the data of Tokyo Metropolitan Government Waterworks Bureau and Osaka Municipal Waterworks Bureau

1. Introduction

Definition of Non-Revenue Water

Water Balance Table of IWA				
System Input Volume	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	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	
			Systematic Data Handling Errors	
		Real Losses	Leakage on Transmission and Distribution Mains	
			Leakage and Overflows at Utility's Storage Tanks	
			Leakage on Service Connections up to point of Customer metering	

1. Introduction

Frequently asked questions from participants of the water supply training courses

Q1. How did Japan reduce leakage from 80% to 3% in some large cities?

Q2. What are the effective measures for reducing NRW?

2. Non-Revenue Water in Japan

(1) Low NRW across the Country

NRW is particularly low in Tokyo (≤4%*), Okinawa, Aichi, Osaka, and Fukuoka Prefectures (≤9%*).

* **NRW** percentage, average in the prefecture

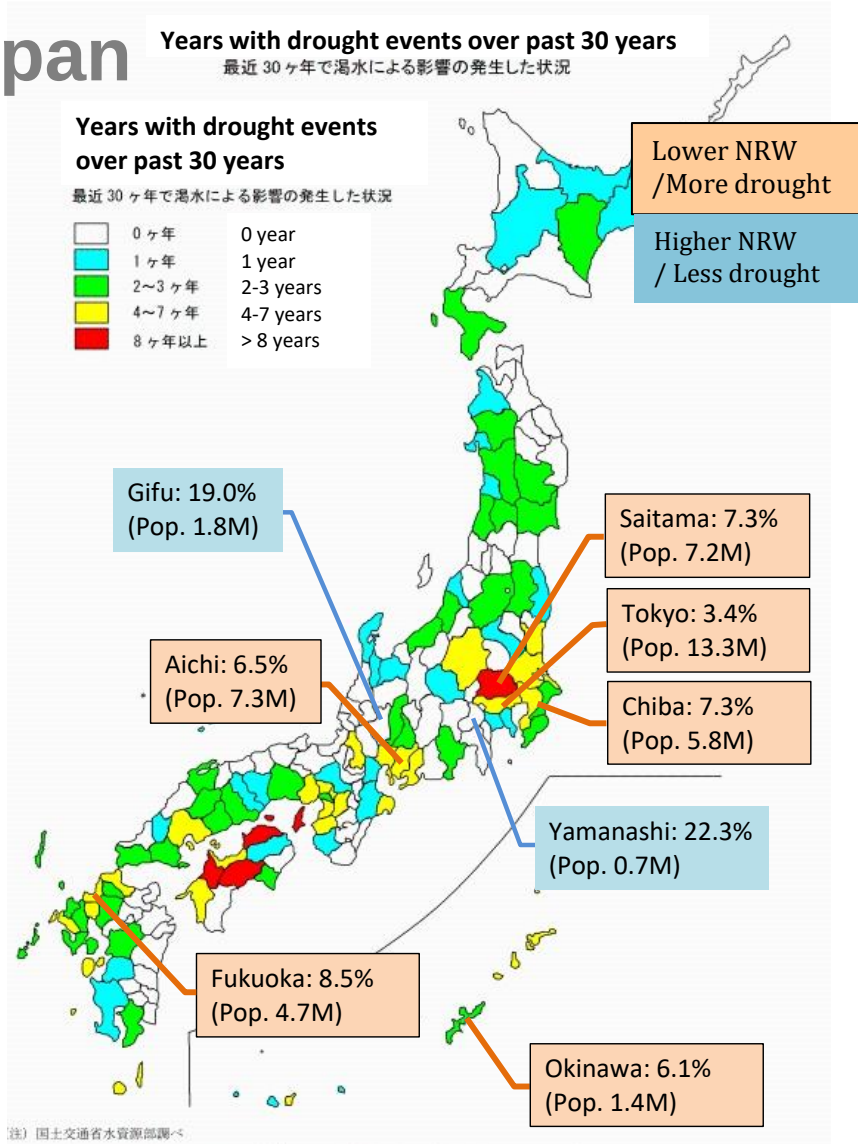
Areas achieving low NRW are...

(1) Major metropolitan areas:

High population density and water demand

(2) Water-scarce areas

(Islands, no major reservoirs etc.)



