Knowledge Sharing Seminar

Overview of Taiwan Water Corporation's Water Loss Management and Smart Water Management

Yu-Lin YUEH

Deputy Director, Department of Water Supply

Taiwan Water Corporation

Po-Yuan TSAI

Section Chief, Department of Water Loss Management, Taiwan Water Corporation

Paul Y. CHUO

Deputy General Manager, Stantec Consulting Services (MWH Global)

Overview

I. About TWC

II. Water Loss Management

III. Smart Water Management

I. About TWC

History of Taiwan Water Corporation (TWC)

- Before 1974, most cities, counties or towns in Taiwan had their own water treatment plants
- In 1974, TWC was set up by merging 128 water treatment plants for increasing overall operational efficiency, and became a public enterprise
- In 1999, TWC has become a state-owned enterprise set up under Ministry of Economic Affairs (MoEA)

I. About TWC

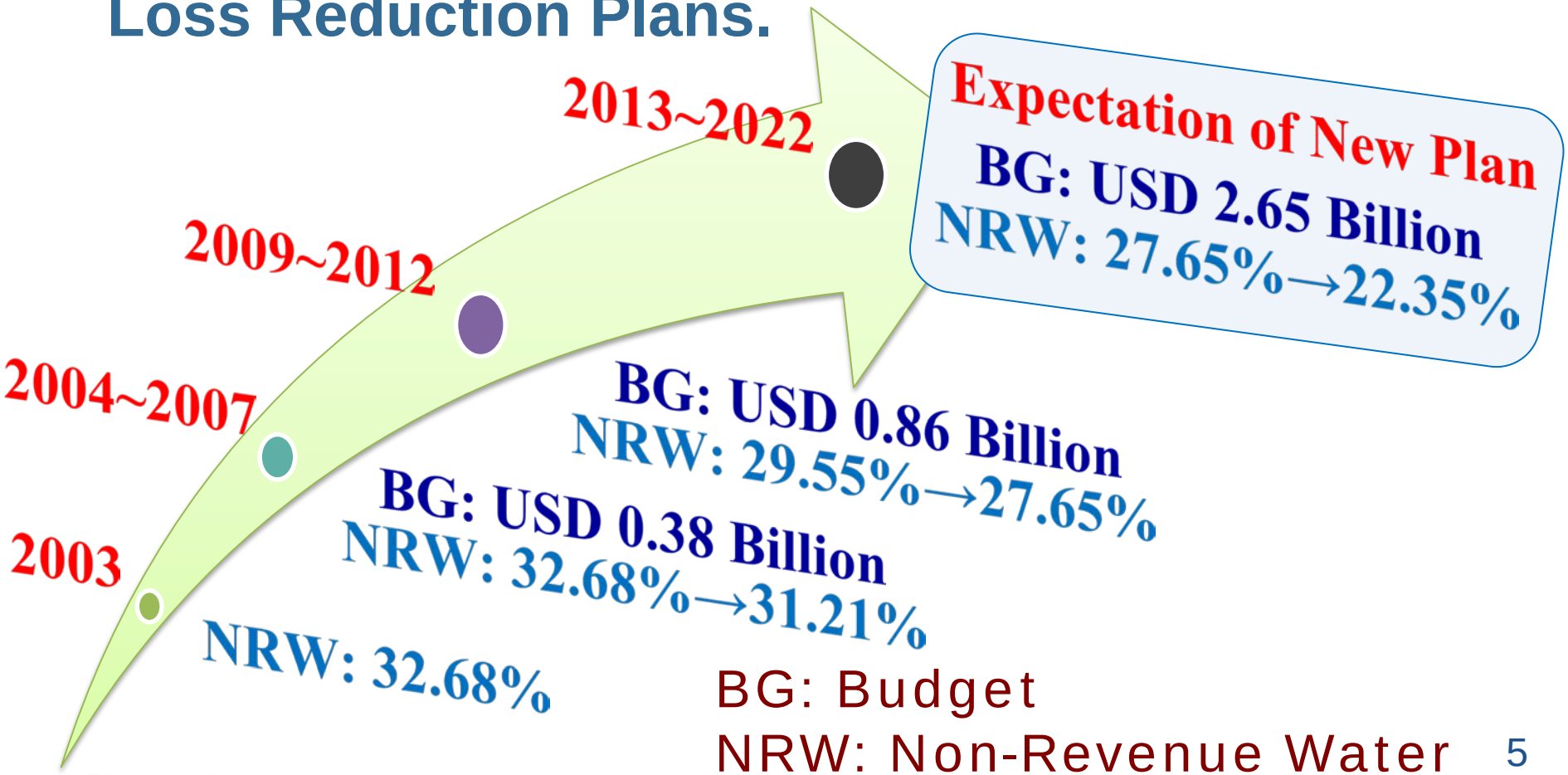
Statistics

	by the end of 2017
Water Supply Systems	144
Water Supply Capacity	11.82 million CMD
Average Daily Water Supply	8.79 million CMD
Percentage of Population Served	92.76%
Customers	6.98 million
Pipe Length	61,458 kilometers
Average Water Tariff of Taiwan (surveyed by IWA, 2016)	USD 0.308/M^3 (one of the lowest in the world)

I. About TWC

■ Water Loss Reduction Plan

➢ Since 2004, we have been implementing Water Loss Reduction Plans.



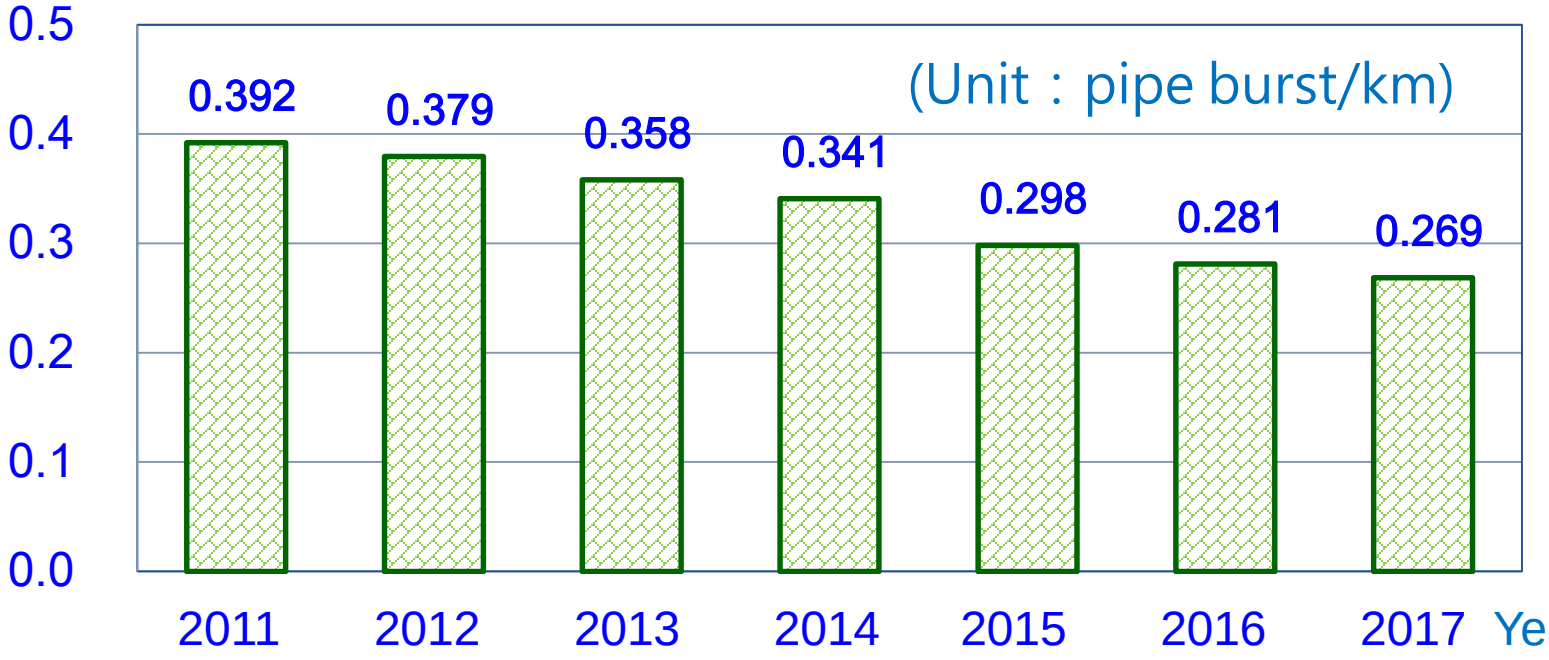
BG: Budget

NRW: Non-Revenue Water

I. About TWC

■ Achievement

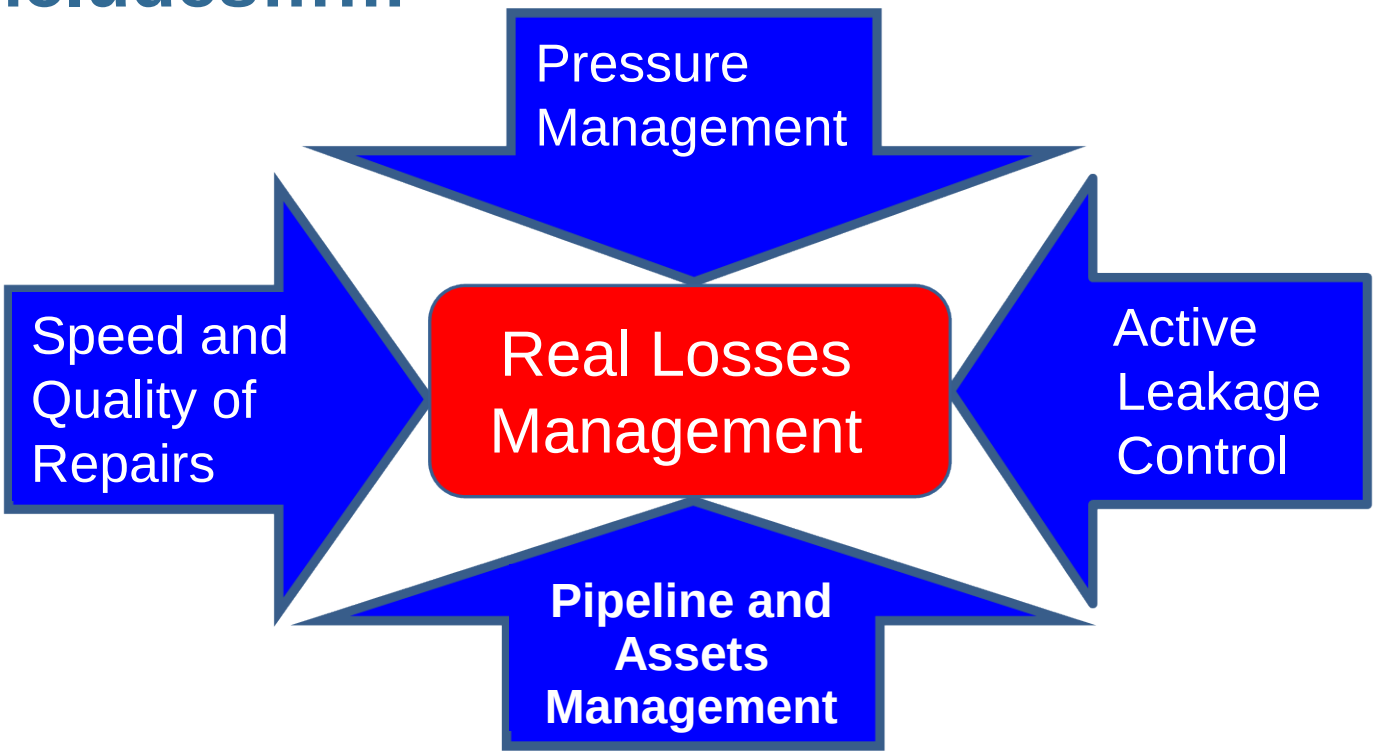
- ➢ The NRW has come down from 32.68% (2004) to 23.59% (2017).
- ➢ Pipe burst frequency has come down from 0.392(2011) to 0.269(2017).



