

## Appendix E

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### Utility Audits Using AWWA WLCC Software

# AWWA Water Loss Control Committee (WLCC) Free Water Audit Software v4.0

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WAS v4.0

**PURPOSE:** 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.

**USE:** The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons on the left below. Descriptions of each sheet are also given below.

**THE FOLLOWING KEY APPLIES THROUGHOUT:**

- Value can be entered by user
- Value calculated based on input data
- These cells contain recommended default values

Please begin by providing the following information, then proceed through each sheet in the workbook:

NAME OF CITY OR UTILITY: City of Brea COUNTRY: USA

REPORTING YEAR: 2007 START DATE (MM/YYYY): 07/2006 END DATE (MM/YYYY): 06/2007

NAME OF CONTACT PERSON: Ron Krause E-MAIL: ronkr@cityofbrea.net TELEPHONE: 714-990-7642 Ext.

PLEASE SELECT PREFERRED REPORTING UNITS FOR WATER VOLUME: Acre-feet

Click to advance to sheet...

Instructions	The current sheet
Reporting Worksheet	Enter the required data on this worksheet to calculate the water balance
Water Balance	The values entered in the Reporting Worksheet are used to populate the water balance
Grading Matrix	Depending on the confidence of audit inputs, a grading is assigned to the audit score
Service Connections	Diagrams depicting possible customer service connection configurations
Definitions	Use this sheet to understand terms used in the audit process
Loss Control Planning	Use this sheet to interpret the results of the audit validity score and performance indicators

Comments: Prepared by Malcolm Pirnie, Inc.

Add comments here to track additional supporting information, sources or names of participants

If you have questions or comments regarding the software please contact us at: [wlc@awwa.org](mailto:wlc@awwa.org)

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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[Back to Instructions](#)

[?](#) Click to access definition

Water Audit Report for: **City of Brea**

Reporting Year: **2007** 7/2006 - 6/2007

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 (1-10) using the drop-down (let 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: ACRE-FEET PER YEAR

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="10"/>	<input type="text" value="7,356.000"/>	acre-ft/yr
Master meter error adjustment (enter positive value):	<input type="text" value="6"/>	<input type="text" value="110.000"/>	under-registered acre-ft/yr
Water imported:	<input type="text" value="10"/>	<input type="text" value="4,904.000"/>	acre-ft/yr
Water exported:	<input type="text" value="10"/>	<input type="text" value=""/>	acre-ft/yr
<b>WATER SUPPLIED:</b>		<b>12,370.000</b>	acre-ft/yr

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="10"/>	<input type="text" value="11,174.000"/>	acre-ft/yr
Billed unmetered:	<input type="text" value="10"/>	<input type="text" value=""/>	acre-ft/yr
Unbilled metered:	<input type="text" value="10"/>	<input type="text" value="281.760"/>	acre-ft/yr
Unbilled unmetered:	<input type="text" value="10"/>	<input type="text" value="154.625"/>	acre-ft/yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>11,610.385</b>	acre-ft/yr

Click here: [?](#) for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

**759.615** acre-ft/yr

**Apparent Losses**

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

Unauthorized consumption:	<input type="text" value="10"/>	<input type="text" value="30.925"/>	acre-ft/yr
Customer metering inaccuracies:	<input type="text" value="10"/>	<input type="text" value="57.567"/>	acre-ft/yr
Systematic data handling errors:	<input type="text" value="10"/>	<input type="text" value="1.000"/>	acre-ft/yr
<b>Apparent Losses:</b>		<b>89.492</b>	

Pcnt:  Value:

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:  **670.123** acre-ft/yr

**WATER LOSSES:** **759.615** acre-ft/yr

**NON-REVENUE WATER**

**NON-REVENUE WATER:**  **1,196.000** acre-ft/yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="10"/>	<input type="text" value="162.0"/>	miles
Number of active AND inactive service connections:	<input type="text" value="10"/>	<input type="text" value="11,753"/>	
Connection Density:		<input type="text" value="73"/>	conn./mile main
Average length of customer service line:	<input type="text" value="10"/>	<input type="text" value="0.0"/>	ft (pipe length between curbside and customer meter or property boundary)
Average operating pressure:	<input type="text" value="10"/>	<input type="text" value="63.0"/>	psi

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="10"/>	<input type="text" value="\$3,330,096"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="10"/>	<input type="text" value="\$1.78"/>	\$/100 cubic feet (ccf)
Variable production cost (applied to Real Losses):	<input type="text" value="10"/>	<input type="text" value="\$478.50"/>	\$/acre-ft/yr

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="9.7%"/>
Non-revenue water as percent by cost of operating system:	<input type="text" value="18.0%"/>
Annual cost of Apparent Losses:	<input type="text" value="\$69,389"/>
Annual cost of Real Losses:	<input type="text" value="\$320,654"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="6.80"/>	gallons/connection/day
Real Losses per service connection per day*:	<input type="text" value="50.90"/>	gallons/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per psi pressure:	<input type="text" value="0.81"/>	gallons/connection/day/psi
<input type="text" value="10"/> Unavoidable Annual Real Losses (UARL):	<input type="text" value="60.69"/>	million gallons/year
<input type="text" value="10"/> Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="3.60"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 93 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: Master meter error adjustment**
- 2: Unauthorized consumption**
- 3: Unbilled unmetered**

[For more information, click here to see the Grading Matrix worksheet](#)