Relationship between NRW and Draught events

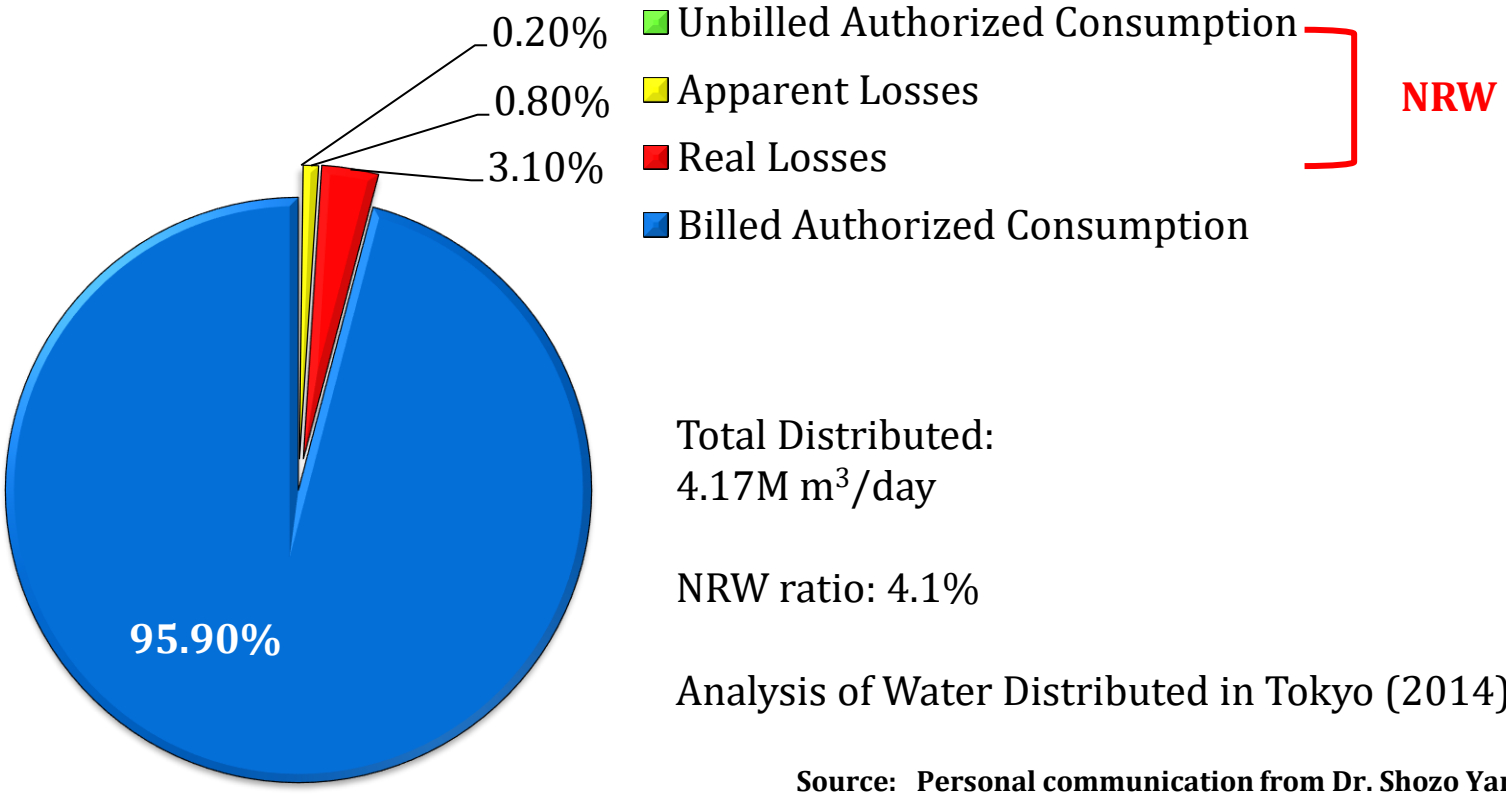
Legend: Name of Prefecture: NRW %(Served Population. Million)

Source: Statistics on Water Supply (2014) and the Ministry of Land, Infrastructure, Transport and Tourism website (the impact of drought in the past 30 years

2. Non-Revenue Water in Japan

(2) Components of NRW

- Illegal connections are rare.
- Apparent/meter loss is at the lowest possible level.
- Focus is on reducing "**leakage**."