I. About TWC

Real Losses Management Strategies

- We follow best practice in the Water Loss Reduction Plan.
- It includes……



II. Water Loss Management

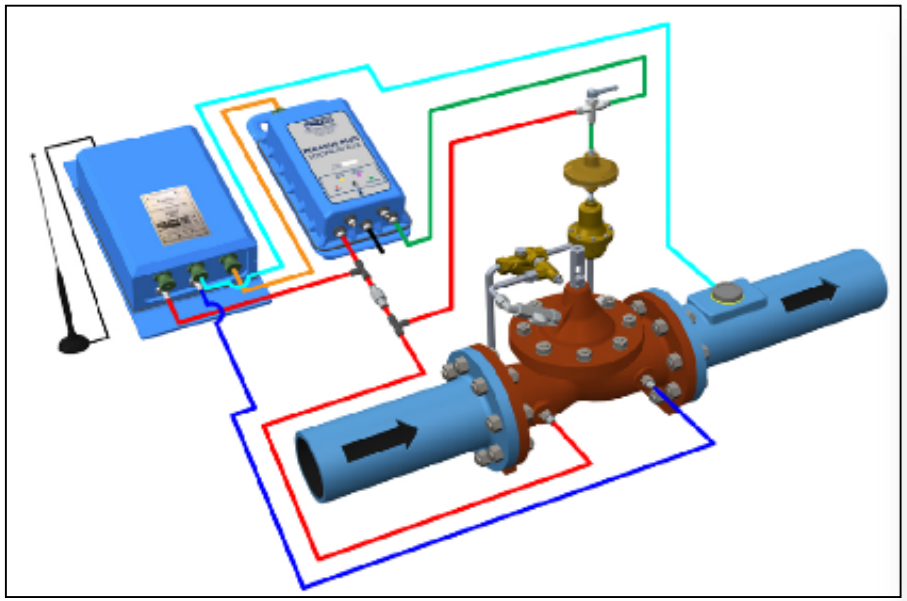
Water Pressure Management

- **Our Strategies include...**
  - installing Variable-frequency Drives in water treatment plants and pumping stations
  - establishing water pressure monitoring stations
  - installing pressure reducing valves (PRV)

II. Water Loss Management

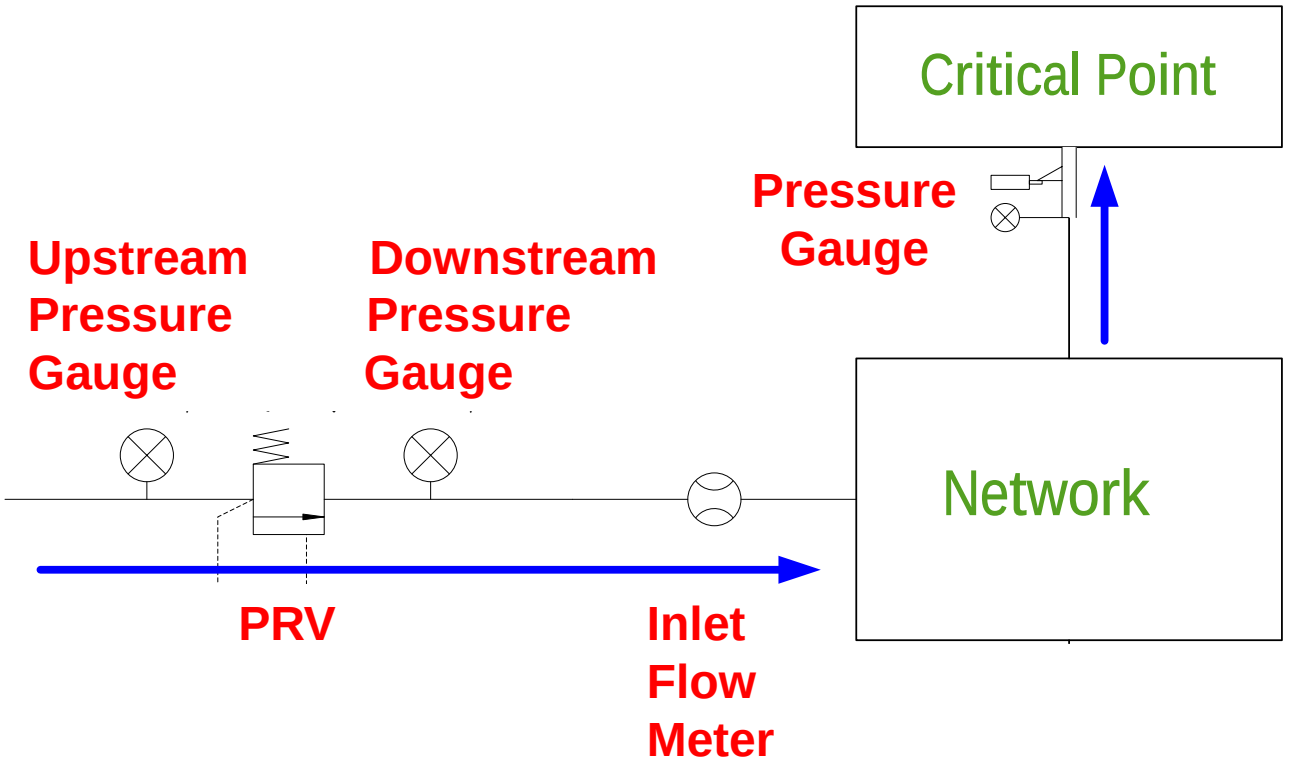
- installing Advanced Water Pressure Control System

  - It means installing an advanced water pressure controller on the pressure reducing valve (PRV) to adjust outlet pressure for meeting critical point customer's need.



II. Water Loss Management

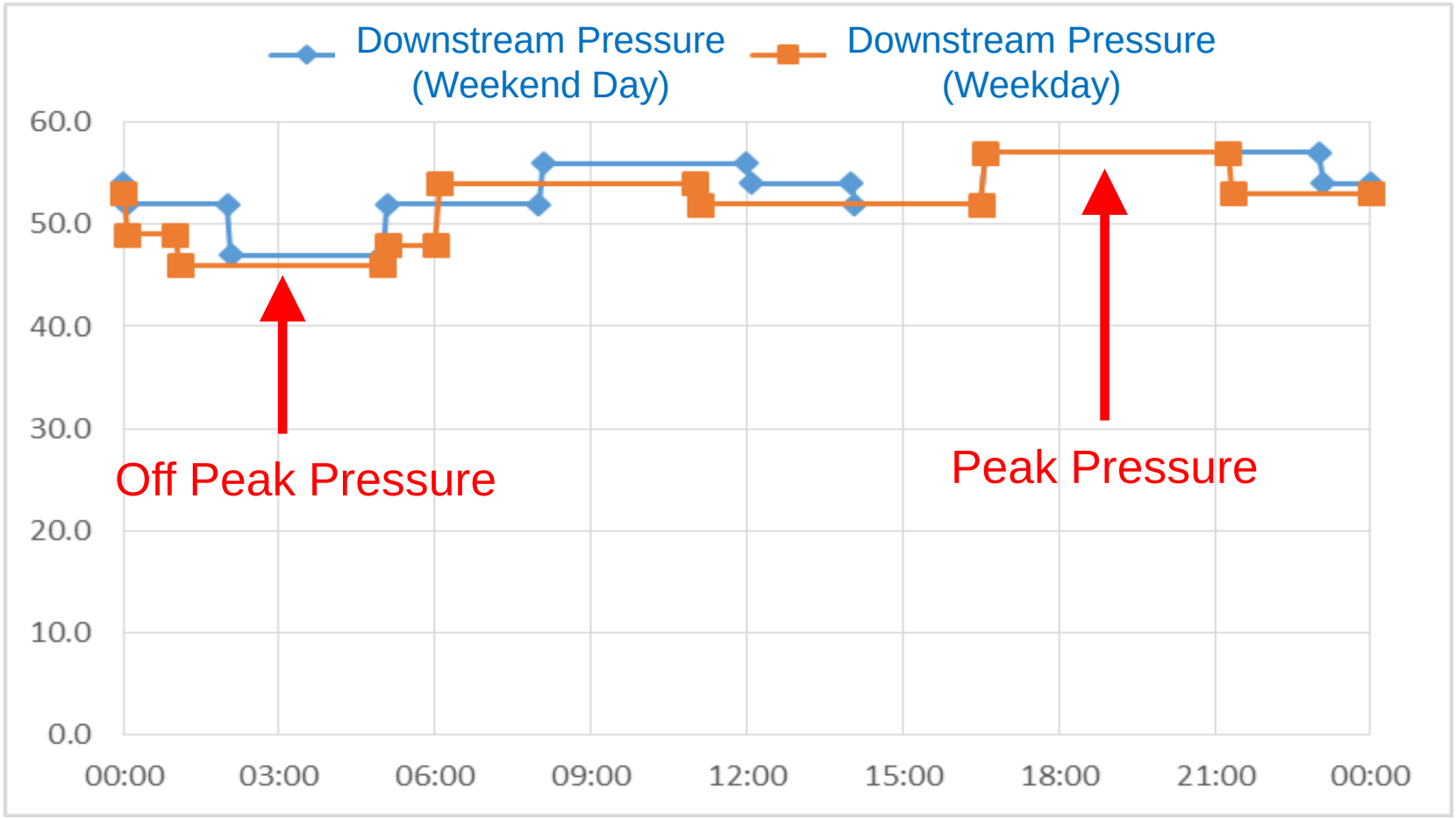
Case Study: Gong-guan DMA, Miaoli County, Taiwan

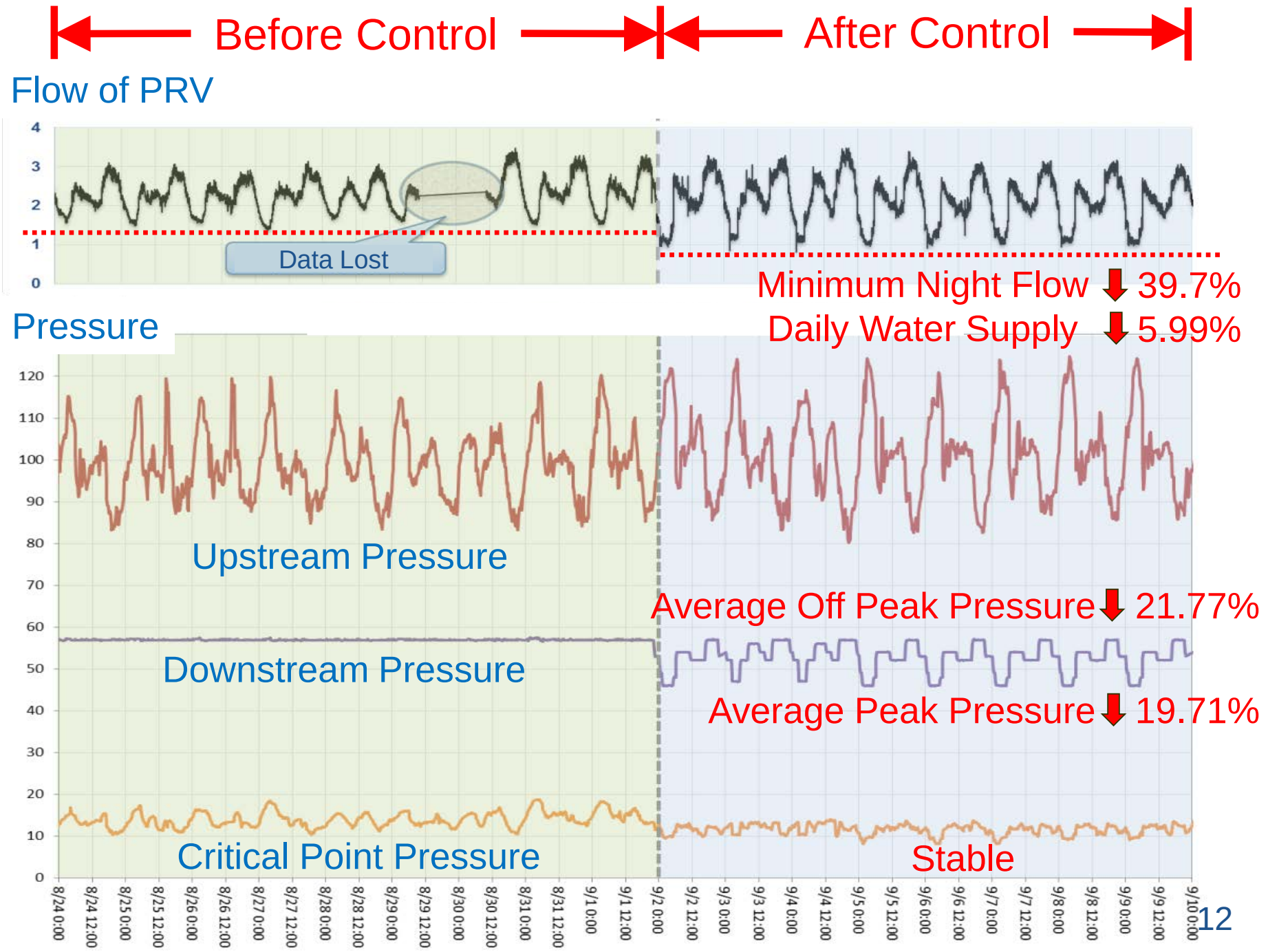


- Isolated small zone
- Gravity water supply
- ϕ300m/m PRV installed
- Upstream pressure 8~9 kg/cm^2
- Downstream pressure 6 kg/cm^2
- 3,500 customers
- Water supply 3,000 CMD
- Elevation of critical point is higher than PRV