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Water Exported		Billed Water Exported		Revenue Water
Own Sources (Adjusted for known errors)	<b>7,466.000</b>	Billed Authorized Consumption	<b>11,174.000</b>	<b>11,174.000</b>
		Unbilled Authorized Consumption	<b>281.760</b>	Non-Revenue Water (NRW)
		Apparent Losses	<b>30.925</b>	<b>1,196.000</b>
		Real Losses	<b>670.123</b>	
Water Imported	<b>4,904.000</b>	Water Losses	<b>759.615</b>	
		Water Supplied	<b>12,370.000</b>	
		Billed Metered Consumption (inc. water exported)	<b>11,174.000</b>	
		Billed Unmetered Consumption	<b>0.000</b>	
		Unbilled Metered Consumption	<b>281.760</b>	
		Unbilled Unmetered Consumption	<b>154.625</b>	
		Unauthorized Consumption	<b>30.925</b>	
		Customer Metering Inaccuracies	<b>57.567</b>	
		Systematic Data Handling Errors	<b>1.000</b>	
		Leakage on Transmission and/or Distribution Mains	<b>Not broken down</b>	
		Leakage and Overflows at Utility's Storage Tanks	<b>Not broken down</b>	
		Leakage on Service Connections	<b>Not broken down</b>	

In the Reporting Worksheet, grades were assigned to each component of the audit to describe the confidence and accuracy of the input data. The grading assigned to each audit component and the corresponding recommended improvements and actions are highlighted in yellow. Audit accuracy is likely to be improved by prioritizing those items shown in red

Grading

	1	2	3	4	5	6	7	8	9	10
Volume from own sources:	Less than 25% of water production sources are metered, remaining sources are estimated. No regular meter accuracy testing.	25% - 50% of water production sources are metered, other sources estimated. Occasional meter accuracy testing.	Conditions between 2 and 4	50% - 75% of water production sources are metered, other sources estimated. Occasional meter accuracy testing.	Conditions between 4 and 8	At least 75% of 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 conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 6 and 8	100% of water supply sources are metered, meter accuracy testing and electronic calibration conducted annually, less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of water production sources are metered, meter accuracy testing and electronic calibration conducted semi-annually, with less than 10% found outside of +/- 3% accuracy
Improvements to obtain higher data grading for "Volume from own Sources" component:	<b>To qualify for 2:</b> Organize efforts to begin collecting data for determining volume from own sources	<b>To qualify for 4:</b> Locate all water production sources in maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered water production sources and replace any obsolete/defective meters	<b>To qualify for 3:</b> No automatic datalogging of production volumes; daily readings are scribbled on paper records. Tank/storage elevation changes are not employed in calculating "Volume from own sources" component. Data is adjusted only when grossly evident data error occurs.	<b>To qualify for 5:</b> Formalize annual meter accuracy testing for all sources meters. Complete installation of meters on unmetered water production sources and complete replacement of all obsolete/defective meters.	<b>To qualify for 6:</b> Conduct annual meter accuracy testing on all meters. Complete project to install new or replace defective existing meters so that entire production meter population is metered. Repair or replace meters outside of +/- 6% accuracy.	<b>To qualify for 7:</b> Hourly production meter data logged automatically & reviewed on a daily basis. Data adjusted to correct error from equipment malfunction and accuracy testing. Tank/storage facility elevation changes are automatically used in calculating a "sources" component.	<b>To qualify for 8:</b> Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology; pilot one or more replacements with innovative meters in attempt to improve meter accuracy.	<b>To qualify for 9:</b> Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/improve metering technology	<b>To qualify for 10:</b> Computerized system (SCADA or similar) automatically balances flows from all sources and stores; results reviewed daily. Mass balance technique compares production meter data to raw (untreated) water and treatment volumes to detect anomalies. Regular calibrations between SCADA and sources meters ensures minimal data transfer error.	<b>To maintain 10:</b> Member meter innovations for development of more accurate and less expensive flowmeters. Continue to replace or repair meters as they perform outside of desired accuracy limits.
Master meter error adjustment:	Select n/a if the water utility fails to have meters on its sources of supply, either its own sources and/or imported (purchased) water sources	No automatic datalogging of production volumes; daily readings are scribbled on paper records. Tank/storage elevation changes are not employed in calculating "Volume from own sources" component. Data is adjusted only when grossly evident data error occurs.	Conditions between 2 and 4	Production meter data is logged automatically in electronic format on a monthly basis. "Volume from own sources" tabulations include estimate of daily changes. Meter data is adjusted when gross data error occur, or occasional meter testing deems this necessary.	Conditions between 4 and 8	Hourly production meter data logged automatically & reviewed on a daily basis. Data adjusted to correct error from equipment malfunction and accuracy testing. Tank/storage facility elevation changes are automatically used in calculating a "sources" component.	Conditions between 6 and 8	Continuous production meter data logged automatically & reviewed daily. Data adjusted to correct gross error from equipment malfunction and accuracy testing. Tank/storage facility elevation changes are automatically used in "Volume from own sources" tabulations.	Conditions between 8 and 10	Computerized system (SCADA or similar) automatically balances flows from all sources and stores; results reviewed daily. Mass balance technique compares production meter data to raw (untreated) water and treatment volumes to detect anomalies. Regular calibrations between SCADA and sources meters ensures minimal data transfer error.