Total Distributed:
4.17M m^3/day

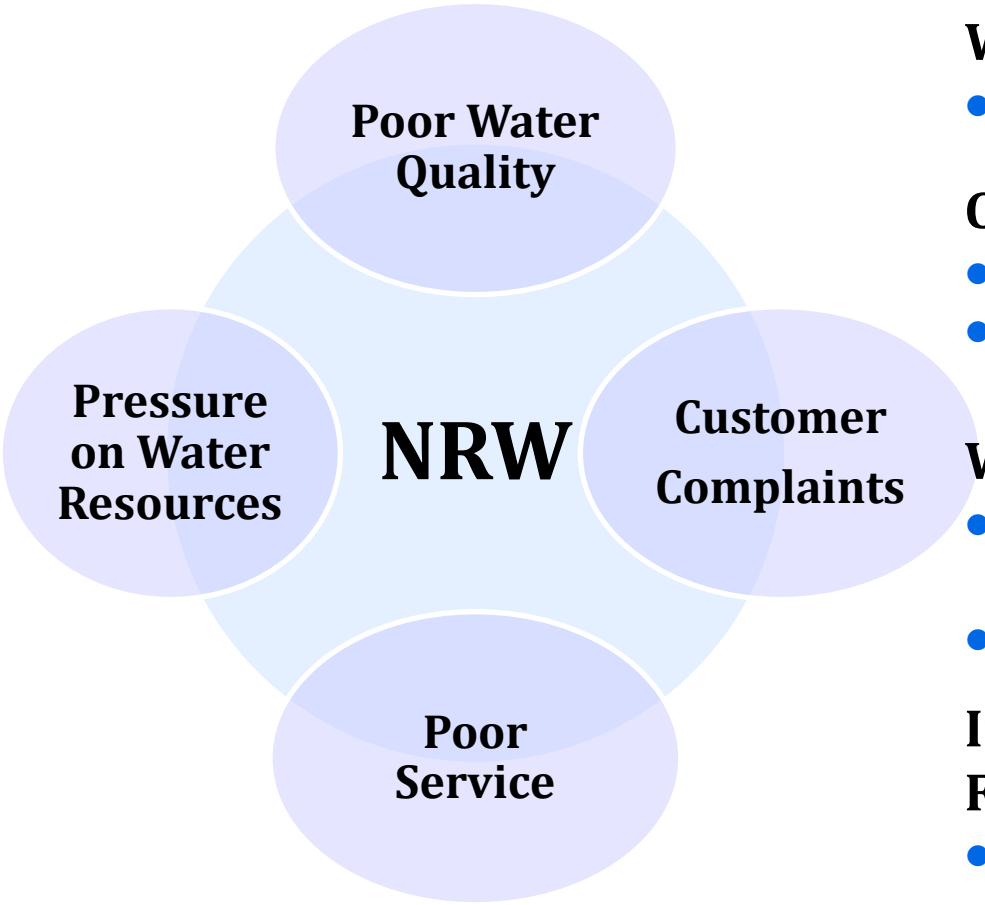
NRW ratio: 4.1%

Analysis of Water Distributed in Tokyo (2014)

Source: Personal communication from Dr. Shozo Yamazaki

3. Causes and Control Measures

(1) Importance of Reducing Non-Revenue Water



Water Quality

- Contamination at leakage point

Customer Complaints

- Complaints of low water pressure
- Low reliability and willingness-to-pay

Water Resources

- Public complaints about water shortage caused by drought
- High cost for water resource development

Impact on Service Efficiency and Financial Management

- Poor service and lost revenue

3. Causes and Control Measures

(2) Causes and Preventive Measures for Leakage

Steps and Categories of the countermeasures for leakage control

Basic measures

- Secure adequate financial sources
- Establish leakage control team
- Conduct surveys, collect & analyze data
- Develop better pipe materials and technology

Corrective measures

- Establish mobile team for prompt repair of burst pipes and other visible leakages
- Schedule for leakage detection and repair

Preventive measures

- Include leakage control as a distinct part of the management plan
- Plan for replacement of old pipes
- Analyze and evaluate pipeline networks
- Implement water pressure control

3. Causes and Control Measures

Quality Control of House Connections

Regulations under the Water Supply Act

Structure and materials for house connections must meet standards. Registration system for the contractors installing service connections.

Quality certification & inspection by third party

Equipment and materials for water supply facilities must meet Japanese Industrial Standards (JIS) and Japan Water Works Association (JWWA) Standards.

Better pipe materials

Changed from lead and galvanized steel to stainless steel, PVC lined steel, 2-layer polyethylene pipes.

3. Causes and Control Measures

Metering error (apparent loss)

Better meter management

Measurement Act requires certain water meter accuracy and replacement every 8 years.

Water meter is protected in a box on loan to the customer from the water utility. It cannot be tampered with, removed or intentionally destroyed.

