This presentation premiered at WaterSmart Innovations

watersmartinnovations.com
AWWA’s New and Improving Tools and Publications for Water Loss Control

Las Vegas, NV
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Best Practice Tools for Water Loss Control

Water Audits and Loss Control Programs

M36

MANUAL OF WATER SUPPLY PRACTICES

Third Edition

WATER AUDIT DATA VALIDITY SCORE: 77 out of 100

**WATER LOSSES (Water Supplied - Authorized Consumption)**: 64.688

**AUTHORIZED CONSUMPTION**

- Billed Authorized Consumption: 8 700.000 MG/Yr 1 MG/Yr
- Unbilled Authorized Consumption: 9 50.000 MG/Yr

**WATER SUPPLIED**

- Water Imported: 1 100.000 MG/Yr 9 MG/Yr
- Water Exported: 1 100.000 MG/Yr 9 MG/Yr
- Service connection density: 10 conn./mile main

**NON-REVENUE WATER**

- Volume from own sources: 5 1,000.000 MG/Yr 1 MG/Yr
- Water exported: 1 100.000 MG/Yr
- Water imported: 5 1,000.000 MG/Yr

**PRIORITY AREAS FOR ATTENTION:**

1. Total annual cost of operating water system: 5 $1,000,000 $/Year
2. Customer metering inaccuracies: 5 7.071 MG/Yr 1.00% MG/Yr
3. Systematic data handling errors: 4 5.000 MG/Yr
4. Average length of customer service line has been set to zero and a data grading score of 10 has been applied

**PERFORMANCE INDICATORS:**

- Apparent Losses: 15.071
- Real Losses: 21,267.500
- Water Losses: 28,762.500

**FINANCIAL:**

- Annual cost of Apparent Losses: $54,788,450
- Annual cost of Real Losses: $33,186,788

**WATER LOSS CONTROL PROGRAMS:**

- Research Foundation Report
- Infrastructure
- Water Research Foundation
- Water Audits and Loss Control Programs

**AWWA Free Water Audit Software: Water Balance**

Philadelphia Water Department

- Reporting Year: 2013
- Reporting Worksheet

**Free Water Audit Software: Water Loss Control**

- Reporting Worksheet
- Water Losses
- Total Annual Cost of Water System
IWA / AWWA Standard Water Balance
Management of NRW

- Fire Dept Usage
- Operational Flushing
- Tools for control include efficient flushing practices and awareness campaigns
- Non-physical / revenue loss - slow meters, billing issues and theft
- Cost impacts at ‘retail’ rate.
- Tools for control include data management, quality control policies/practices, & meter testing & replacement
- Physical loss - leakage
- Cost impacts at ‘wholesale’ rate
- Tools for control include leakage and pressure management

Tools for control include:

- Leakage & Overflows at Storage
- Non-Revenue Water
- Unbilled Metered Consumption
- Billed Unmetered Consumption
- Billed Water Exported

- Fire Dept Usage
- Operational Flushing
- Tools for control include efficient flushing practices and awareness campaigns
- Non-physical / revenue loss - slow meters, billing issues and theft
- Cost impacts at ‘retail’ rate.
- Tools for control include data management, quality control policies/practices, & meter testing & replacement
- Physical loss - leakage
- Cost impacts at ‘wholesale’ rate
- Tools for control include leakage and pressure management
History

- 1st Edition (1991) Based upon method from California Dept. of Water Resources
- 4th Edition (2015 targeted) Expansion of content on new tools and better management of water production metering and data management
This spreadsheet-based water audit tool is designed to help quantify and track water losses associated with water distribution systems and identify areas for improved efficiency and cost recovery. It provides a "top-down" summary water audit format, and is not meant to take the place of a full-scale, comprehensive water audit format.

The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons below.

