Non-Revenue Water Management in Cyprus

Amman, December 3, 2018
Presentation Contents

• Water Management in Cyprus
• Network Design and Development
• Non-Revenue Water Activities
• Leakage Monitoring and Management
• Targeting and Benchmarking
• Intermittent Water Supply
Water Management in Cyprus
Recent Water Situation in Cyprus

- Gradual change in the climate
- Substantial decrease in annual rainfall > 20%
- Reduction of runoff into the reservoirs > 40%
- Periods of low rainfall are becoming more frequent
- Demand is continuously increasing
- Frequent periods of low or no rainfall (1991-92, 1997-2000, 2008-09)
- Government forced to apply water restriction measures
  - Drastic water cuts in irrigation
  - Severe restrictions to domestic water supply
- Add water to the National Balance:
  - Construction of desalination plants: 80Mm$^3$ (2017)
  - Use of treated effluent for agriculture: 22Mm$^3$ (2017)
- Need for water conservation and water loss management
Recent Water Statistics for Cyprus

**Water Usage by Sector**

- Agriculture: 28.4%
- Household: 64%
- Tourism: 2.9%
- Industry: 4.7%

Total needs: 250 Mm³/year

**Water Inflow to Dams**

(Total Dam Storage: 332 Mm³)

**Annual Quantities of Treated Effluent from WWTPs**

**Source Contribution to Potable Water**

Source: Water Development Department
Shipping Water

Athens – Limassol
August 2008 – April 2009
35,000 m³/day
5 Euro/m³
NRW Management

NRW is:

- a continuous activity
- an integral part of distribution network management
- based on a long term strategy
- cost effective, especially in water scarce areas

HOWEVER, ITS SUCCESS DEPENDS ON:

- Commitment and dedication at all levels
- Adoption of appropriate methodologies and technologies
- Use of appropriate and reliable indicators for benchmarking, such as liters/service connection/day and ILI
## Key Performance Indicators

Continuous 24x7x365 potable water supply – coverage is 100% in all areas

### Water Board of Nicosia

<table>
<thead>
<tr>
<th>YEAR</th>
<th>% of SIV</th>
<th>ILI</th>
<th>Lit/conn/day</th>
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<td>2007</td>
<td>19.5</td>
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<td>2012</td>
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### Water Board of Larnaca

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<th>ILI</th>
<th>Lit/conn/day</th>
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<td>2007</td>
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<td>2012</td>
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### Water Board of Lemesos

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<th>Lit/conn/day</th>
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<td>2007</td>
<td>16.7</td>
<td>1.8</td>
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<td>2012</td>
<td>24.0</td>
<td>2.8</td>
<td>143</td>
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Network Design and Development
Major Network Developments (Water Board of Lemesos)

- **1986 - 1990**
  - Major expansion of storage and supply network
  - Establishment of pressure zones and DMAs
  - Installation of SCADA system

- **1991 - 1993**
  - Pressure reduction study
  - Installation of pressure management in 8 out of 27 DMAs

- **1994 - 1995**
  - Digitization of all maps of the water supply and distribution system

- **1997 - 1998**
  - Review of leakage control activities by external consultant
  - Recommendations for the establishment of a leakage management policy

- **1999 - 2012**
  - DMA re-design and application of pressure management (45 DMAs)
  - Use of advanced technology in DMA monitoring and leak detection
  - Adoption of IWA WLSG “best practice” approach to NRW management

Source: WBL
Network Design – Key Considerations

DMA categories

- Small : <1000 properties
- Medium : 1000 – 3000 properties
- Large : 3000 – 5000 properties

Factors considered in DMA design

- Minimum variation in ground level
- Single entry point into the DMA
- Well defined DMA boundaries
- Area meters correctly sized and located
- Apply pressure management
- Continuous monitoring

Source: WBL
Typical DMA Inlet Chamber

- Pressure reducing valve (downstream pressure control, open/close capability)
- Pressure sensor (downstream pressure monitoring)
- District meter (mechanical “Woltman” type)
- Strainer (meter protection)

Source: WBL
Monitoring and Data Transfer

**Dedicated Computer in Control Room**

**Data Communication**
- E-mails / SMS sent from each DMA
- Alarms sent to Operator’s mobile phone for:
  - High/Low pressure
  - High MNF
  - No flow
  - Low battery status

**PSTN and GSM Network**

**PROGRAMMABLE CONTROLLERS IN DMAs**
Pressure Management

Reduction in:

- surges and excess pressures
- burst rates and background leakage
- repair costs
- flow rates of all leaks
- some components of consumption
Pipeline and Assets Management

- High quality materials / Proper installation
- High standard of maintenance
- Pipeline replacement using a decision support system
Accurate and Comprehensive Metering

The first step in establishing how much water is produced and used

Accurate measurement of:

- Water produced and/or imported
- Water flow to and out of treatment plants
- Water flow to and out of storage reservoirs
- Water flow into Districts
- Customer consumption

Eliminate or minimise

Authorised Un-metered Consumption
Non-Revenue Water Activities
## Annual Water Balance (m³) (“Top - Down”) 