Meters

Accurate measurement
Less apparent loss

Old Meter Box

Source: (Photo) Nagoya City Waterworks and Sewerage Bureau

4. Importance of Leakage Control

(1) Metering Practices

- **Water shortages due to increasing demands** were common problems for utilities.
- Example in Nagoya
  - **Flat-rate tariff was the main cause of water wastage** because there was no incentive to save water.
  - Started to install meters at all households.
  - Started to manufacture **domestic meters .**

- Importance of metering was fully recognized.
- Supply of quality meter was established before the period of major expansion.
- **"Measurement Act"** (1951) requires appropriate management of meters.
- **Resulted in low apparent losses**

Public Awareness Poster
"Make your kitchen better: A household that values water prospers.
A household that wastes water suffers."

Source: Nagoya City Waterworks and Sewerage Bureau

4. Importance of Leakage Control

(2) WW II Destruction of Infrastructure

- "Leaking like a sieve": 80% leakage in Tokyo water supply networks.
- 90 cities were damaged by air raids, and 1.67 million of 3.13 million km of service pipes were destroyed.

Source : Ministry of Internal Affairs and Communications

Ichinomiya City, Aichi Prefecture After WWII

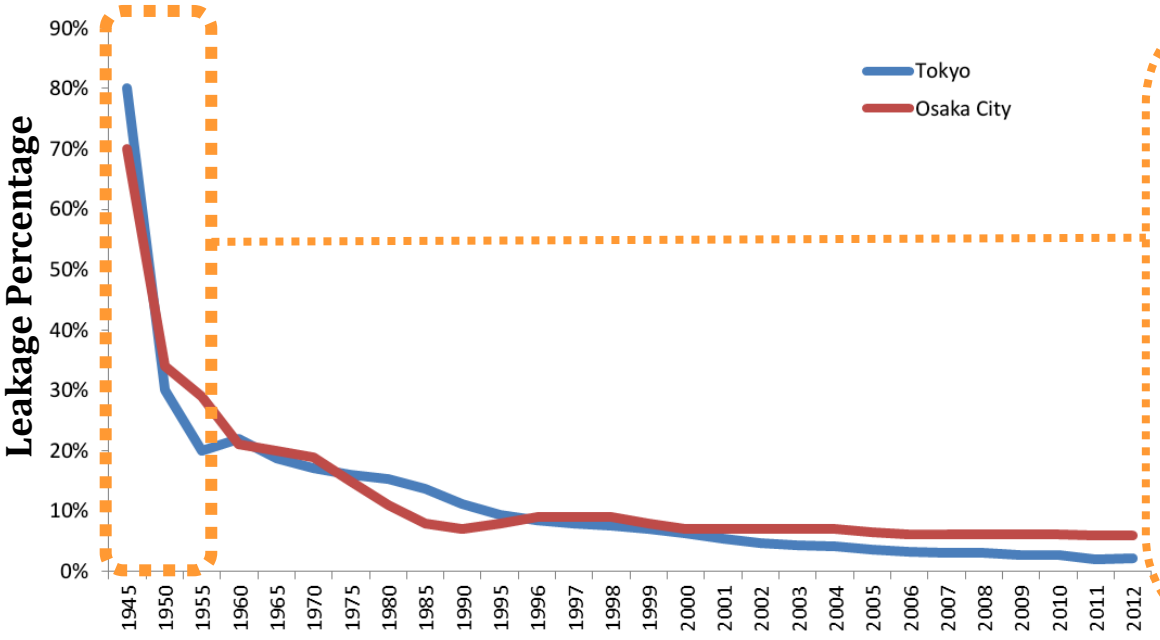
Importance of leakage control was recognized by all water utilities in Japan.

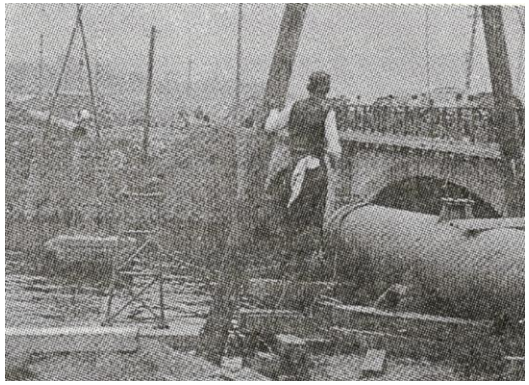
4. Importance of Leakage Control

(2) WW II Destruction of Infrastructure

Post war reconstruction

- Immediate efforts by utilities
- National subsidies (1/3 of expenditures)





Repair work by utilities (partly subsided by national fund)

Source: Photo from "100 years history of modern water supply"

4. Importance of Leakage Control

(3) Water Demand Increase and Water Shortage

- Rapid growth of population and economy from 1950's to late 1970's.
- Severe droughts occurred during the course of demand growth. Strict water supply restrictions were imposed.