Please begin by providing the following information

Name of Contact Person: David Sayers
Email Address: david.sayers@drbc.state.nj.us
Telephone (incl Ext.): 609 883 9500 x236
Name of City / Utility: Northern San Leandro Combined Water Sewer Storm Utility District
City/Town/Municipality: Townville
State / Province: Select a state / province from the list
Country: USA
Year: 2013 Calendar Year

The following guidance will help you complete the Audit

All audit data are entered on the Reporting Worksheet

Use of Option (Radio) Buttons:

Select the default percentage by choosing the option button on the left

To enter a value, choose this button and enter a value in the cell to the right

The following worksheets are available by clicking the buttons below or selecting the tabs along the bottom of the page

Instructions
- The current sheet. Enter contact information and basic audit details (year, units etc)

Reporting Worksheet
- Enter the required data on this worksheet to calculate the water balance and data grading

Comments
- Enter comments to explain how values were calculated or to document data sources

Performance Indicators
- Review the performance indicators to evaluate the results of the audit

Water Balance
- The values entered in the Reporting Worksheet are used to populate the Water Balance

Dashboard
- A graphical summary of the water balance and Non-Revenue Water components

Example Audits
- Reporting Worksheet and Performance Indicators examples are shown for two validated audits

Acknowledgements
- Acknowledgements for the AWWA Free Water Audit Software v5.0

If you have questions or comments regarding the software please contact us via email at: wlc@awwa.org

Software Features
- Industry Standard
- "FREE"
- +10,000 downloads
- Defaults provided
- 10 volume inputs
- 7 system data inputs
- Data grading

Awwa.org/resources-tools/water-knowledge/water-loss-control.gspx
### WATER AUDIT REPORT

**Water Audit Report for:** Northern San Leandro Combined Water Sewer Storm Utility District (0007900)

**Reporting Year:** 2013 - 1/2013 - 12/2013

#### WATER SUPPLIED

<table>
<thead>
<tr>
<th>Source</th>
<th>Volume</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume from own sources</td>
<td>1,000,000</td>
<td>5</td>
</tr>
<tr>
<td>Water imported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water exported</td>
<td>100,000</td>
<td>1</td>
</tr>
</tbody>
</table>

**WATER SUPPLIED:** 825,000 MG/yr

#### AUTHORIZED CONSUMPTION

<table>
<thead>
<tr>
<th>Category</th>
<th>Volume</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billed metered</td>
<td>700,000</td>
<td>8</td>
</tr>
<tr>
<td>Billed unmetered</td>
<td>50,000</td>
<td>9</td>
</tr>
<tr>
<td>Unbilled metered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unbilled unmetered</td>
<td>10,313</td>
<td>9</td>
</tr>
</tbody>
</table>

**AUTHORIZED CONSUMPTION:** 760,313 MG/yr

#### WATER LOSSES (Water Supplied - Authorized Consumption)

<table>
<thead>
<tr>
<th>Loss Type</th>
<th>Volume</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unauthorized consumption</td>
<td>3,000</td>
<td>10</td>
</tr>
<tr>
<td>Customer metering inaccuracies</td>
<td>7,071</td>
<td>5</td>
</tr>
<tr>
<td>Systematic data handling errors</td>
<td>5,000</td>
<td>4</td>
</tr>
</tbody>
</table>

**Apparent Losses:** 15,071 MG/yr

**Real Losses (Current Annual Real Losses or CARL):** 49,617 MG/yr

**WATER LOSSES:** 64,688 MG/yr

#### NON-REVENUE WATER

**NON-REVENUE WATER:** 75,000 MG/yr

---

**Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades.**

---

**All volumes to be entered as: MILLION GALLONS (US) PER YEAR**

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**Master Meter Error Adjustments**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Value</th>
<th>Grade</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100,000</td>
<td>9</td>
<td>25,000</td>
</tr>
</tbody>
</table>

Enter negative % or value for under-registration
Enter positive % or value for over-registration

---

**American Water Works Association. Copyright © 2014, All Rights Reserved.**
Unauthorized consumption: 10 3.000 MG/Yr
Customer metering inaccuracies: 5 7.071 MG/Yr 1.00% MG/Y
Systematic data handling errors: 4 5.000 MG/Yr 0.25%