Reaching the point of Accountability

<table>
<thead>
<tr>
<th>System Input Volume</th>
<th>Authorised Consumption</th>
<th>Unbilled Authorised Consumption</th>
<th>Billed Authorised Consumption</th>
<th>Billed metered consumption (including water exported)</th>
<th>Billed unmetered consumption</th>
<th>Unbilled metered consumption</th>
<th>Unbilled unmetered consumption</th>
<th>Revenue water</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 887 876</td>
<td>10 714 505</td>
<td>64 440</td>
<td>10 650 065</td>
<td>10 650 065 (82,64%)</td>
<td>Zero</td>
<td>Zero</td>
<td>64 440 (0,50%)</td>
<td>10 650 065 (82,64%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-revenue water</th>
<th>2 237 811</th>
<th>17,36%</th>
<th>1 722 295</th>
<th>Leakages on raw water mains and at the treatment works Zero</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Leakage on transmission and/or distribution mains 90 215 (0,7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Leakage and overflows at transmission and/or distribution storage tanks 12 888 (0,10%)</td>
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<tr>
<td></td>
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<td></td>
<td>Leakage on service connections up to the metering point 296 421 (2,30%)</td>
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<tr>
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<td>171717</td>
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</table>

<table>
<thead>
<tr>
<th>Apparent Losses</th>
<th>451 076</th>
<th>3.50%</th>
<th>Unauthorised use 64 440 (0.50%)</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>Metering inaccuracies 386 863 (3.00%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Losses</th>
<th>2 173 371</th>
<th>16.86%</th>
<th>Real Losses 1 722 295</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>13.36%</td>
</tr>
</tbody>
</table>
Commercial Losses

All customers are metered

Water theft
  o Theft from hydrants
  o Meter by-passes
  o Tampering with meters

Meter under-registration
  o Improve meter accuracy
  o Use of volumetric meters
  o Certified meter test bench

Meter reading errors
  o Hand-held devices
  o Change meter readers’ routes
  o Check zero/low consumption

Accounting errors
  o Billing software
  o Threshold alarms

Source: Rizzo and Cilia, 2005
Physical Losses

Reduction in:

- Surges and excess pressures
- Burst rates and background leakage
- Flow rates of all leaks
- Some components of consumption

- Minimize “Leak Run Time”
- Use quality materials & specification
- Perform quality repairs & inspection

- High quality materials / Proper installation
- High standard of maintenance
- Pipeline replacement using a decision support system
Speed and Quality of Repairs

Minimize “leakage run time”; Management of leak ID, location, and repair processes; Measure leak run & repair times; Quality materials specification; Quality repairs & inspection

Number of Pipes Repaired

- House connection polyethylene: 712 (34%)
- House connection galvanised iron: 1,169 (55%)
- Distribution pipework: 243 (11%)

Response Repair Time

- Same day: 712 (34%)
- Next day: 1,169 (55%)
- Next two days: 243 (11%)

Source: WBL
Active Leakage Control
## Pressure Reduction

### DMA (Sector 2)

<table>
<thead>
<tr>
<th>DMA (Sector 2)</th>
<th>AZNP (m)</th>
<th>Actual MNF (m³/hr)</th>
<th>Background losses (m³/hr)</th>
<th>Locatable losses (m³/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>before</td>
<td>after</td>
<td>before</td>
<td>after</td>
</tr>
<tr>
<td>220</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>221</td>
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<tr>
<td>234</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

**Annual water saving = 220 000 m³**

or € 170 000

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**REDUCTION**

30 m³/hr (25%)
**Reduced Burst Frequency**

(Reported Leaks)

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of bursts reported</th>
<th>Reduction of leaks</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Before (7 months)</td>
<td>After (7 months)</td>
</tr>
<tr>
<td>Distribution</td>
<td>49</td>
<td>27</td>
</tr>
<tr>
<td>Communication  pipes</td>
<td>296</td>
<td>178</td>
</tr>
</tbody>
</table>

**ANNUAL COST SAVING**

**IN PIPE BURST REPAIRS €100 000**

**Comparison of Results**

<table>
<thead>
<tr>
<th>Location</th>
<th>Pressure Reduction</th>
<th>Overall reduction in burst incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyprus</td>
<td>32%</td>
<td>41%</td>
</tr>
<tr>
<td>(Water Board of Lemesos)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>40%</td>
<td>55%</td>
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<td>(A.Lambert)</td>
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</table>
Leakage Monitoring and Management
DMA Flow and Pressure Monitoring
**MNF Analysis**