Year	Drought Events
1961~65	Tokyo endured close to 5 years of water supply restrictions
1964	Over 8 months of water supply restrictions in Nagasaki
1967	278 utilities rationed water supply due to wide spread drought

Utilities and customers are well aware of the scarcity of water. **Importance of leakage control is clearly recognized.**

Emergency water supply during severe drought in 1964 (Tokyo Olympic year)

Source: Bureau of Waterworks, Tokyo Metropolitan Government

4. Importance of Leakage Control

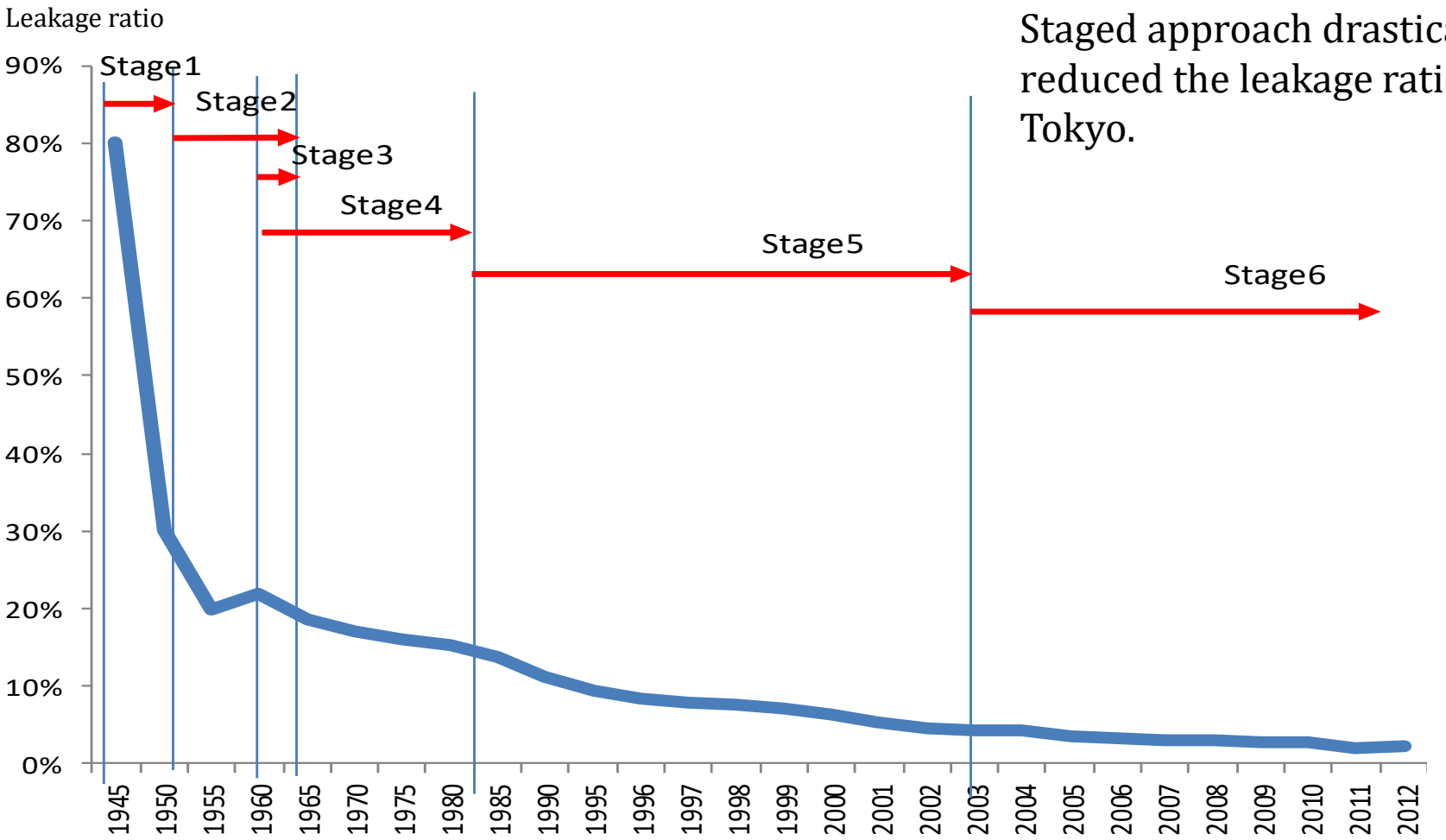
(4) National Policy for Leakage Control

Year	Major Event	Average NRW % (Year)
1960s – 1970s	● Guideline for Leakage Control (JWWA) (1960) ● "Leakage Prevention for Water Supply" (1960) Notice by Ministry of Health	22.4% (1970)
1970s –	● Leakage Prevention Guideline (1977) by JWWA	16.4% (1980)
1980s –	● Enforcement of Leakage Prevention (1990) (Enforce 90% – 95% of effective water ratio)	11.0% (1990)

Guidelines and Notices from National Government promoted leakage prevention

5. Best Practices: Tokyo

(1) Staged Approach to Leakage Management



Staged approach drastically reduced the leakage ratio in Tokyo.