Improvements to obtain higher data grading for "Master meter error adjustment" component:	<b>To qualify for 2:</b> Develop plan to restructure reconciling system to capture all flow data; set procedure to review data daily to detect input errors	<b>To qualify for 4:</b> Install automatic datalogging equipment on production meters. Identify tank/storage facilities and include estimated daily volume of water added to, or subtracted from, "Water Supplied" volume based upon changes in storage	<b>To qualify for 3:</b> Review hourly production meter data for gross error on, at least, a weekly basis. Begin to install instrumentation on tank/storage facilities to record elevation changes. Use daily net storage change to balance flows in calculating "Water Supplied" volume.	<b>To qualify for 5:</b> Review hourly production meter data for gross error on, at least, a weekly basis. Begin to install instrumentation on tank/storage facilities to record elevation changes. Use daily net storage change to balance flows in calculating "Water Supplied" volume.	<b>To qualify for 6:</b> Complete installation of elevation instrumentation on all tank/storage facilities. Continue to use daily net storage change in calculating balanced "Volume from own sources" component. Adjust production meter data for gross error and inaccuracy confirmed by testing.	<b>To qualify for 7:</b> Link all production and tank/storage facility elevation change data to a Supervisory Control & Data Acquisition (SCADA) System, or similar computerized monitoring/control system, and establish automatic flow balancing algorithm and regularly calibrate between SCADA and source meters.	<b>To qualify for 8:</b> Link all production and tank/storage facility elevation change data to a Supervisory Control & Data Acquisition (SCADA) System, or similar computerized monitoring/control system, and establish automatic flow balancing algorithm and regularly calibrate between SCADA and source meters.	<b>To qualify for 9:</b> Link all production and tank/storage facility elevation change data to a Supervisory Control & Data Acquisition (SCADA) System, or similar computerized monitoring/control system, and establish automatic flow balancing algorithm and regularly calibrate between SCADA and source meters.	<b>To qualify for 10:</b> Member meter innovations for development of more accurate and less expensive flowmeters. Continue to replace or repair meters as they perform outside of desired accuracy limits.	<b>To maintain 10:</b> Member meter innovations for development of more accurate and less expensive flowmeters. Continue to replace or repair meters as they perform outside of desired accuracy limits.
Water imported:	Less than 25% of imported water sources are metered, remaining sources are estimated. No regular meter accuracy testing.	25% - 50% of imported water sources are metered, other sources estimated. No regular meter accuracy testing.	Conditions between 2 and 4	50% - 75% of imported water sources are metered, other sources estimated. Occasional meter accuracy testing.	Conditions between 4 and 8	At least 75% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy	Conditions between 6 and 8	100% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted semi-annually, with less than 10% found outside of +/- 3% accuracy
Improvements to obtain higher data grading for "Water Imported Volume" component:	<b>To qualify for 2:</b> Review bulk water purchase agreements with partner suppliers, confirm requirements for use and maintenance of accurate metering. Identify needs for new or replacement meters with goal to meter all imported water sources.	<b>To qualify for 4:</b> Locate all imported water sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered imported water interconnections and replace obsolete/defective meters	<b>To qualify for 3:</b> Formalize annual meter accuracy testing for all imported water meters. Continue installation of meters on unmetered imported water interconnections and replacement of obsolete/defective meters.	<b>To qualify for 5:</b> Formalize annual meter accuracy testing for all imported water meters. Continue installation of meters on unmetered imported water interconnections and replacement of obsolete/defective meters.	<b>To qualify for 6:</b> Complete project to install new, or replace defective, meters on all imported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	<b>To qualify for 7:</b> Complete project to install new, or replace defective, meters on all imported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	<b>To qualify for 8:</b> Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology; pilot one or more replacements with innovative meters in attempt to improve meter accuracy.	<b>To qualify for 9:</b> Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/improve metering technology	<b>To qualify for 10:</b> Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/improve metering technology	<b>To maintain 10:</b> Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/improve metering technology