II. Water Loss Management

We adopted time-based modulation setting of this advanced water pressure controller …




Before Control
After Control
Flow of PRV
Data Lost
Minimum Night Flow ⬇ 39.7%
Daily Water Supply ⬇ 5.99%
Pressure
Upstream Pressure
Average Off Peak Pressure ⬇ 21.77%
Downstream Pressure
Average Peak Pressure ⬇ 19.71%
Critical Point Pressure
Stable

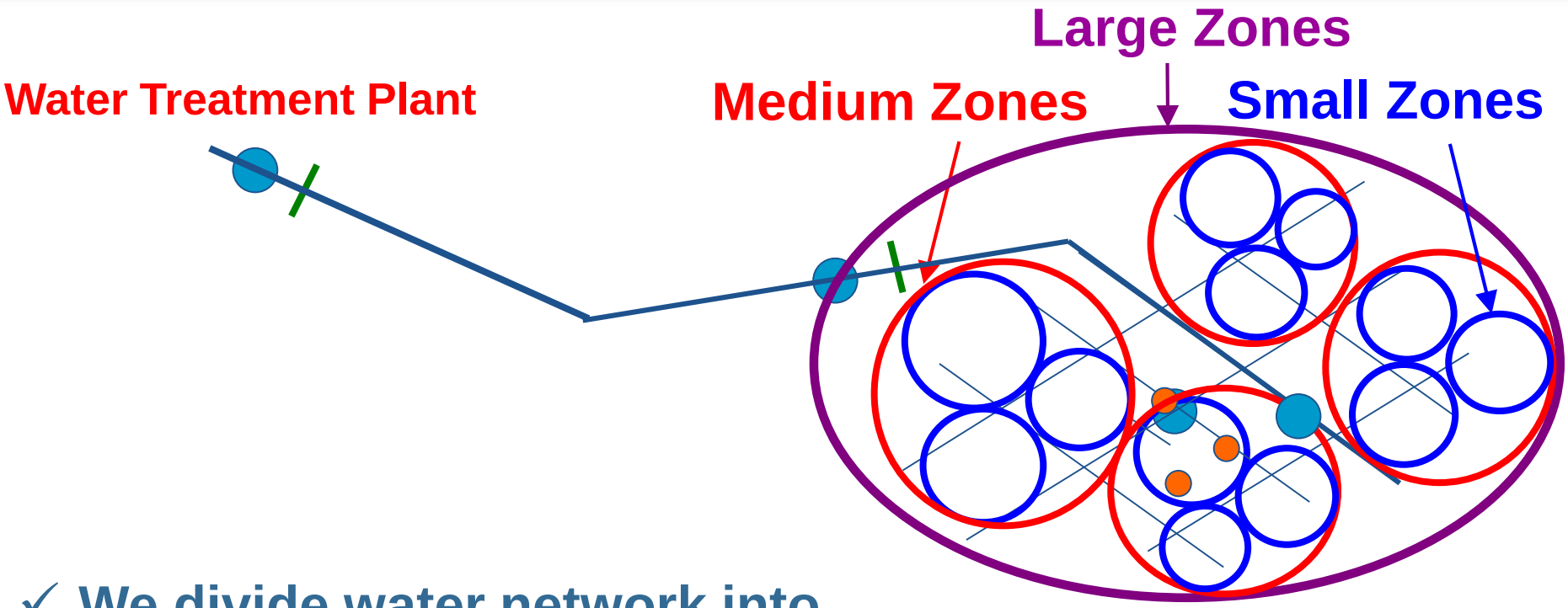
II. Water Loss Management

Active Leakage Control

- **Our strategies include...**
  - **implementing Annual Water Loss Detection Plan**
  - **establishing and maintaining District Metered Areas (DMAs)**

- **DMA means a hydraulically isolated sub-zone in a distribution network for which the water consumption is monitored by water meters.**

II. Water Loss Management



- ✓ We divide water network into 3 levels of DMAs.
- ✓ We have established around 2000 DMAs since 2006.

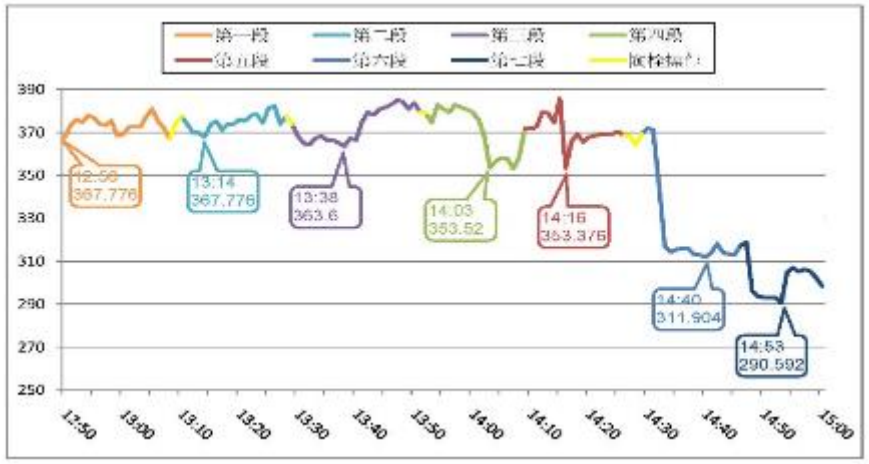
Water Pressure Monitoring Station

Meter

Valve

II. Water Loss Management

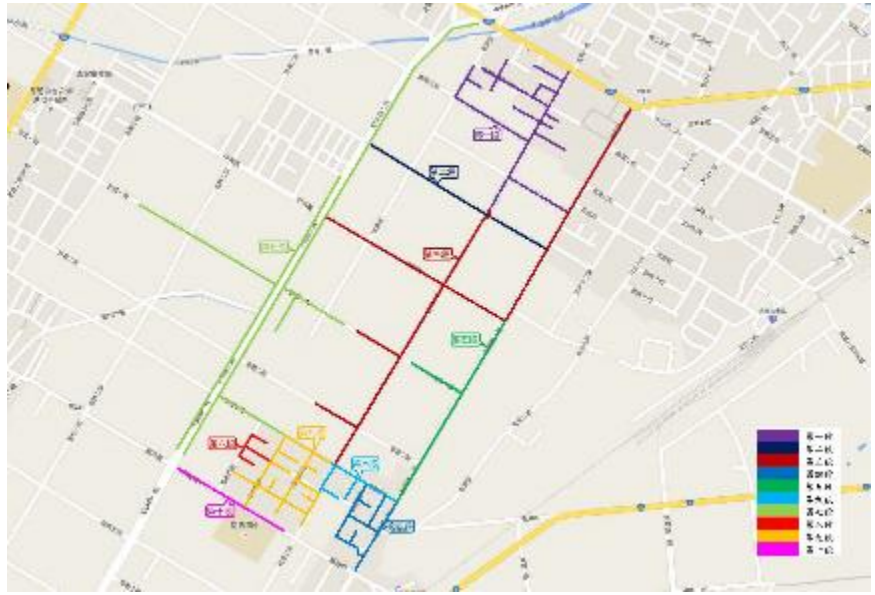
Step Test



管段	漏水量	口徑(mm)	管種	管線年份
一	34.6CMD	80,100,200	PVCP,DIP,DIP	2002,2012,2006
二	16.2CMD	50	PVCP	1987
三	74.9CMD	80,200,200,200	PVCP,DIP,DIP,DIP	1989,1998,2006,2012
四	45.1CMD	80	PVCP	無資料
五	164.5CMD	200	DIP	1998
六	72.9CMD	80,200	PVCP,DIP	無資料,1999
七	430.6CMD	100,200,300,400	PVCP,DIP,SP,SP	無資料,1999,1996,1996
八	16.6CMD	80	PVCP	無資料
九	33.1CMD	100,200	PVCP,DIP	無資料,1999
十	132.5CMD	300	DIP	1999
合計	1020.9CMD			

Leakage Calculation

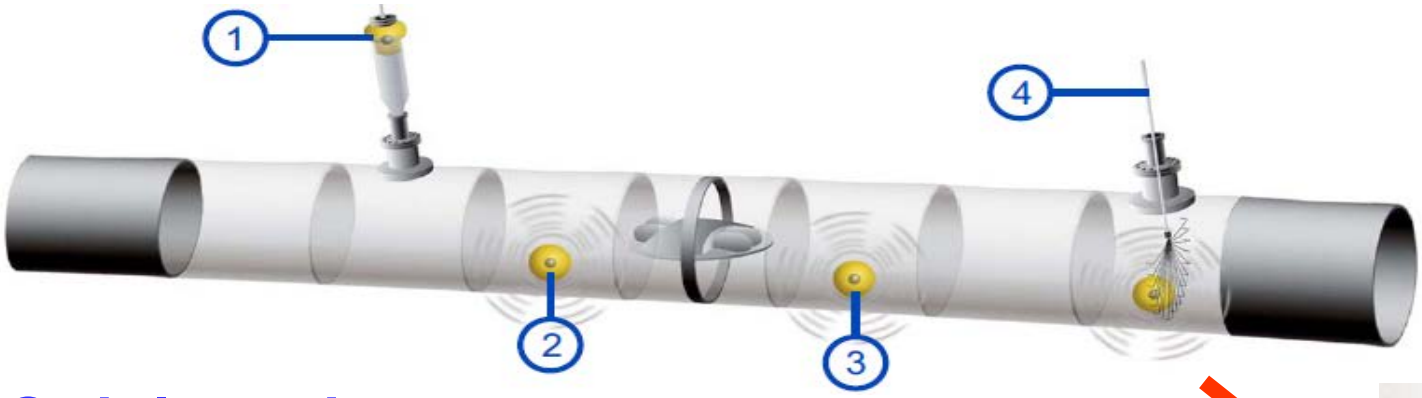
- ✓ **In case of leakage recurrent or high frequency leakage in DMAs, we'll replace those pipe sections ASAP.**



Distribution Diagram of Leakage

II. Water Loss Management

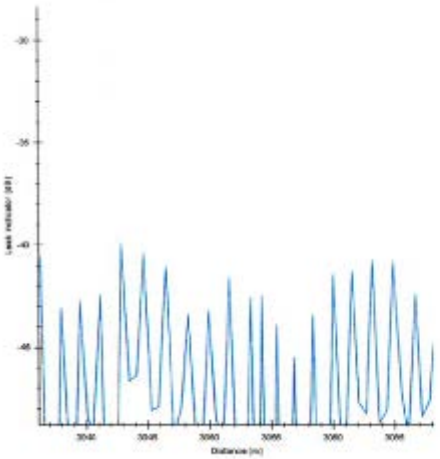
- **Case Study:** We have adopted SmartBall leakage detection technology in ***large diameter*** pipelines …
  - for leakage detection and condition assessment
  - innovative free-swimming in-line leakage detection technology designed to operate in a live pipeline