Source: Mr. Shozo Yamazaki

5. Best Practices: Tokyo

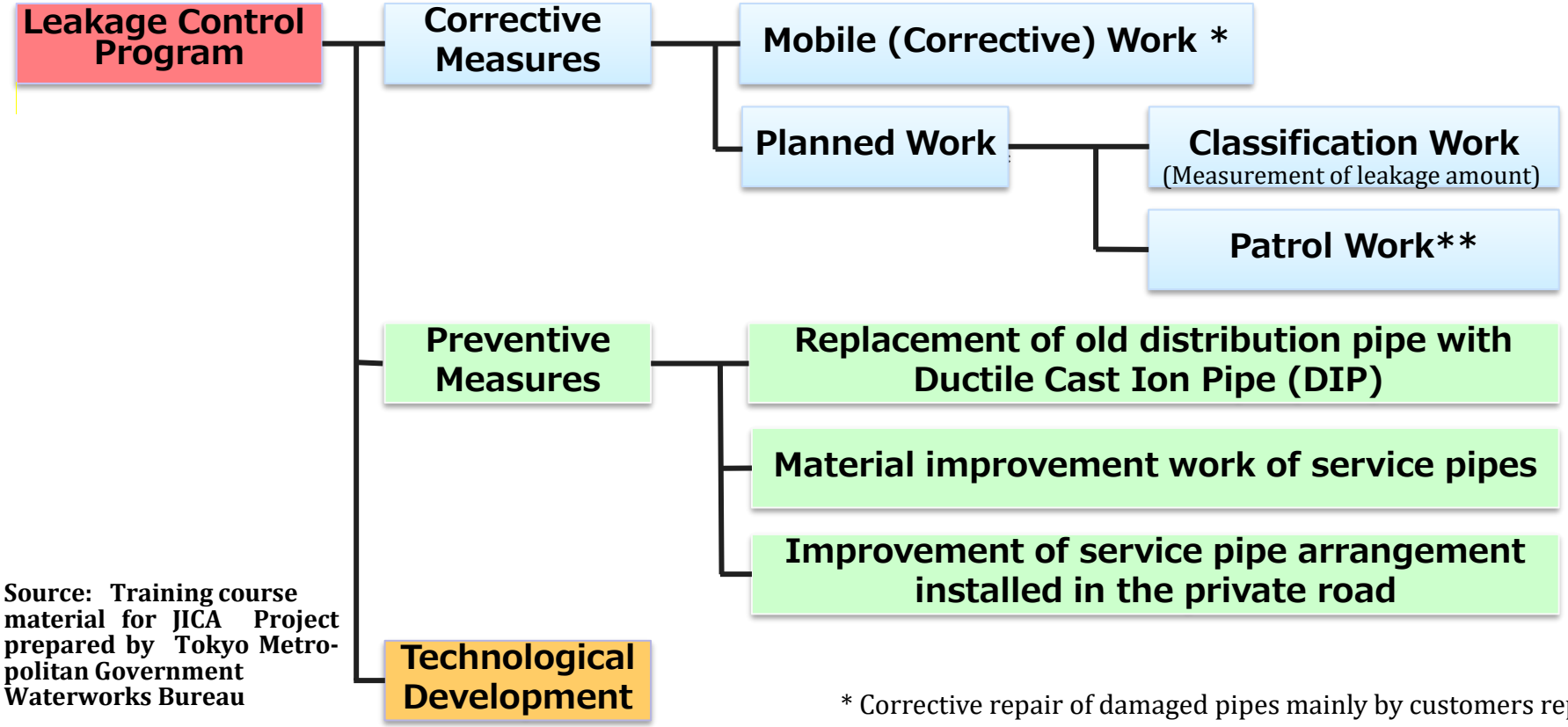
(1) Staged Approach to Leakage Management