Grading										
	1	2	3	4	5	6	7	8	9	10
Water Exported:  Improvements to obtain higher data grading for "Water Exported Volume" component:	Select n/a if the water utility sells no bulk water to neighboring utilities (no exported water sales)	Less than 25% of exported water sources are metered; remaining sources are estimated. No regular meter accuracy testing.	25% - 50% of exported water sources are metered; other sources estimated. No regular meter accuracy testing.	50% - 75% of exported water sources are metered; other sources estimated. Occasional meter accuracy testing.	Conditions between 4 and 6	At least 75% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of meters are found outside of +/- 6% accuracy.	Conditions between 6 and 8	100% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, with less than 10% found outside of +/- 3% accuracy.	Conditions between 8 and 10	100% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, with less than 10% found outside of +/- 3% accuracy.
	Review bulk water sales agreements with partner suppliers; confirm requirements for use & upkeep of accurate metering. Identify needs to install new, or replace defective meters as needed.	Locate all exported water sources on maps and in field; launch meter accuracy testing for existing meters; begin to install meters on unmetered exported water interconnections and replace obsolete/defective meters.	Formalize annual meter accuracy testing for all exported water meters. Continue installation of interconnections and replacement of obsolete/defective meters.	Complete project to install new, or replace defective, meters on all exported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	Complete project to install new, or replace defective, meters on all imported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology; pilot one or more replacements with innovative meters in attempt to improve meter accuracy.	Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/field improving metering technology.			
Billed metered:  Improvements to attain higher data grading for "Billed Metered Consumption" component:	Select n/a if the customer population is not metered, and is billed for water service on a flat or fixed rate basis	At least 50% of customers with volume-based billing from meter reads; flat or fixed rate billed for remainder. Manual meter reading used, less than 50% read success rate, failed reads are estimated. Limited customer meter records, no regular meter testing or replacement. Billing data maintained on paper records, with no auditing.	At least 75% of customers with volume-based billing from meter reads; flat or fixed rate billed for remainder. Manual meter reading used, at least 50% meter read success rate, failed reads are estimated. Purchase records, very few of customer meters, only very limited meter accuracy testing is conducted. Customer meters replaced only upon complete failure. Computerized billing records, but only periodic internal auditing conducted.	Conditions between 2 and 4	Conditions between 4 and 6	At least 90% of customers with volume-based billing from meter reads; remaining accounts are estimated. Manual customer meter reading gives at least 80% success rate. Good customer meter records. Regular meter accuracy testing, regular replacement of oldest meters. Computerized billing records with routine auditing of global statistics.	Conditions between 6 and 8	At least 97% of customers with volume-based billing from meter reads. At least 80% customer meter read success rate; or minimum 80% read success rate with planning and budgeting for trials of Automatic Metering Reading (AMR) in one or more pilot areas. Good customer meter records. Regular meter accuracy testing guides replacement of statistically significant number of meters each year. Routine auditing or computerized billing records for global and detailed statistics; verified periodically by third party.	Conditions between 8 and 10	At least 99% of customers with volume-based billing from meter reads. At least 95% customer meter read success rate, or minimum 80% meter reading success rate, with Automatic Meter Reading (AMR) trials underway. Statistically significant customer meter testing and replacement program in place. Computerized billing with routine auditing of computerized billing sample of accounts. Annual audit verification by third party.
	Conduct investigations or trials of customer meters to select appropriate meter models. Budget funding for meter installations. Investigate volume based water rate structures.	Implement policies to improve meter reading success. Catalog meter information during meter read visits to identify algorithm of existing meters. Test a minimal number of meters for accuracy. Install computerized billing system.	Purchase and install meters on unmetered accounts. Eliminate flat fee billing and establish appropriate water rate structure based upon measured consumption. Continue to achieve verifiable success in removing manual meter reading barriers. Expand meter accuracy testing. Launch regular meter replacement program. Conduct routine audit of global statistics.	Purchase and install meters on unmetered accounts. Assess cost-effectiveness of Automatic Meter Reading (AMR) system for portion or entire system; or achieve ongoing improvements in manual meter reading success rate. Refine meter accuracy testing program. Set meter replacement goals based upon accuracy test results. Refine routine auditing procedures based upon third party guidance.	Purchase and install meters on unmetered accounts. Assess cost-effectiveness of Automatic Meter Reading (AMR) system for portion or entire system; or achieve ongoing improvements in manual meter reading success rate. Refine meter accuracy testing program. Set meter replacement goals based upon accuracy test results. Refine routine auditing procedures based upon third party guidance.	Regular internal and third party auditing, and meter accuracy testing ensures that accurate customer meter readings are obtained and entered as the basis for volume based billing. Stay abreast of improvements in Advanced Metering Infrastructure (AMI) and information management. Plan and budget for justified upgrades in metering, meter reading and billing data management.				
Billed unmetered:  Select n/a if it is the policy of the water utility to meter all customer connections and it has been confirmed by detailed auditing that all customers do indeed have a water meter, i.e. no unmetered accounts exist	Water utility policy does not require customer metering, flat or fixed fee billed. No data collected on customer consumption. Only estimates available are derived from data received on passable registers. Data for interconnection for the total customer population. Site specific estimation methods are used for unusual buildings/water users.	Water utility policy does not require customer metering, flat or fixed fee billed. Some metered accounts exist in parts of the system (pilot areas or District Metered Areas) with consumption recorded on passable registers. Data for interconnection for the total customer population. Site specific estimation methods are used for unusual buildings/water users.	Water utility policy does require metering and volume based billing but lacks written procedures and employs casual oversight, resulting in up to 20% of billed accounts believed to be unmetered. A rough estimate of the annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Water utility policy does require metering and volume based billing but lacks written procedures and employs casual oversight, resulting in up to 20% of billed accounts believed to be unmetered. A rough estimate of the annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Water utility policy does require metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 3% of billed accounts unmetered and installation is limited by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained from unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 3% of billed accounts unmetered and installation is limited by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained from unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 3% of billed accounts unmetered and installation is limited by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained from unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 3% of billed accounts unmetered and installation is limited by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained from unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 3% of billed accounts unmetered and installation is limited by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained from unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 3% of billed accounts unmetered and installation is limited by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained from unmetered accounts via site specific estimation methods.