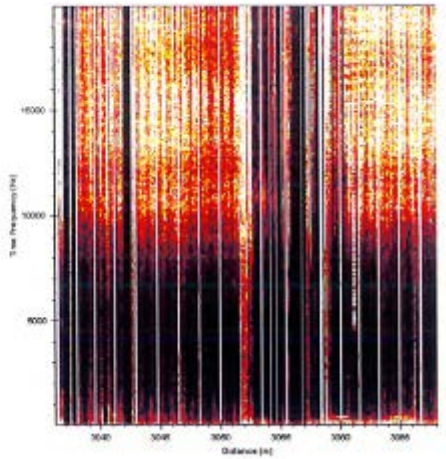


①- inlet point
②③- leakage detection
④- retrieval point

source: http://www.puretechltd.com

- ✓ **The pilot project was in north of Taiwan in 2011.**
- ✓ **We found that ϕ1,000mm PCCP was leaking, but the leaking points were difficult to detect.**
- ✓ **Pipe Length of Leakage Detection was 6.5km.**





Sound spectrum

II. Water Loss Management

- **Result:**

We found 4 leaking points.

a leaking exhaust valve

II. Water Loss Management

Speed and Quality of Repairs

- **Our strategies include ...**
  - **establishing leakage repair management information system to record repair information, location of leaking point, expenditure, etc.**

II. Water Loss Management

- increasing Leakage Repair Rate

- **Leakage Repair Rate: the proportion of leakage that was repaired in 1 or 3 days**

Year	Leakage Repair Rate in 1 day	Leakage Repair Rate in 3 days
2013	92.92%	99.53%
2014	90.86%	98.60%
2015	92.02%	98.50%
2016	92.31%	97.47%
2017	95.35%	99.03%

II. Water Loss Management

Pipeline and Assets Management

- **Our strategies include ...**
  - **On average we replace 800km pipelines each year (around 1.3%).**
  - **We set out rules for pipe replacement. The main indicators are "age", "leakage frequency (leaking points/km)", and "material".**

II. Water Loss Management

- We adopted DIP (diameter under ϕ2000mm) or PCCP (diameter over ϕ2000mm) as distribution pipe , and we also adopted HIWP, SSP, or DIP (diameter under ϕ100mm) as service pipe.
- According to our analysis, 70% of leaking points were found in the service pipes. We replace distribution pipes together with connected service pipes.

III. Smart Water Management

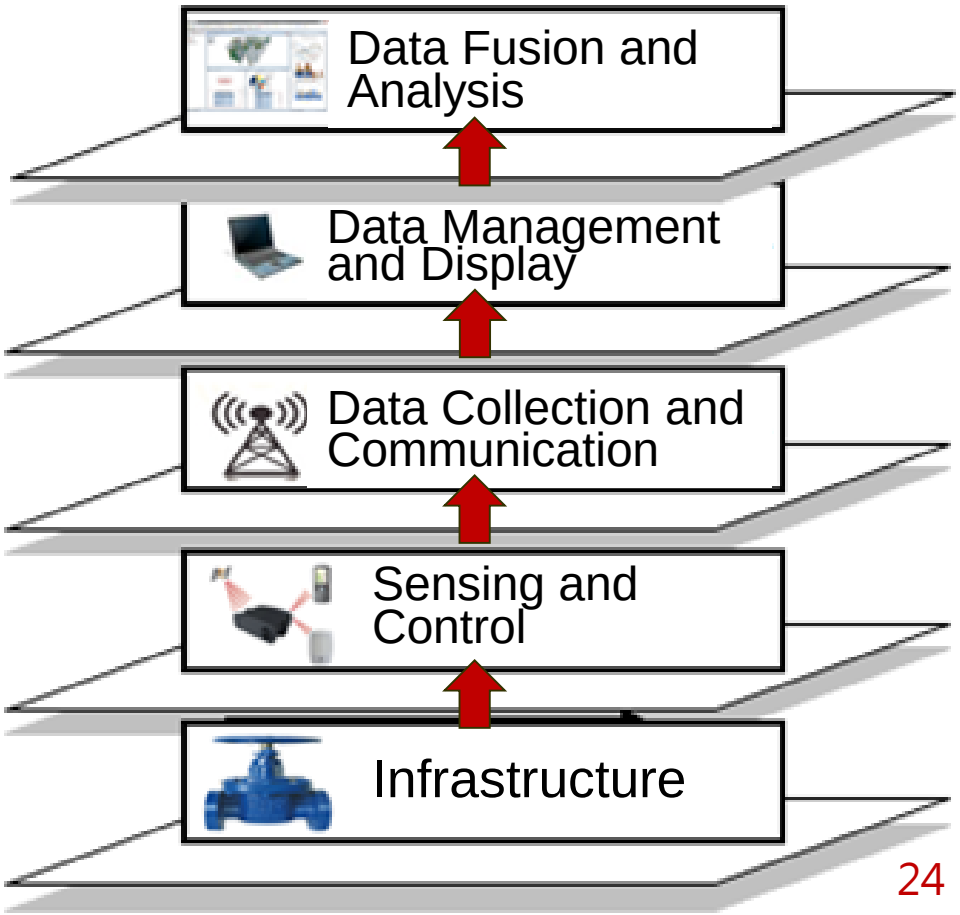
III. Smart Water Management

Basic Framework of Smart Water Management

Management Needs

- Customer Service
- Decision-Making
- Data Management
- Water Supply Monitoring
- Pipelines and Assets Management

Smart Water Framework



III. Smart Water Management

Pipeline and Assets Management

➢GIS establishment

- 2004 --- Set up a “GIS Promotion Task Force”
- 2005 – 2015 --- digitalized all the paper maps into digital format
- 2016-2017：We had upgraded GIS software to free and open-source software

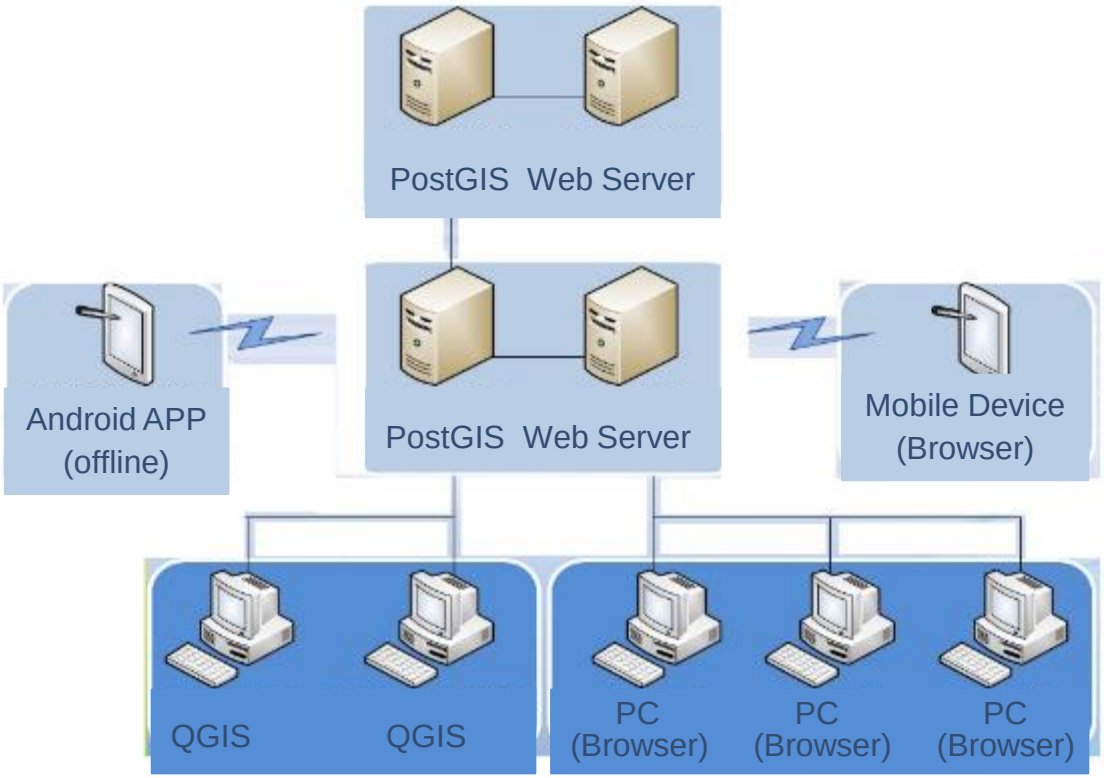
- **Previous GIS was costly to upgrade when new OSs were announced each time. After evaluation, we adopted free and open-source GIS software (QGIS).**

III. Smart Water Management

- **GIS Renewal Project**

Software Architecture

- Drawing Tools (standalone version) QuantumGIS
- Database Software Postgre SQL/PostGIS
- Web Server Mapserver



III. Smart Water Management

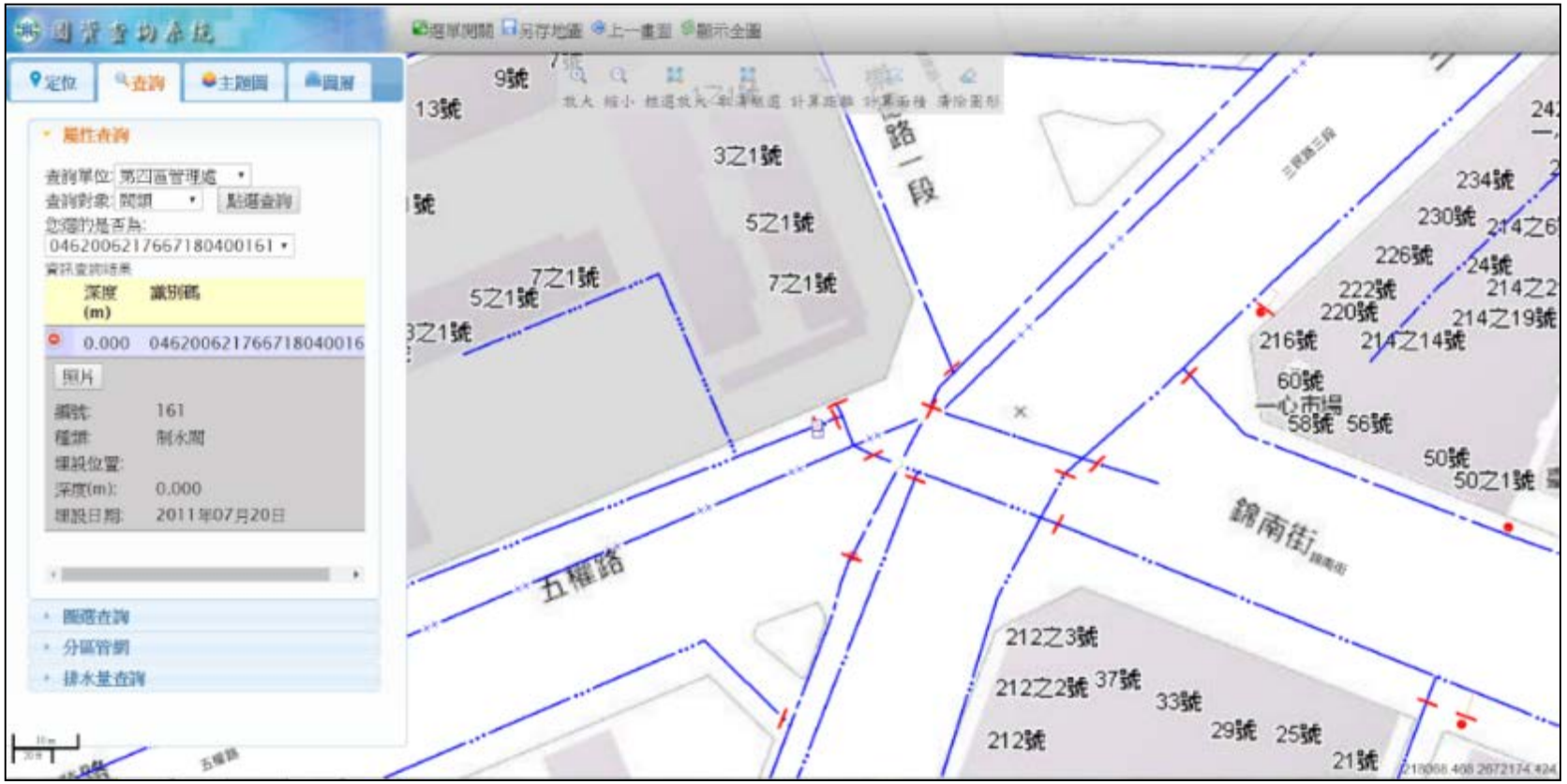
- The spatial database consists of many map layers.