Stage	Leakage ratio	Leakage control work	Method
1	>30%	Decrease aboveground visible leakage	Intensive repair activities
2	30%-20%	Decrease underground leakage	Zoning, accurate piping maps, training & utilizing good quality equipment for detection
3	25%-20%	Prevent recurrence of leakage	Increase in leakage control work, starting replacement of deteriorated pipes, use of DCIP
4	20%-12%	Carry out thorough leakage control work	Revision of working method & acceleration of pipe replacement work
5	12%-5%	Improve service pipes	Introduction of stainless steel service pipes which are strong and durable
6	<5%	Maintain low NRW	Systematic pipe replacement and leakage control work based on cost and benefit analysis

Source: Personal communication from Dr. Shozo Yamazaki

5. Best Practices: Tokyo

(2) Early Detection and Repair: Planned and Corrective Work



Source: Training course material for JICA Project prepared by Tokyo Metropolitan Government Waterworks Bureau

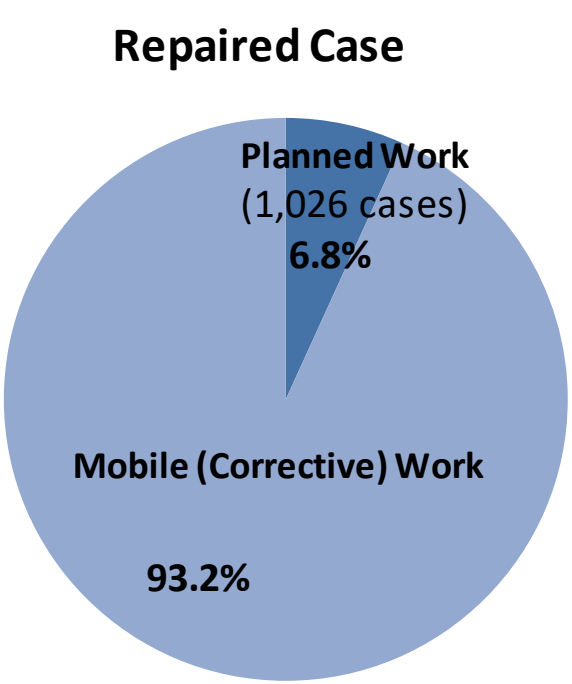
* Corrective repair of damaged pipes mainly by customers report
** Scheduled patrol including repair work for underground leakages

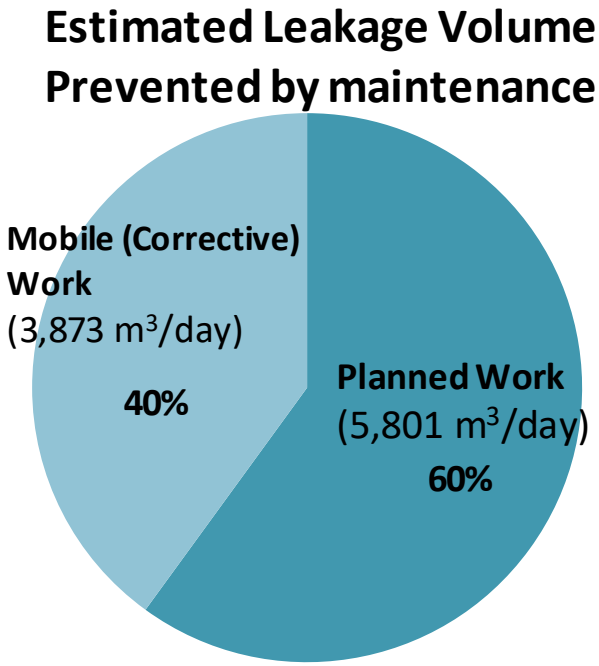
***Corrective* and *preventive* measures - pillars of leakage control**

5. Best Practices: Tokyo

(2) Planned Work for Leakage Prevention

Planned work consists of 6.8% of total repairs but fixes 60% of the leakage.