Grading										
	1	2	3	4	5	6	7	8	9	10
Improvements to obtain higher data grading for "Unmetered Consumption" component:	<p><b>To qualify for 2:</b> Investigate a new water utility policy to require metering of the customer population, and a study to include several different meter types, which will provide data for economic assessment of full scale metering options. Assess sites with access difficulties to devise means to obtain water consumption volumes.</p>	<p><b>To qualify for 4:</b> Implement a new water utility policy requiring customer metering. Expand pilot metering study to include several different meter types, which will provide data for economic assessment of full scale metering options. Assess sites with access difficulties to devise means to obtain water consumption volumes.</p>	<p><b>To qualify for 3:</b> Implement a new water utility policy requiring customer metering. Expand pilot metering study to include several different meter types, which will provide data for economic assessment of full scale metering options. Assess sites with access difficulties to devise means to obtain water consumption volumes.</p>	<p><b>To qualify for 4:</b> Budget for staff resources to review billing records to identify unmetered properties. Specify metering needs and funding requirements to install sufficient meters to significantly reduce the number of unmetered accounts.</p>	<p><b>To qualify for 6:</b> Install customer meters on a full scale basis. Refine metering policy and procedures to ensure that all accounts, including municipal properties, are designated for meters. Implement procedures to obtain reliable consumption estimates for unmetered accounts awaiting meter installation.</p>	<p><b>To qualify for 8:</b> Continue customer meter installation throughout the service area, with a goal to minimize unmetered accounts. Sustain the effort to investigate accounts with access difficulties to devise means to install water meters or otherwise measure water consumption.</p>	<p><b>To qualify for 9:</b> Continue to refine estimation methods for unmetered consumption and explore means to estimate metering, for as many unmetered accounts as is economically feasible.</p>	<p><b>To qualify for 10:</b> Continue to refine estimation methods for unmetered consumption and explore means to estimate metering, for as many unmetered accounts as is economically feasible.</p>	<p><b>To qualify for 10:</b> Continue to refine estimation methods for unmetered consumption and explore means to estimate metering, for as many unmetered accounts as is economically feasible.</p>	<p><b>To qualify for 10:</b> Continue to refine estimation methods for unmetered consumption and explore means to estimate metering, for as many unmetered accounts as is economically feasible.</p>
Unmetered metered:	<p>Billing practices exempt certain accounts, such as municipal buildings, but written policies do not exist; and a reliable count of unmetered metered accounts is unavailable. Meter reading occurs on an as-needed basis. The total annual water consumption for all unmetered, metered accounts is estimated based upon approximating the number of accounts and assigning consumption from meter size.</p>	<p>Billing practices exempt certain accounts, such as municipal buildings, but written policies do not exist; and a reliable count of unmetered metered accounts is unavailable. Meter reading occurs on an as-needed basis. The total annual water consumption for all unmetered, metered accounts is estimated based upon approximating the number of accounts and assigning consumption from meter size.</p>	<p>Conditions between 2 and 4</p>	<p>Dated written procedures permit billing exemption for specific accounts, such as municipal properties, but are unclear regarding certain other types of accounts. Meter reading is given low priority and is sporadic. Consumption is quantified from meter readings where available. The total number of unmetered accounts must be estimated along with consumption volumes.</p>	<p>Conditions between 4 and 6</p>	<p>Written policies regarding billing exemptions exist but adherence in practice is spotty. Metering and metering for specific buildings is reliable but specific accounts. Periodic auditing of such accounts. High level directly from meter readings where available, but the majority of the consumption is estimated.</p>	<p>Conditions between 6 and 8</p>	<p>Written policy identifies the types of accounts granted a billing exemption. Customer meter management and meter reading are considered secondary priorities. Meter reading is performed on a regular basis to obtain consumption volume for the annual water audit. High level auditing of billing records ensures that a reliable census of such accounts exists.</p>	<p>Conditions between 8 and 10</p>	<p>Clearly written policy identifies the types of accounts given a billing exemption, with emphasis on maintaining such accounts to a minimum. Customer meter management and meter reading for these accounts is given proper priority and is reliably conducted. Periodic auditing of these accounts is taken from reliable readings from accounts meters.</p>
Improvements to obtain higher data grading for "Unmetered Consumption" component:	<p><b>To qualify for 2:</b> Reassess the water utility's policy allowing certain accounts to be granted a billing exemption. Draft an outline of a new written policy for billing exemptions, with clear justification as to why any accounts should be exempt from billing, and with the intention to keep the number of such accounts to a minimum.</p>	<p><b>To qualify for 3:</b> Review historic written directives and policy documents allowing certain accounts to be billed-exempt. Draft an outline of a written policy for billing exemptions, with a goal of keeping the number of accounts to a minimum.</p>	<p><b>To qualify for 4:</b> Draft a new written policy regarding billing exemptions based upon consensus criteria allowing this occurrence. Assign resources to audit meter records and billing records to obtain census of unbilled metered accounts.</p>	<p><b>To qualify for 6:</b> Communicate billing exemption policy throughout the organization and implement procedures that ensure proper account management. Conduct inspections of accounts confirmed in unbilled metered status and verify that accurate meters exist and are scheduled for routine meter readings.</p>	<p><b>To qualify for 8:</b> Ensure that meter management (meter accuracy testing, meter replacement) and meter reading activities are accorded the same priority as billed accounts. Establish ongoing annual auditing process to ensure that water consumption is reliably collected and provided to the annual water audit process.</p>	<p><b>To qualify for 10:</b> Reassess philosophy in allowing any water uses to go "unbilled". It is possible to meter and bill all for water consumption is discarded or waived. Metering and billing of accounts ensures that water consumption is tracked and water costs from minimizing leaks is detected and minimized.</p>	<p>Clear policies and good recordkeeping exist for accounts (for unmetered fire hydrant, residential consumption), but other uses (for miscellaneous uses of fire hydrants) have limited oversight. Total consumption is a mix of well quantified use such as from formulae (time x typical flow) or temporary meters, and relatively subjective estimates of less regulated use.</p>	<p>Clear policies exist to identify permitted use of water in unbilled, unmetered fashion, with the intention of minimizing this type of consumption. Good records document each occurrence and consumption is quantified via formulae (time x typical flow) or use of temporary meters.</p>		