NO.	Layer Code	Layer Name
1	eumeter	Customer Meter
2	eupipe	Service Pipe
3	hydrant	Fire Hydrant
4	hydrantl	Hydrant Pipe
5	saddle	Tapping Saddle
6	meter	Bulk Meter
7	valve	Valve
8	manhole	Manhole
9	pipe	Pipe
10	station	Monitoring Station
11	stationl	Water Treatment Plant
12	smallarea	District Metered Area

Spatial Database

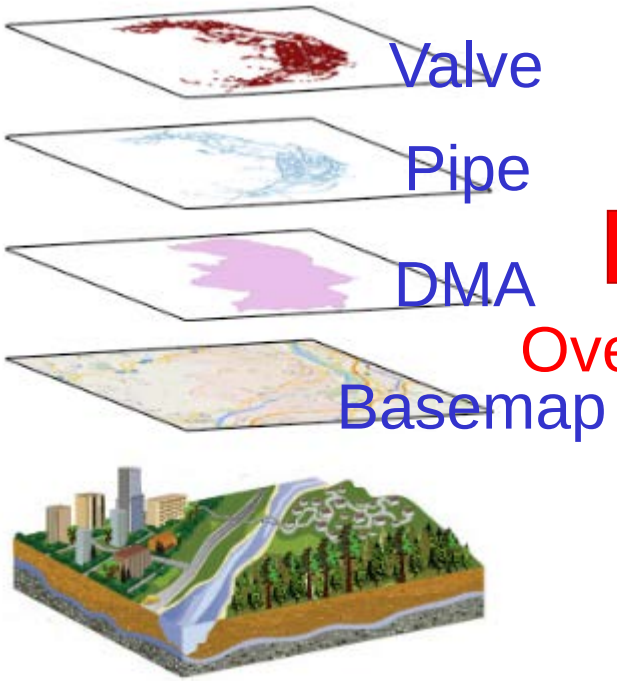
III. Smart Water Management

- The basic function is to display spatial data on the map.



III. Smart Water Management

- We also overlap the spatial data to create theme maps.



Overlapping

III. Smart Water Management

- **Example:** We overlap the layers of material, age, information of leakage points, etc., for evaluation of pipe replacement.

III. Smart Water Management

- Our GIS includes Mobile Equipment Inspection System for valves and hydrants management.

III. Smart Water Management

- We also provide API (Application Programming Interface) for sharing spatial data with external systems.

TwcApi

SOAP 1.1

下列是 SOAP 1.1 要求與回應的範例。預留位置顯示之處必須代入實際的值。

```
POST /TWCApi/API.asmx HTTP/1.1
Host: localhost
Content-Type: text/xml; charset=utf-8
Content-Length: length
SOAPAction: "http://www.water.gov.tw/Coordinate"

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http:
  <soap:Body>
    <Coordinate xmlns="http://www.water.gov.tw/">
      <crs>string</crs>
      <x>double</x>
      <y>double</y>
    </Coordinate>
  </soap:Body>
</soap:Envelope>
```

Example: sharing spatial data with Water Outage Query System

III. Smart Water Management

Water Supply Monitoring & Data Management

1999 → 2002 → 2007 → 2009 → 2011 → 2013 → 2014 → 2017

➢Standalone Monitoring System

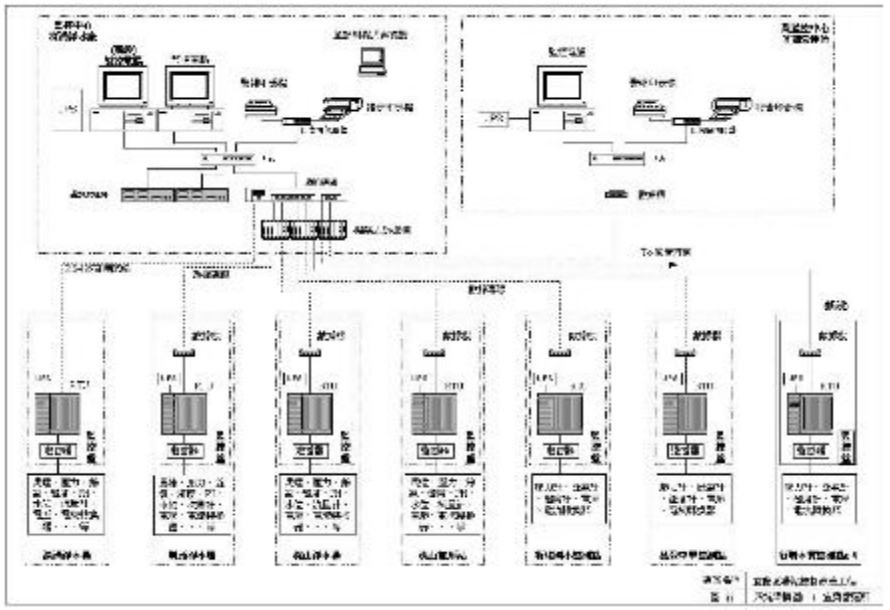
- adopted PLCs (Programmable Logic Controller) to connect sensors with computers
- **standalone system for single water treatment plant without connecting to branch office**
- **User Interface of DOS**
- connected to external monitoring system by communication card

III. Smart Water Management

1999 2002 2007 2009 2011 2013 2014 2017

➢Client-Server SCADA System (1st Generation)

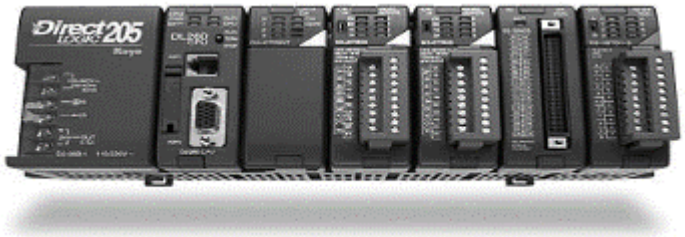
- adopted Client-Server architecture to integrate monitoring terminals of WTPs and branch office
- Graphic User Interface of Windows
- monitoring terminals were connected to the others by dial-up internet connection (low speed)
- new and old PLCs coexisted

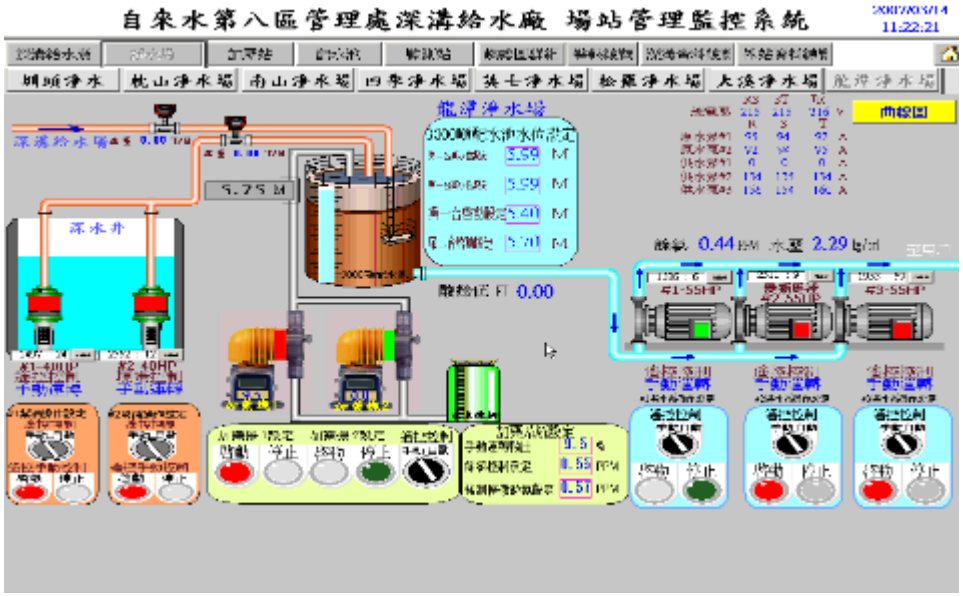


III. Smart Water Management

1999 2002 2007 2009 2011 2013 2014 2017

➢Integrated SCADA System (2nd Generation)





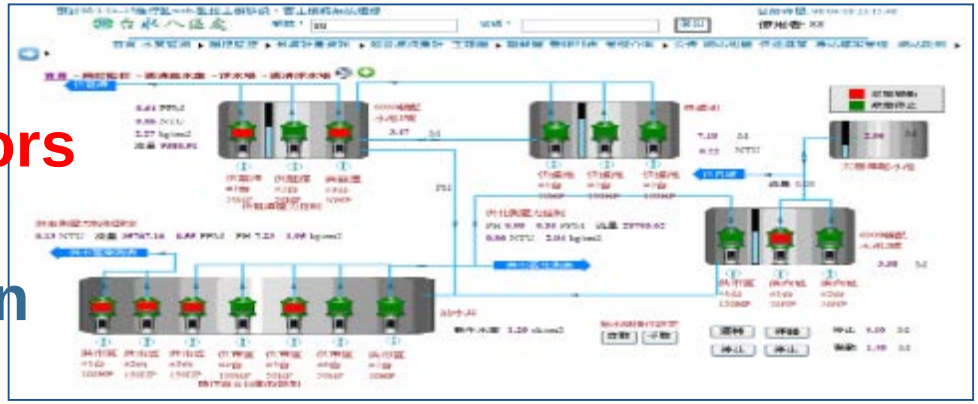
- upgraded and rehabilitated hardware and software
- Graphic User Interface of Windows
- monitoring terminals were connected to the others by broad-band network (higher speed)
- PLCs were Integrated and upgraded
- Started Web-based SCADA system pilot project

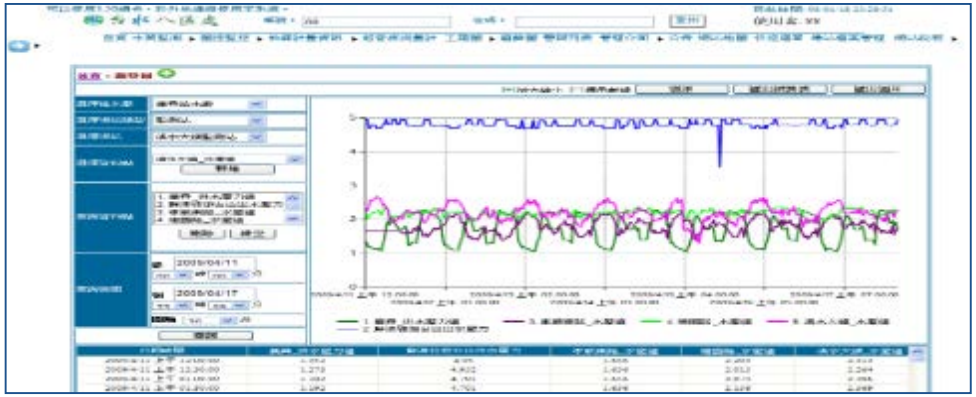
III. Smart Water Management

1999 2002 2007 2009 2011 2013 2014 2017

➢Web-based SCADA System (2nd Generation)

- shared data for administrators of branch office
- added data analysis function
- installed mobile (GPRS) pressure and flow sensing devices
- integrated Automatic Meter Reading (AMR) system into SCADA system