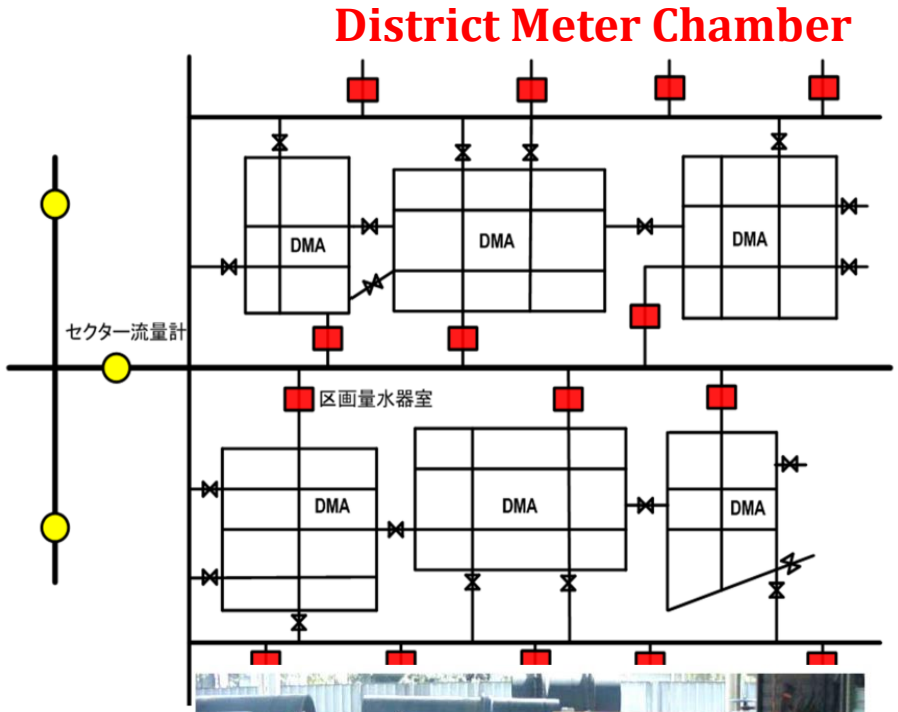
Source: Training course material for JICA Project prepared by Tokyo Metropolitan Government Waterworks Bureau

Planned work is an efficient measure for leakage prevention

5. Best Practices: Tokyo

(3) Selective Measurement by Distribution Block

- Distribution area is divided into blocks with 1,100 households in each block.
- Each block is remotely monitored by district flow meter.
- Minimum Night Flow (MNF) is recorded.



Schematic of distribution block and picture of district meter with telemetering function

Source: Based on training course material for JICA Project prepared by Tokyo Metropolitan Government Waterworks Bureau

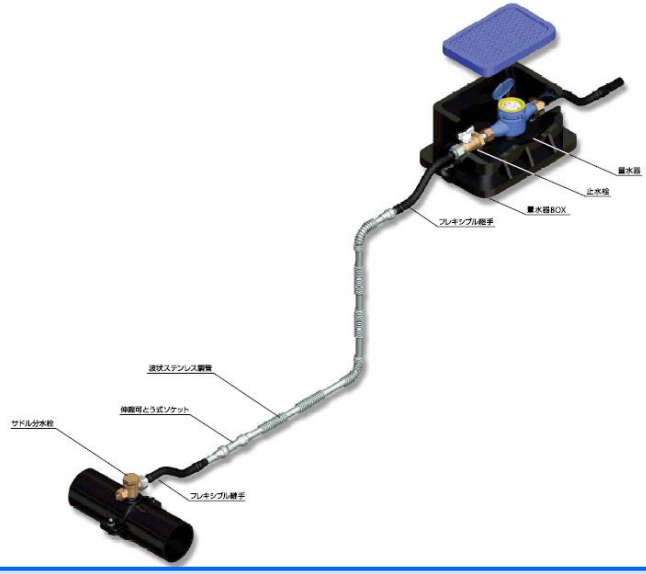
5. Best Practices: Tokyo

(4) Planned Pipeline Replacement and Improved Pipe Materials

More than 95% leakage occurred at service pipes

Planned pipe replacement and improved pipe materials

Ferrule with stainless steel saddle



Flexible service connection

Source: Based on training course material for JICA Project prepared by Tokyo Metropolitan Government Waterworks Bureau

6. Lessons Learned (1)

- **(Need for Leakage Prevention)** Japanese water utilities recognize the importance of leakage control and prevention because of their experience with infrastructure destruction during the war, severe droughts, and water restrictions.
- **(Leakage Control for Reducing NRW)** The major cause of NRW in Japan is leakage. Utilities have dramatically improved NRW by reducing leakages. It is important to install meters and analyze water flow, locate leaks and develop control measures. This requires a coordinated effort among various work units within the utility.
- **(Accuracy of Meters)** The Measurement Act requires replacement of water meters every 8 years and utilities are obliged to keep them in good working order under the Water Supply Act. Metering errors can be kept to a minimum with a strong legislative framework.

6. Lessons Learned (2)

- **(Progressive Leakage Control)** An active leakage control program can start with improved response to repairing visible leaks. Then the activities can shift to early detection of leaks not yet visible above ground, and eventually to systematic planned replacement of aging pipes. Planned pipeline replacement and improved pipe materials is effective for NRW reduction.