Grading

	1	2	3	4	5	6	7	8	9	10
Improvements to obtain higher data grading for "Unlabeled Unmetered Consumption" component:	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water use should be allowed as unlabeled or unmetered. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 3:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 4:</b> Evaluate the documentation of events that have been observed. Meet with user groups (ex: fire hydrants - fire departments, contractors to ascertain their need for water from fire hydrants).</p>	<p><b>To qualify for 5:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p>	<p><b>To qualify for 6:</b> Expedient means to gain a reasonable quantification of all such use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.</p>	<p><b>To qualify for 7:</b> Assess water utility policy and procedures to ensure that fire hydrant permits are issued for use by persons outside of the utility. Create written procedures for use and documentation of fire hydrants by water utility personnel.</p>	<p><b>To qualify for 8:</b> Refine written procedures to ensure that all uses of unlabeled, unmetered water are overseen by a structured permitting process managed by water utility personnel. Reassess policy to determine if some of these uses have value in being converted to billed and/or metered status eventually.</p>	<p><b>To maintain 10:</b> Continue to refine policy and procedures with intention of reducing the number of allowable uses of water in unlabeled and unmetered fashion. Any uses that can feasibly become billed and metered should be converted eventually.</p>			
Unauthorized consumption:	<p>Extent of unauthorized consumption is unknown due to unclear policies and poor recordkeeping. Total unauthorized consumption is guesstimated.</p>	<p>Unauthorized consumption is a known occurrence, but its extent is a mystery. There are no requirements to document observed events, but periodic field reports capture some of these occurrences. Total unauthorized consumption is approximated from this limited data.</p>	<p>Conditions between 2 and 4</p>	<p>Procedures exist to document some unauthorized consumption such as observed unauthorized fire hydrant openings. Use formulae to quantify this consumption (time running x typical flowrate x number of events).</p>	<p>Default value of system input volume is employed</p>	<p>Coherent policies exist for some forms of unauthorized consumption but others await closer evaluation. Reasonable surveillance and recordkeeping exist for occurrences that fall under the policy. Volumes quantified by inference from these records. Unsupervised uses are guesstimated.</p>	<p>Clear policies exist to identify all known unauthorized uses of water. Staff and procedures exist to provide enforcement of policies and detect violations. Each occurrence is quantified via formulae (time x typical flow) or similar methods.</p>			
Improvements to obtain higher data grading for "Unauthorized Consumption" component:	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 3:</b> Use accepted default of 0.25% of system input volume</p> <p><b>To qualify for 4:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p>Conditions between 2 and 4</p>	<p>Utilize accepted default value of 0.25% of system input volume as expedient means to gain a reasonable quantification of all such use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.</p>	<p><b>To qualify for 5:</b> Proceed if top-down audit tests and/or a great volume of such use is suspected.</p>	<p><b>To qualify for 6:</b> Assess water utility policies to ensure that all known occurrences of unauthorized consumption are captured, and that written procedures for use and documentation of various occurrences of unauthorized consumption as they are uncovered.</p>	<p><b>To maintain 10:</b> Continue to refine policy and procedures to eliminate any loopholes that allow or tacitly encourage unauthorized consumption. Continue to be vigilant in documentation and enforcement efforts.</p>			
Customer metering inaccuracies:	<p>Customer meters exist, but with unorganized paper records on meters; no meter accuracy testing or meter replacement program. Workflow is driven chaotically by customer complaints with no proactive management. Loss volume due to aggregate meter inaccuracy is guesstimated.</p>	<p>Poor recordkeeping and meter oversight is recognized by water management who has allotted staff and funding resources to organize improved recordkeeping and start meter accuracy testing. Existing paper records gathered and organized to provide cursory disposition of meter population.</p>	<p>Conditions between 2 and 4</p>	<p>Reliable recordkeeping exists; meter information is improving as meters are replaced. Meter accuracy testing is conducted annually for a small number of meters. Limited number of older meters replaced each year. Inaccuracy volume is largely an estimate, but refined based upon limited testing data.</p>	<p>Conditions between 4 and 6</p>	<p>A reliable electronic recordkeeping system for meters exists. Population includes a mix of new/high performing meters and dated meters with suspect accuracy. Routine, but limited, meter accuracy testing and meter replacement occur. Inaccuracy volume is quantified using a mix of reliable and less certain data.</p>	<p>Opping meter replacement and accuracy testing result in highly accurate customer meter population. Testing is conducted on samples of meters at varying lifespans to determine optimum replacement time for various types of meters.</p>	<p>Good records of number, type and size of customer meters; ongoing meter replacement occurs. Regular meter accuracy testing gives reliable measure of composite inaccuracy volume for the system. New metering technology is embraced to keep overall accuracy improving.</p>		
Improvements to obtain higher data grading for "Customer meter inaccuracy volume" component:	<p><b>To qualify for 1:</b> Gather available meter purchase records. Conduct testing on a small number of meters believed to be the most inaccurate. Review staffing needs of metering group and budget for necessary resources to better organize meter management.</p>	<p><b>To qualify for 2:</b> Implement a meter recordkeeping system for meter history. Primary data collection methods typically rely on the Customer Meter System or Customer Information System. Expand meter accuracy testing to a larger group of meters.</p>	<p>Conditions between 2 and 4</p>	<p>Standardized meter recordkeeping with the electronic information system. Annual meter accuracy testing and meter replacements guided by testing results.</p>	<p><b>To qualify for 5:</b> Expand annual meter accuracy testing to evaluate a statistically significant number of meters using standardized replacement program to replace statistically significant number of poor performing meters each year.</p>	<p><b>To qualify for 6:</b> Continue efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Expand testing in 5-10 customer accounts each year in order to test improving metering technology.</p>	<p><b>To maintain 10:</b> Increase the number of meters tested and replaced as justified by meter accuracy test data. Continually monitor development of new technology in Advanced Metering Infrastructure (AMI) to grasp opportunities for greater accuracy in metering and customer consumption data.</p>			