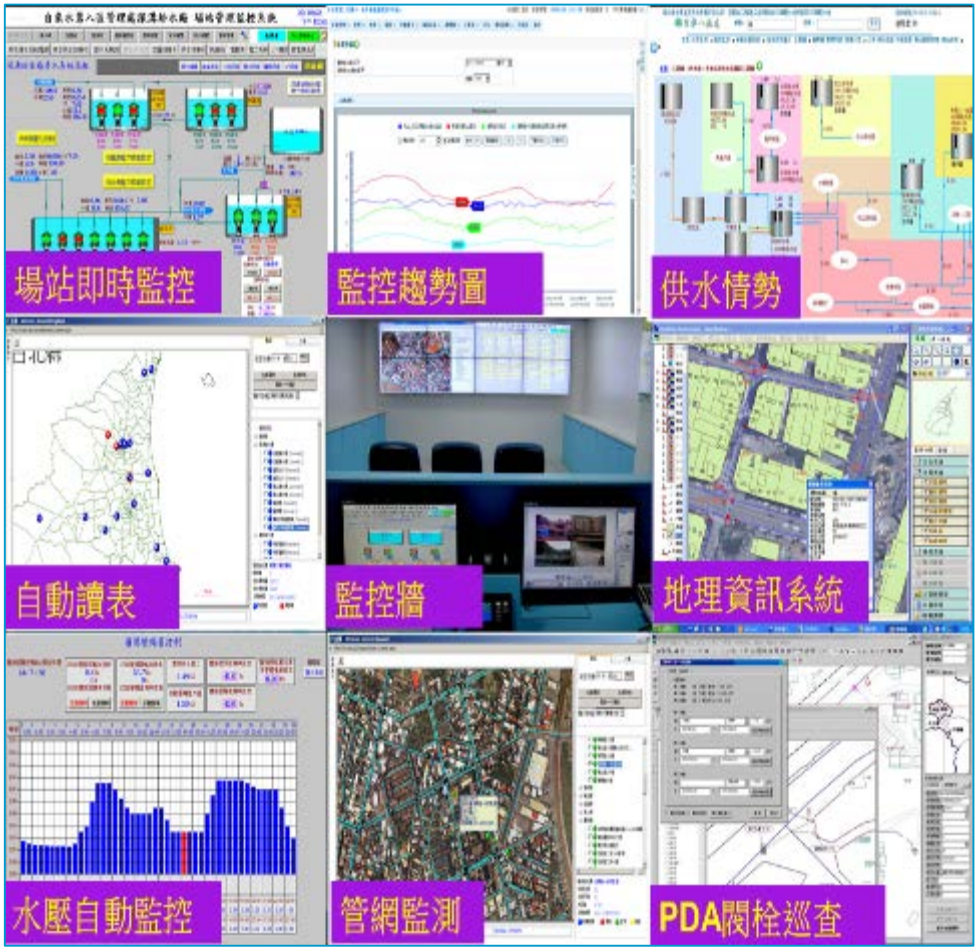




III. Smart Water Management

1999 → 2002 → 2007 → 2009 → 2011 → 2013 → 2014 → 2017

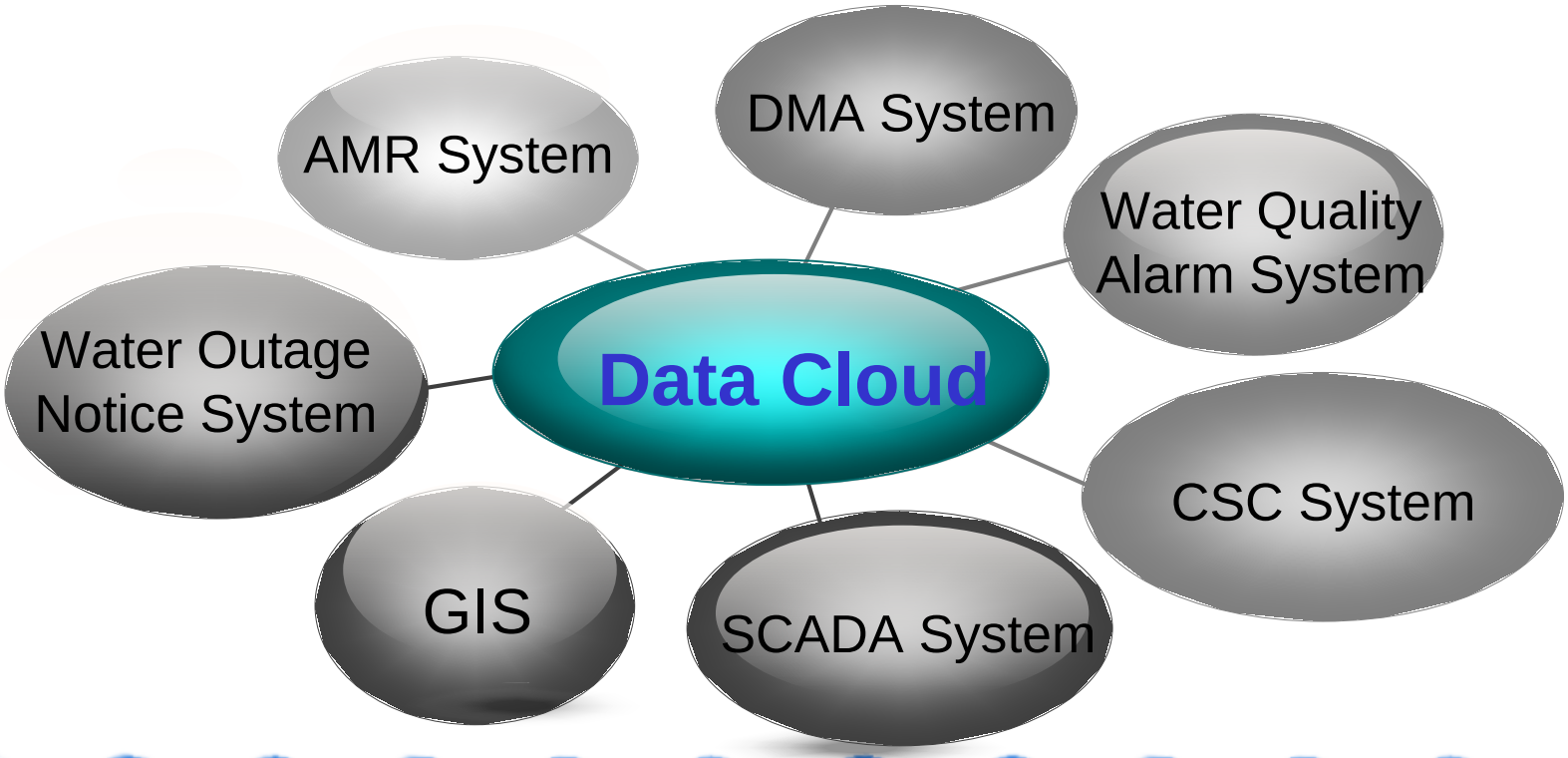
- Integrated GIS with SCADA
- established Maintenance Information System



III. Smart Water Management

1999 2002 2007 2009 2011 2013 2014 2017

- integrated monitoring data into the data cloud built in TWC's headquarters
- Integrated Customer Service Center (CSC) System

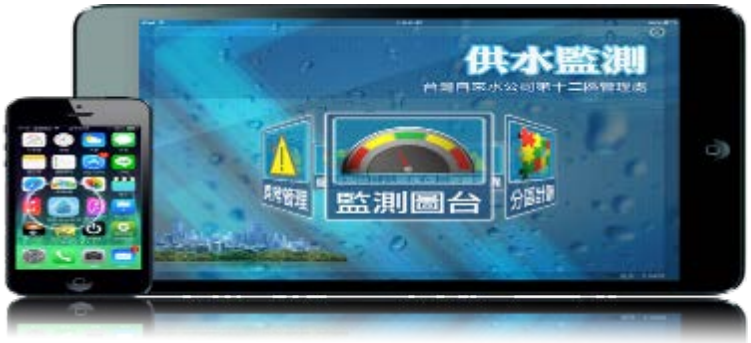


III. Smart Water Management

1999 2002 2007 2009 2011 2013 2014 2017

➢Integrated Water Treatment Plant Information System (3nd Generation)

- adopted web-based SCADA System
- remote data backup
- established Water Supply Monitoring Platform
- adopted broad-band network to communicate among sensing devices, SCADA system, WTPs, and branch offices



III. Smart Water Management

1999 2002 2007 2009 2011 2013 2014 2017

Flow Pressure Water Quality (pH, turbidity, residual chlorine) Water Level Valve Electronic Meter

- **We collect 8 kinds of real-time monitoring data into Data Cloud.**

III. Smart Water Management

Data Management

- **Data Cloud -- data storage and exchange**

It collects data from 12 branch offices & over 100 WTPs.

III. Smart Water Management

■ Water Supply Monitoring System

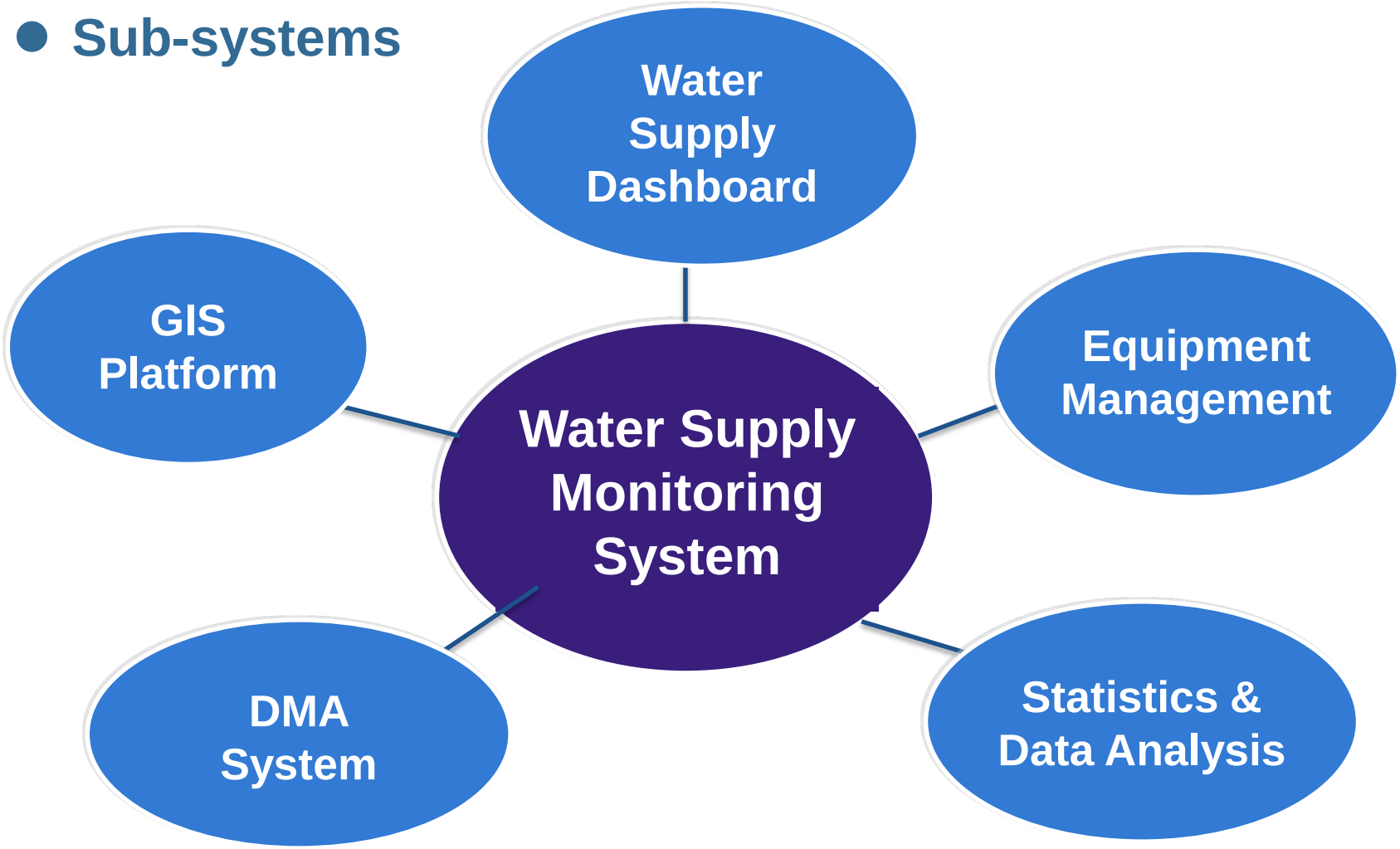
(for displaying all collected data from data cloud)

