NON REVENUE WATER
INTERNATIONAL BEST PRACTICE FOR ASSESSMENT, MONITORING AND CONTROL

Malcolm Farley, Principal Consultant,
Malcolm Farley Associates
Oxfordshire, UK

12th Annual CWWA Conference
Paradise Island, Bahamas
29 September - 3 October 2003
Dubai: 2.6 million gallons of desalinated water in Wild Wadi Water Park

Calcutta, India: Mother bathing child
Flow Rate From Leak m$^3$/day

High Flow / Short Duration

Low Flow / Long Duration

A = Awareness Time
L = Location Time
R = Repair / Isolation Time
UK EXPERIENCE

• Stringent regulation and reporting

Better mechanisms for:

• understanding losses
• accurate measurement and calculation
• setting and achieving economic leakage targets
• technologies for monitoring and controlling leakage
• software development
INTERNATIONAL EXPERIENCE

- International comparisons
- Performance indicators
  - real losses
  - litres per service connection/day
  - litres per kilometre of main
- Infrastructure leakage index
- Components of Water Balance
The 4 Basic Methods of Managing Real Losses

- Pressure Management
- Active Leakage Control
- Speed and Quality of Repairs
- Pipeline and Assets Management: Selection, Installation, Maintenance, Renewal, Replacement

Current Annual Real Losses

© WRP (Pty) Ltd, 2001
Current Annual Real Losses

Unavoidable Annual Real Losses

Pressure Management

Speed and Quality of Repairs

Active Leakage Control

Pipeline and Assets Management: Selection, Installation, Maintenance, Renewal, Replacement
Current Annual Real Losses

Pressure Management

Economic Level of Real Losses

Unavoidable Annual Real Losses

Potentially Recoverable Real Losses

Speed and Quality of Repairs

Active Leakage Control

Pipeline and Assets Management: Selection, Installation, Maintenance, Renewal, Replacement
IWA Recommended PIs for Operational Management of Real Losses

- %s by volume unsuitable for this purpose
  - due to influence of consumption and intermittent supply
- Level 1 PI depends on Density of Connections
  - if > 20/km mains, use ‘per service connection’
  - if < 20/km mains, use ‘per km mains’
  - calculate per day ‘when system pressurised’
- New Level 3 PI - the Infrastructure Leakage Index
  - Infrastructure Leakage Index is the ratio of Current Annual Real Losses to Unavoidable Annual Real Losses
DEVELOPING A STRATEGY

The key to developing a water loss strategy is to:

- Ask some questions
- Select procedures and tools to find the solutions.
QUESTIONS & SOLUTIONS

• How much water is being lost?
  - Water Balance
• Where is it being lost from?
  - Network Audit
• Why is it being lost?
  - Review network and operational practices
• How to improve performance?
  - Strategy development
• How to sustain performance?
  - Training and O&M
## HOW MUCH?

<table>
<thead>
<tr>
<th>System Input Volume (corrected for known errors)</th>
<th>Authorised Consumption</th>
<th>Billed Authorised Consumption</th>
<th>Billed Metered Consumption (including water exported)</th>
<th>Revenue Water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Billed Unmetered Consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unbilled Metered Consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unbilled Unmetered Consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Losses</td>
<td>Apparent Losses</td>
<td>Unauthorised Consumption</td>
<td></td>
<td>Non-Revenue Water (NRW)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Customer Metering Inaccuracies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Real Losses</td>
<td>Leakage on Transmission and/or Distribution Mains</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leakage and Overflows at Utility’s Storage Tanks</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leakage on Service Connections up to point of Customer metering</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IWA Standard International Water Balance and Terminology
WHERE FROM?
THE ZONING PRINCIPLE
REAL OR APPARENT?

REAL LOSSES

• Leakage studies
  - Reservoirs
  - Transmission mains
  - Distribution network

APPARENT LOSSES

• Customer studies
  - Metering and charging policies
  - Condition of meters
  - Theft and illegal connections
  - Unmeasured use
WHY IS IT BEING LOST?

Review Network Features and Operating Practices

• Discuss - with key staff
• Review - records and record systems
• Observe - operating procedures and skills
• Identify - strengths and weaknesses
• Assess - local influences, cultural / financial / social & political factors
• Report - findings and recommendations
HOW TO IMPROVE PERFORMANCE?

Strategy Development

• Design pilot study areas
• Update network records - GIS / network analysis
• Introduce zoning
• Introduce leakage monitoring and equipment
• Consider pressure management
• Introduce action plans - short, medium and long term
EQUIPMENT FOR LEAKAGE MANAGEMENT

- Flowmeters
- Data loggers
- Leak localisers (noise loggers)
- Sounding stick
- Ground microphone
- Leak noise correlator
- Gas injection
- New technologies (radar, in-pipe, infra-red)
CHANGING POLICIES

• Review meter policy - production, consumption etc.
• Detect and repair leaks
• Consider pressure management
• Consider rehabilitation policy
• Address causes of apparent losses
• Demand management and water conservation
HOW TO MAINTAIN THE STRATEGY AND SUSTAIN PERFORMANCE?

Training and O&M

• Conduct awareness seminars & training workshops
• Increase motivation
• Ensure technology and skills transfer
• Introduce appropriate technology
• Demonstrate best practice
• Encourage performance monitoring and follow up
• Involve the community
• O&M from an early stage
SHORT TERM ACTION PLANS

• Bulk meters at sources
• Create source supply zones
• Use zones for water loss monitoring
• Set up customer use studies
• Set up pilot study areas
• Introduce leakage control teams
• Empower with equipment, vehicles and knowledge
• Conduct awareness seminars and training
• Plan network improvements while upgrading
• Plan water conservation programmes
CONCLUSIONS
Lessons learnt

• Avoid multiple consultants and reports
• Maintain continuity
• Always produce something besides a report
• Small changes increase motivation
• Initiate leakage and demand management before major upgrades and augmentation projects
• Cultural changes are harder than network improvements
• Without funding nothing happens
• Maintain contact and continual follow-up
SUMMARY

• An International Review and Case Study
• Water Loss management is becoming a science
• IWA ‘best practice’ water balance and standard terminology being promoted
  – Try to separate Apparent Losses and Real Losses
  – Component analysis of Real Losses now possible
• Ongoing advances in leak detection equipment
  – noise loggers likely to have significant impact
• Insufficient active leakage control in most countries