APPENDIX: LOSSES



Grading										
	1	2	3	4	5	6	7	8	9	10
select via only if the customer population is billed a flat or fixed rate charge that is not based upon measured volumes of water consumption (unmetered population)	Vague policy for permitting (creating new customer accounts) and billing. Billing records which are in disarray. No audits conducted to confirm billing data handling efficiency. Unknown number of customers escape routine billing due to lack of billing process oversight.	Policy for permitting and billing exists but needs refinement. Billing data maintained on paper records or insufficiently capable electronic database. Only periodic unstructured auditing work conducted to confirm billing data handling efficiency. Volume of unbilled water due to billing lapses is a guess.	Conditions between 2 and 4	Policy and procedures for permitting and billing exist but needs refinement. Computerized billing system in use with basic reporting available. Any effect of billing adjustments on measured consumption volumes is well understood. Internal checks of billing data error conducted annually. Reasonably accurate quantification of consumption volume lost to billing lapses is obtained.	Conditions between 4 and 6	Policy for permitting and billing is adequate and reviewed periodically. Computerized billing system in use with basic reporting available. Any effect of billing adjustments on measured consumption volumes is well understood. Internal checks of billing data error conducted annually. Reasonably accurate quantification of consumption volume lost to billing lapses is obtained.	Conditions between 6 and 8	Permitting and billing policy reviewed at least biannually. Computerized billing system includes an array of reports to confirm billing data and system functionality. Annual internal checks conducted with periodic third party audit. Accountability checks flag billing lapses. Consumption lost to billing lapses is well quantified and reducing year-by-year.	Conditions between 8 and 10	Sound policy exists for permitting of all customer billing accounts. Robust computerized billing system gives high functionality and reporting capabilities. Assessment of policy and data handling errors conducted internally and audited by third party annually, ensuring consumption lost to billing lapses is minimized and detected as it occurs.
Systematic Data Handling Error:										
Improvements to attain higher data grading for "Systematic Data Handling Error volume" component:	<i>To qualify for 2:</i> Draft written policy for permitting and billing. Investigate and budget for computerized customer billing system. Conduct initial audit of billing records by flow-charting the basic business processes of the customer account/billing function.	<i>To qualify for 4:</i> Finalize written policy for permitting and billing. Implement a computerized customer billing system. Conduct initial audit of billing records as part of this process.	<i>To qualify for 6:</i> Refine permitting and billing procedures and ensure consistency with the utility policy regarding billing. Upgrade or replace customer billing system for needed functionality - ensure that billing adjustments don't corrupt the value of consumption volumes. Procedure internal annual audit process.	<i>To qualify for 8:</i> Formalize regular review of permitting and billing practices. Enhance reporting capability of computerized billing system. Formalize regular auditing process to reveal scope of data handling error.	<i>To qualify for 10:</i> Close policy/procedure to improve that show promising error to exist. Ensure that internal and third party audits are conducted annually.	<i>To maintain 10:</i> Stay abreast of customer information management developments and innovations. Monitor developments and innovations of Advanced Metering Infrastructure (AMI) and integrate technology to ensure that customer endpoint information is well-maintained and error/lapses are at an economic minimum.				
<b>SYSTEM DATA</b>										
Length of mains.	Poorly assembled and maintained paper as-built records of existing water main installations makes accurate determination of system pipe length impossible. Length of mains is guesstimated.	Paper records in poor condition (no annual tracking of installations & abandonments). Poor procedures to ensure that new water mains installed by developers are accurately documented.	Conditions between 2 and 4	Sound policy and procedures for permitting and commissioning new water mains. Highly accurate paper records with regular field validation; or electronic records and asset management system in good condition. Includes system backup.	Conditions between 4 and 6	Sound policy and procedures exist for permitting and commissioning new water mains. Highly accurate paper records with regular field validation; or electronic records and asset management system in good condition. Includes system backup.	Conditions between 6 and 8	Sound policy and procedures exist for permitting and commissioning new water mains. Electronic recordkeeping and asset management system are used to store and manage data.	Conditions between 8 and 10	Sound policy exists for managing water mains extensions and replacements. Geographic Information System (GIS) data and asset management database agree and random field validation proves truth of databases.
Improvements to attain higher data grading for "Length of Water Mains" component:	<i>To qualify for 2:</i> Assign personnel to inventory current as-built records and compare with customer billing system records and highway plans. Assemble policy documents regarding permitting and documentation of water main installations by the utility and including developers. Identify gaps in procedures that result in poor documentation.	<i>To qualify for 4:</i> Complete inventory of paper records of water main installations & abandonments for a number of years prior to audit year. Review policy and procedures for commissioning and documenting new water main installation and abandonments.	<i>To qualify for 6:</i> Finalize updates/improvements to policy and main installations. Confirm inventory of records for five years prior to audit year; correct any errors or omissions.	<i>To qualify for 8:</i> Launch random field checks of limited number of locations. Convert to electronic databases with backup as justified.	<i>To qualify for 10:</i> Link Geographic Information System (GIS) and asset management databases, conduct field verification of data.	<i>To maintain 10:</i> Continue with standardization and random field validation to improve knowledge of system.				
Number of active AND inactive service connections.	Vague permitting (of new service connections) policy and poor paper recordkeeping of customer connections/billings result in suspect determination of the number of service connections, which may be 10-15% in error from actual count.	General permitting policy exists but paper records, procedural gaps, and weak oversight result in questionable total for number of connections, which may vary 5-10% of actual count.	Conditions between 2 and 4	Permitting policy and procedures exist, but with some gaps in performance and oversight. Computerized information management system is being brought online to replace dated paper recordkeeping system. Reasonably accurate tracking of service connection installations & abandonments; but count can be up to 5% in error from actual total	Conditions between 4 and 6	Permitting policy and procedures are adequate and reviewed periodically. Computerized information management system is in use with annual installations & abandonments tabulated. Very limited field verifications and audits. Error in count of number of service connections is believed to be no more than 3%.	Conditions between 6 and 8	Permitting policy and procedures reviewed at least biannually. Well managed computerized information management system and routine, periodic field checks and internal system audits allows counts of connections that is no more than 2% in error.	Conditions between 8 and 10	Sound permitting policy and well managed and audited procedures ensure reliable management of service connection population. Computerized information management system and Geographic Information System (GIS) information agree, field validation proves truth of databases. Count of connections believed to be in error by less than 1%.
Improvements to attain higher data grading for "Number of Active and Inactive customer service connections" component:	<i>To qualify for 2:</i> Draft new policy and procedures for permitting and billing. Research and collect paper records of installations & abandonments for several years prior to audit year.	<i>To qualify for 4:</i> Refine policy and procedures for permitting and billing. Research computerized recordkeeping system (Customer Information System or Customer Billing System) to improve documentation format for service connections.	<i>To qualify for 6:</i> Refine procedures to ensure consistency with permitting policy to establish new service connections or decommission existing ones. Improve process to include all totals for at least five years prior to audit year.	<i>To qualify for 8:</i> Formalize regular review of permitting policy and procedures. Launch random field checks of limited number of locations. Develop reports and auditing mechanisms for computerized information management system.	<i>To qualify for 10:</i> Close any procedural loopholes that allow installations to go undocumented. Link computerized information management system with Geographic Information System (GIS) and formalize field inspection and information system auditing processes. Documentation of new or decommissioned service connections encounters several levels of checks and balances.	<i>To maintain 10:</i> Continue with standardization and random field validation to improve knowledge of system.				