- **web edition for PC & laptop**

- **app edition for tablet & smartphone**

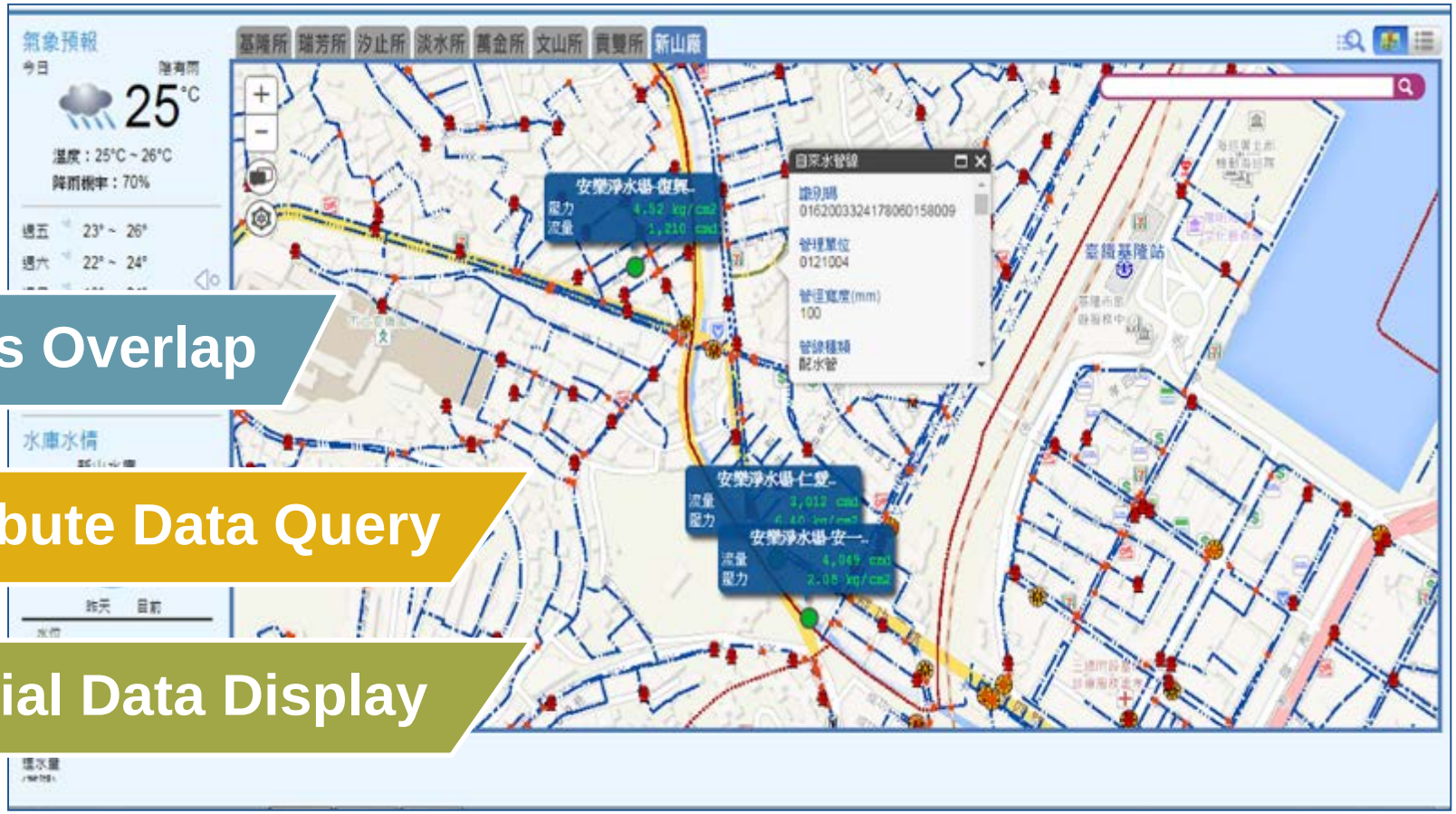
III. Smart Water Management

- Sub-systems



III. Smart Water Management

GIS Platform



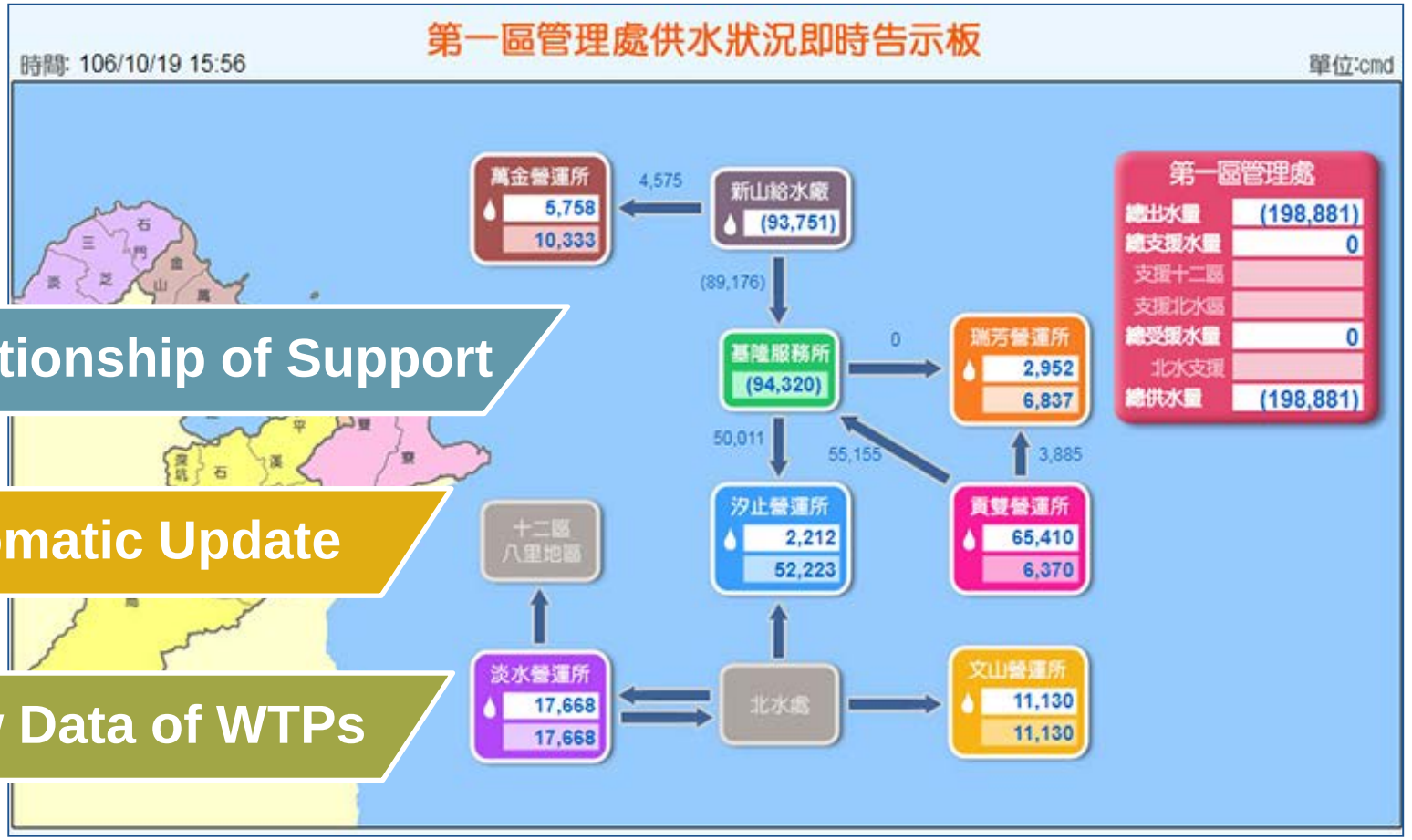
Maps Overlap

Attribute Data Query

Spatial Data Display

III. Smart Water Management

Water Supply Dashboard



Relationship of Support

Automatic Update

Flow Data of WTPs

III. Smart Water Management

Distribution of water pressure

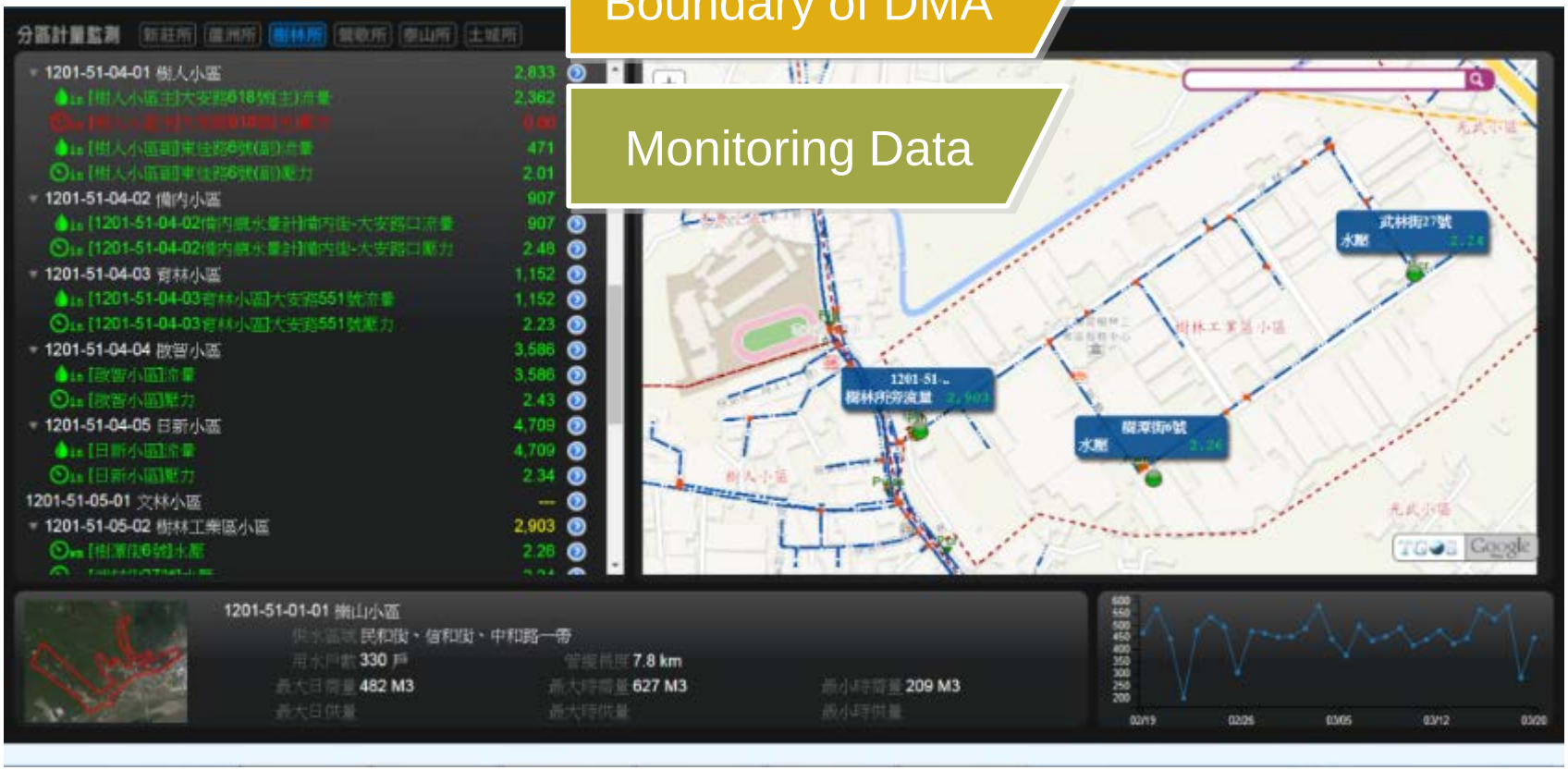
III. Smart Water Management

DMA System

III. Smart Water Management

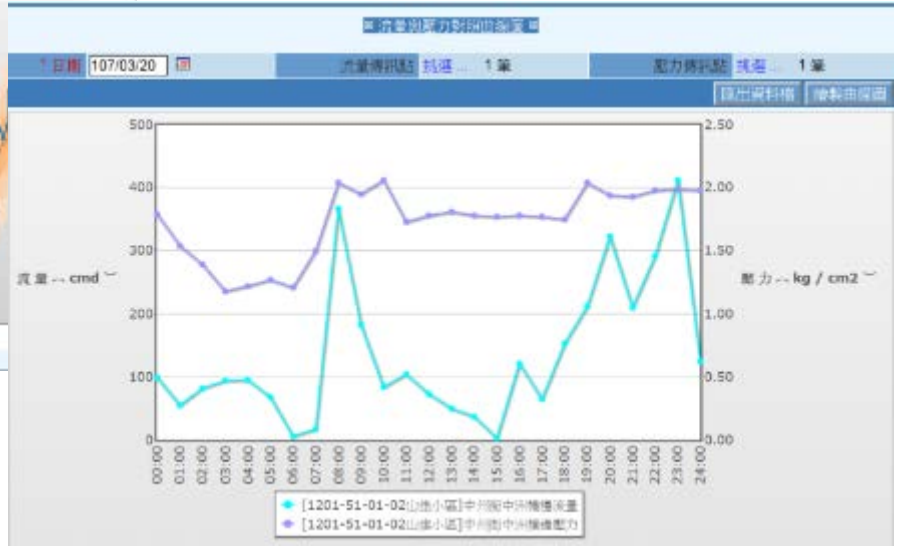
Boundary of DMA

Monitoring Data



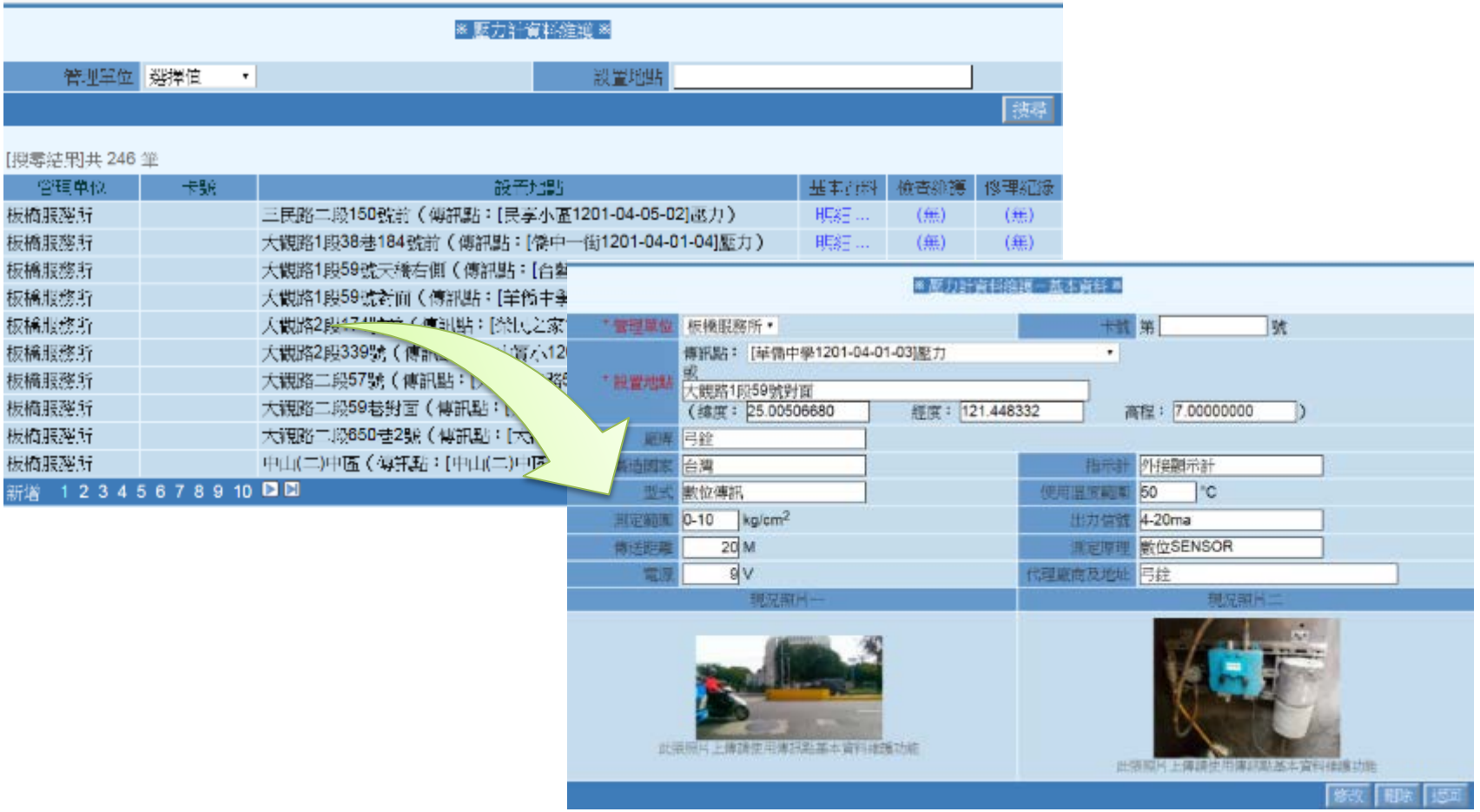
III. Smart Water Management

Statistics & Data Analysis



III. Smart Water Management

Equipment Management



III. Smart Water Management

Decision Making

■ Emergency Response Platform

- web-based
- displayed on LED TV wall
- established in Emergency Response Center of the branch office
- Including monitoring data, weather, etc.