Apparent Losses: 15.071 MG/Yr

Real Losses (Current Annual Real Losses or CARL)
Real Losses = Water Losses - Apparent Losses: 49.617 MG/Yr

WATER LOSSES: 64.688 MG/Yr

NON-REVENUE WATER
NON-REVENUE WATER: 75.000 MG/Yr
= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA
Length of mains: 7 100.0 miles
Number of active AND inactive service connections: 6 1,000
Service connection density: 10 conn./mile main

Average length of customer service line has been set to zero and a data grading score of 10 has been applied

COST DATA
Total annual cost of operating water system: 5 $1,000,000 $/Year
Customer retail unit cost (applied to Apparent Losses): 7 $3.50 $/1000 gallons (US)
Variable production cost (applied to Real Losses): 7 $3,000.00 $/Million gallons

WATER AUDIT DATA VALIDITY SCORE:

*** YOUR SCORE IS: 60 out of 100 ***
A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:
Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Customer metering inaccuracies
3: Total annual cost of operating water system
Water Audit Report for: Northern San Leandro Combined Water Sewer Storm Utility District (0007900)

Reporting Year: 2013

System Attributes:

Apparent Losses: 15.071 MG/Yr

Real Losses: 49.617 MG/Yr

Water Losses: 64.688 MG/Yr

Unavoidable Annual Real Losses (UARL): 15.13 MG/Yr

Annual cost of Apparent Losses: $52,747

Annual cost of Real Losses: $148,850 Valued at Variable Production Cost

Performance Indicators:

Non-revenue water as percent by volume of Water Supplied: 9.1%

Non-revenue water as percent by cost of operating system: 23.3% Real Losses valued at Variable Production Cost

Apparent Losses per service connection per day: 41.29 gallons/connection/day

Real Losses per service connection per day: N/A gallons/connection/day

Real Losses per length of main per day*: 1,359.36 gallons/mile/day

Real Losses per service connection per day per psi pressure: N/A gallons/connection/day/psi

From Above, Real Losses = Current Annual Real Losses (CARL): 49.62 million gallons/year

Infrastructure Leakage Index (ILI) [CARL/UARL]: 3.28

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 60 out of 100 ***
**AWWA Free Water Audit Software© (V5.0)**

**Data Grading for each input**

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### AWWA Free Water Audit Software: Reporting Worksheet

**Water Audit Report for:** << Please enter system details and contact information on the instructions tab >>

**Reporting Year:**

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grade.

**PLEASE CHOOSE REPORTING UNITS FROM THE INSTRUCTIONS SHEET BEFORE ENTERING DATA**

---

#### WATER SUPPLIED

<table>
<thead>
<tr>
<th>Component</th>
<th>Grading</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume from own sources</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Water imported</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Water exported</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

**Master Meter Error Adjustments**

- **1.** Less than 25% of water production sources are metered, remaining sources are estimated. No regular meter accuracy testing or electronic calibration conducted.
- **2.** 25% - 50% of treated water production sources are metered; other sources estimated. No regular meter accuracy testing or electronic calibration conducted.
- **3.** Conditions between 2 and 4.
- **4.** 50% - 75% of treated water production sources are metered; other sources estimated. Occasional meter accuracy testing or electronic calibration conducted.
- **5.** Conditions between 4 and 6.
- **6.** At least 75% of treated water production sources are metered, or at least 90% of the source flow is derived from metered sources. Meter accuracy testing and/or electronic calibration of related instrumentation is conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.
- **7.** Conditions between 6 and 8.
- **8.** 100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted annually, less than 10% of meters are found outside of +/- 6% accuracy.
- **9.** Conditions between 8 and 10.
- **10.** 100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted semi-annually, with less than 10% found outside of +/- 3% accuracy. Procedures are reviewed by a third party knowledgeable in the M36 methodology.

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#### AUTHORIZED CONSUMPTION

<table>
<thead>
<tr>
<th>Component</th>
<th>Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billed metered</td>
<td>+</td>
</tr>
<tr>
<td>Billed unmetered</td>
<td>+</td>
</tr>
<tr>
<td>Unbilled metered</td>
<td>+</td>
</tr>
<tr>
<td>Unbilled unmetered</td>
<td>+</td>
</tr>
</tbody>
</table>

Enter a positive value, otherwise a default percentage of 1.25% (of billed metered) is used.