### District Night Flow Targets

**Data Entry and Results**

<table>
<thead>
<tr>
<th>District No</th>
<th>Actual AZNP m</th>
<th>Actual MNF m³/hr</th>
<th>Target MNF m³/hr</th>
<th>Equiv Serv Pipe Bursts no</th>
<th>Actual Tot Losses m³/d</th>
<th>Locatable Losses m³/d</th>
<th>Locatable Loss Value £/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>43</td>
<td>39.5</td>
<td>16.51</td>
<td>15</td>
<td>576.79</td>
<td>459.86</td>
<td>£55,390</td>
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<td>121</td>
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<td>8</td>
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<td>225</td>
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<tr>
<td>120</td>
<td>58</td>
<td>1.5</td>
<td>0.89</td>
<td>0</td>
<td>12.77</td>
<td>0.00</td>
<td>£</td>
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<tr>
<td>325</td>
<td>52</td>
<td>0.7</td>
<td>0.61</td>
<td>0</td>
<td>9.32</td>
<td>0.00</td>
<td>£</td>
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<tr>
<td>124</td>
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<td>1.4</td>
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<td>£</td>
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<td>£</td>
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<td>£</td>
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</tbody>
</table>

**Summary for the** 20-Nov-02

<table>
<thead>
<tr>
<th>No of ESPB's</th>
<th>Total Losses Estimate m³/day</th>
<th>Locatable Losses m³/day</th>
<th>Total Cost of Locatable Losses £</th>
</tr>
</thead>
<tbody>
<tr>
<td>08</td>
<td>5002</td>
<td>2002</td>
<td>£315,771</td>
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</tbody>
</table>
MNF Monitoring

**District 227**
Year 2005 Minimum Night Flow

**District 226**
Year 2005 Minimum Night Flow

**District 232**
Year 2005 Minimum Night Flow

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Data entry | Calculated values | Data from another Worksheet
---|---|---
**Step 1:** Enter Country, Currency, Volume Units, Utility and System
- **Country:** Cyprus
- **Currency:** EC
- **Volume units:** m³
- **Utility:** Water Board of Leros/Cos
- **System:** D326

**Step 2:** Enter mains length & number of service connections
- **Length of mains:** 17.8 km
- **Number of service connections:** 1500

**Step 3:** Enter key parameters for calculations (CV, CI, RR)
- **Variable cost of water CV:** 0.850 EC/m³
- **Full system intervention cost CI:** 3669 EC
- **Natural Rate of Rise of unreported leakage RR:** 41 m³/day in a year
- **Economic annual % surveyed:** 106% of system
- **Annual Budget for Intervention:** 3.9 Thousand EC
- **Economic Unreported Leakage:** 12.9 litres/service conn./day

---

**Step 4:** Review calculated figures for Economic Intervention
- **Economic Intervention every:** 11 months
- **Economic Unreported Leakage:** 1.08 m³/km of mains/day
- **Economic Intervention:** 1.08 m³/km of mains/day
- **Economic Unreported Leakage:** 1.08 m³/km of mains/day

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**LEAKS software**
Leak Location and Repair

Awareness (A) = 2 days; Location (L) = 10 days; Repair (R) = 1 day
Loss of water = 4200 m³

April, May 2004 Flow & Pressure

Awareness (A) = 2 days; Location (L) = 28 days; Repair (R) = 1 day
Loss of water = 7200 m³

District 129
August, September 2004 Flow & Pressure
Targeting and Benchmarking
Targeting and Benchmarking

Goal Setting

• Identified areas to be improved
• Prioritized most effective actions

Benchmarking

• Decided on Key Performance Indicators
• Checked and compared performance to other utilities
Non – Revenue Water

Financial PI basic (IWA Level 1, Fi 36)

Source: WBL
Liters / service connection / day

Operational PI for Real Losses basic (IWA Level 3, Op 24)

Technical Performance: A – pressurized system: average pressure 40 m

(Developed Countries) : <100 liters/connection/day

Source: WBL
Infrastructure Leakage Index

Operational PI for Real Losses Detailed (IWA Level 3, Op 25)

Technical Performance: **A**  (ILI 1-2: Excellent – no specific intervention required)
(Developed Countries)

Source: WBL
Intermittent Water Supply
Increase in Leakage

Source: Water Board Lemesos, Cyprus
## Increase in the Number of Breaks

### 20 DMAs: 373Km: 45% total

2008 – 2009 Intermittent Water Supply (IWS)

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of reported breaks</th>
<th>%increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007 (24x7x365) Before IWS</td>
<td>2010 (24x7x365) After IWS</td>
</tr>
<tr>
<td>Mains</td>
<td>14 / 100km</td>
<td>42 / 100km</td>
</tr>
<tr>
<td>Service connections</td>
<td>15 / 1000 connections</td>
<td>30 / 1000 connections</td>
</tr>
</tbody>
</table>

Source: Water Board Lemesos, Cyprus
## System Input vs Consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>System Input Volume</th>
<th>Customer Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007 Before Intermittent Supply</td>
<td>0% (base line)</td>
<td>0% (base line)</td>
</tr>
<tr>
<td>2008 Intermittent Supply</td>
<td>-17,5%</td>
<td>-9,2%</td>
</tr>
<tr>
<td>2009 Intermittent Supply</td>
<td>-9,1%</td>
<td>-8,9%</td>
</tr>
<tr>
<td>2010 After Intermittent Supply</td>
<td>+12,8%</td>
<td>-1,2%</td>
</tr>
</tbody>
</table>

Source: Water Board Lemesos, Cyprus
Thank you

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