III. Smart Water Management

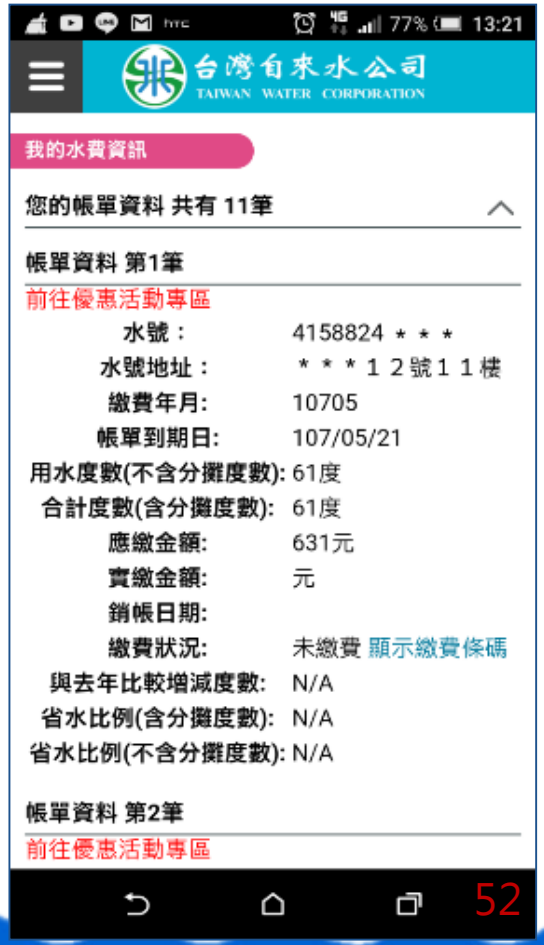
Customer Service

●Water Outage Query

●Water Quality Query

淨水場：	新山淨水場(Sinshan)基隆市麥金路720號	最大限值
英文：	Sinshan	
自由有效餘氯(mg/L)：	0.71	0.2-1.0
濁度(NTU)：	0.45	2
色度(鉑鈷單位)：	<5	5
臭度(初嗅數)：	<1	3
總鹼度(mg/L)：	28.5	-
pH值(一)：	7.1	6.0-8.5
氯鹽(mg/L)：	17.6	250

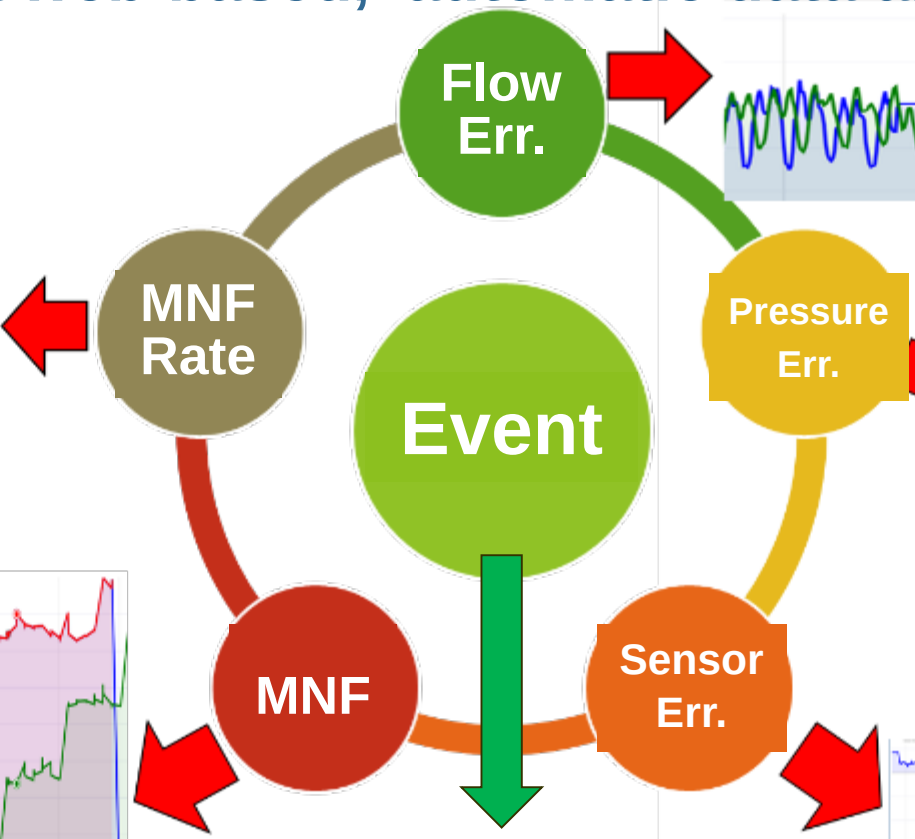
●Water Tariff Query

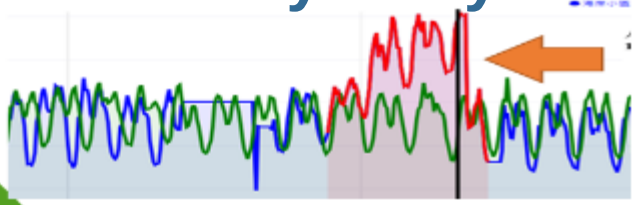


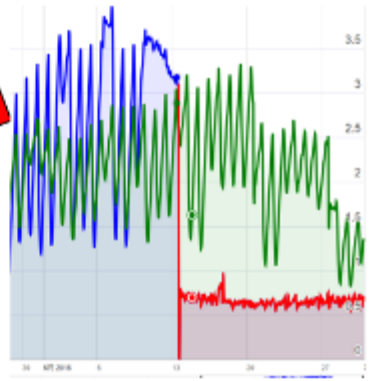
III. Smart Water Management

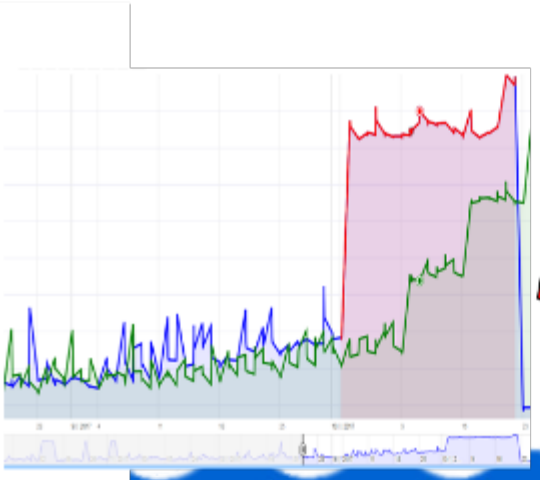
What's next……?

We are now setting up a Big Data Analysis Task Force, and developing a web-based, automatic data analysis system.









Concluding Remarks

- Providing high standard service and high quality drinking water has been a goal that TWC has persistently pursued.
- TWC hopes to become a leader among the domestic water utilities and keep pace with the best international water utilities.

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Thank You

Chengcing Lake Scenic Area, Kaohsiung City, Taiwan