---

#### WATER LOSSES (Water Supplied - Authorized Consumption)

**Apparent Losses**

<table>
<thead>
<tr>
<th>Component</th>
<th>Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unauthorized consumption</td>
<td>+</td>
</tr>
</tbody>
</table>

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed.

---

Customer metering inaccuracies: +

Systematic data handling errors: +
# Water Loss Control Planning Guide

<table>
<thead>
<tr>
<th>Functional Focus Area</th>
<th>Water Audit Data Validity Level / Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level I (0-25)</td>
</tr>
<tr>
<td>Audit Data Collection</td>
<td>Launch auditing and loss control team; address production metering deficiencies</td>
</tr>
<tr>
<td>Short-term loss control</td>
<td>Research information on leak detection programs. Begin flowcharting analysis of customer billing system</td>
</tr>
<tr>
<td>Long-term loss control</td>
<td>Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or Automatic Meter Reading (AMR) system.</td>
</tr>
<tr>
<td>Target-setting</td>
<td>Establish long-term apparent and real loss reduction goals (+10 year horizon)</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)</td>
</tr>
</tbody>
</table>

For validity scores of 50 or below, the shaded block’s should not be focus areas until better data validity is achieved.
Goal: create a dataset of validated water utility water audit data (IWA/AWWA Method)

Steps:
- Enlist water utilities that are motivated to employ best practices
- Gather the water audit data via AWWA Free Water Audit Software©
- Conduct a 60-90 minute telephone interview w/ WLC Committee members
- Post the utility data on the AWWA website as examples of best practice adopters and their data

Primary Focus: “Validation” of data
**AWWA Free Water Audit Software©**

**Companion “Compiler” Software**

- EXCEL spreadsheet tool that allows data from multiple water audits to be “compiled” into one spreadsheet
- Data can be copied to user’s EXCEL files
- Available for free download from AWWA website

<table>
<thead>
<tr>
<th>Administrative</th>
<th>City of Asheboro</th>
<th>Austin Water</th>
<th>City of Belmont</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of City or Utility</td>
<td>USA</td>
<td>Utility States</td>
<td>USA</td>
</tr>
<tr>
<td>Country</td>
<td>FY08-09</td>
<td>7/1/2008</td>
<td>10/1/2009</td>
</tr>
<tr>
<td>Start Date</td>
<td>7/1/2009</td>
<td>6/30/2010</td>
<td>7/1/2009</td>
</tr>
<tr>
<td>End Date</td>
<td>Name of Contact Person</td>
<td>Michael Rhoney</td>
<td>Dan Strub</td>
</tr>
<tr>
<td>E-Mail</td>
<td><a href="mailto:mrhoney@ci.asheboro.gov">mrhoney@ci.asheboro.gov</a></td>
<td><a href="mailto:dan.strub@ci.austin.gov">dan.strub@ci.austin.gov</a></td>
<td><a href="mailto:cflowers@cityofbelmont.gov">cflowers@cityofbelmont.gov</a></td>
</tr>
<tr>
<td>Telephone</td>
<td>336-626-1234</td>
<td>512-972-0349</td>
<td>704-825-0512</td>
</tr>
<tr>
<td>Telephone Ext</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Audit Data

<table>
<thead>
<tr>
<th>Volume Units</th>
<th>Exposed</th>
<th>USA</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume From Own Sources</td>
<td>1,491.690</td>
<td>43,786.936</td>
<td>593,075</td>
</tr>
<tr>
<td>Master meter error adjustment</td>
<td>138.572</td>
<td>893.611</td>
<td>12,104</td>
</tr>
<tr>
<td>Water imported</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Water exported</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### WATER SUPPLIED

| Billed metered | 1,311.441 | 39,367.872 | 438,054 |
| Unbilled metered | 35.791 | 90.417 | - |
| Unbilled unmetered | 113.521 | 191,471 | 45,612 |

### AUTHORIZED CONSUMPTION

| Unbilled unmetered (1 = Default; 2 = Value) | 2 | 2 | 2 |
| WATER LOSSES (Water Supplied - Authorized Consumption) | 169,509 | 4,719,353 | 121,513 |
| Unauthorized consumption (1 = Default; 2 = Value) | 4,076 | 125,480 | 1,513 |
| Customer metering inaccuracies | 41,667 | 857,613 | 18,252 |
| Systematic data handling errors | 1,007,978 | 19,765 | |

### WATER LOSSES

| Real Losses = (Water Losses - Apparent Losses) | 123,766 | 3,711,375 | 101,748 |

### Non-Revenue Water

| NON-REVENUE WATER | 318,821 | 5,001,241 | 167,125 |
| Length of mains | 237 | 3,639 | 95 |
| System Data | 13,000 | 210,893 | 4,600 |
| Number of active AND inactive service connections | 54.9 | 58.0 | 48.4 |
| Connection density | 20 | 20 | 20 |
| Average length of customer service line | 75 | 77.3 | 66 |

### Cost Data

| Total annual cost of operating water system | $3,048,480 | $168,249,678 | $1,357,542 |
| Customer retail unit cost (applied to Apparent Losses) | $5.90 | $3.91 | $6.98 |
| Customer retail unit cost (units) | $/$100 cubic feet (cc | $/$1000 gallons (US | $/$1000 gallons (US |
| Variable production cost (applied to Real Losses) | $10.00 | $341.00 | $330.00 |
| Unavoidable Annual Real Losses (UARL) | 98.591 | 1,447.995 | 32.151 |
| Infrastructure Leakage Index (ILI) [Real Losses/UARL] | 1.255 | 2.563 | 3.165 |

### Performance Indicators

#### Financial Indicators

| Non-revenue water as percent by volume | 19.6% | 11.2% | 27.6% |
| Non-revenue water as percent by cost | 16.4% | 3.2% | 13.7% |
| Annual cost of Apparent Losses | $360,779 | $3,941,194 | $137,961 |
| Annual cost of Real Losses | $63,121 | $1,265,579 | $33,577 |

#### Operational Efficiency Indicators

| Apparent Losses per service connection per day | 9.640 | 13.095 | 11.772 |
| Real Losses per service connection per day | 26.084 | 48.215 | 60.600 |
| Real Losses per length of main per day* | N/A | N/A | N/A |
| Real Losses per service connection per day per psi pressure* | 0.348 | 0.624 | 0.918 |
| Real Losses per service connection per day per psi pressure | 98.591 | 1,447,995 | 32,151 |
| Infrastructure Leakage Index (ILI) [Real Losses/UARL] | 1.255 | 2.563 | 3.165 |
Real losses: gallons per service connection per day

Apparent losses: gallons per service connection per day
Tool to set a Leakage Management Strategy

- Water Research Foundation Project 4372: Real Loss Component Analysis – A Tool for Economic Water Loss Control
- Free Spreadsheet tool hosted on AWWA website
- Input data on leak events and cost; guidance is provided on best leakage control strategies
Real (Leakage) Loss Tool to set a Leakage Control Strategy

Inputs

- Number of Leaks
- Types of Leaks
- Timing of events (leak identified, leak repaired)
Real (Leakage) Loss Tool to set a Leakage Control Strategy

**Real Loss Component Analysis**

To set a Leakage Control Strategy

**WaterRF 4372 COMPONENT ANALYSIS MODEL SUMMARY**

As the input data is filled into the model, this sheet will populate with the results and recommendations from the Real Losses Component Analysis, A-L-R Times, Economic Intervention and Pressure Management tabs. The performance indicators from the AWWA Free Water Audit Software have been added to show a brief review of the performance of the system being analyzed.

**KEY**

Utilities need to start to routinely compile data on leak events in a standardized format.
Robust, accessible tools exist for water utilities for audit supplies and control losses


Free Tools are available to:
- Compile the water audit
- Compare with other utilities
- Plan leakage reductions