**Grading**

	1	2	3	4	5	6	7	8	9	10
	n/a	Grading 1-9 apply if customer meters exist and are located inside the customer building premises, or if the water utility owns and is responsible for the entire service connection piping from the water main to the customer building. In any of these cases the average distance between the curbside or boundary separating utility/customer responsibility for service connection piping, and the typical first point of use (ex: faucet) or the customer meter should be quantified. Grading 1-9 are used to grade the validity of the means to quantify this value. (See the "Service Connection Diagram" worksheet)								
Average length of customer service line:	If customer water meters are located outside of the customer building and adjacent to the curbside or boundary separating utility/customer responsibility for the service connection piping (typically in a meter box or meter pit), or the properties are unmetred. In either case the distance is highly reliable since data is drawn from a Geographic Information System (GIS) and confirmed by routine field checks.	Vague policy exists to define the delineation of water utility ownership and customer ownership of the service connection piping. Curbstops are perceived as the breakpoint but these have not been well-maintained or documented. Their location varies widely from site-to-site, and estimating this distance is arbitrary due to the unknown location of many curbstops.	Policy requires that the curbside point serves as the delineation point between water utility ownership and customer ownership of the service connection piping. Curbstops are generally installed as needed and are reasonably documented. Their location varies widely from site-to-site, and an estimate of this distance is hindered by the availability of paper records.	Good policy requires that the curbside point serves as the delineation point between water utility ownership and customer ownership of the service connection piping. Curbstops are generally installed as needed and are reasonably documented. Their location varies widely from site-to-site, and an estimate of this distance is hindered by the availability of paper records.	Conditions between 4 and 6	Clear policy exists to define utility/customer responsibility for service connection piping. Accurate, well-maintained paper or basic electronic recordkeeping system exists. Periodic field checks confirm piping lengths for a sample of customer properties.	Conditions between 6 and 8	Clearly worded policy standardizes the location of curbstops and meters, which are inspected upon installation. Accurate and well maintained electronic records exist with periodic field checks to confirm locations of service lines, curbstops and customer meter pits. An accurate number of customer properties from the customer billing system allows for reliable averaging of this length.	Conditions between 8 and 10	Either of two conditions can be met to obtain a grading of 10: a) The customer water meter is located outside of the customer building adjacent to the curbside or boundary separating utility/customer responsibility for the service connection piping. In this case enter a value of zero in the Reporting Worksheet with a grading of 10. b) Customer water meters are located inside customer buildings, or the properties are unmetred. In either case the distance is highly reliable since data is drawn from a Geographic Information System (GIS) and confirmed by routine field checks.
Improvements to obtain higher data grading for "Average Length of Customer Service Line" component:	Research and collect paper records of service line installations. Inspect several sites in the field using pipe locators to locate curbstops. Obtain the length of this small sample of connections in this manner.	Formalize and communicate policy delineating utility/customer responsibilities for service connection piping. Assess accuracy of paper records by field inspection of a small sample of service connections using pipe locators as needed. Research the potential migration to a computerized information management system to store service connection data.	Establish curbside, meter installation and documentation is followed. Gain consensus within the water utility for the establishment of a computerized information management system.	Implement an electronic means of recordkeeping, typically via a customer information system or customer billing system. Standardize the process to conduct field checks of limited number of locations.	to qualify for 8: Link customer information management system and Geographic Information System (GIS), random field validation to improve knowledge of system.	to qualify for 10: Continue with standardization and random field validation to improve knowledge of system.				
Average operating pressure:	Available records are poorly assembled and maintained paper records of supply pump characteristics and water distribution system operating conditions. Average pressure is guesstimated based upon this information and ground elevations from crude topographical maps. Widely varying distribution system pressures due to undulating terrain, high system head loss and weak/erratic pressure controls further compromise the validity of the average pressure calculation.	Limited telemetry monitoring of individual sites only when low pressure complaints arise, and is affected by significant variation in ground elevations, system head loss and pipe in pressure controls at points in the distribution system.	Effective pressure controls separate different pressure zones, moderate pressure variation across the system, occasional open boundary valves are discovered that breach pressure zones. Basic telemetry monitoring of the distribution system logs pressure data electronically. Pressure data gathered by gauges or dataloggers at fire hydrants or buildings when low pressure complaints arise, and during fire flow tests and system flushing. Average pressure is determined by using this mix of reliable topographical data. Average pressure is calculated using this mix of data.	Reliable pressure controls separate distinct pressure zones, only very occasional open boundary valves are encountered that breach pressure zones. Well-covered telemetry monitoring of the distribution system logs pressure data electronically. Pressure gathered by gauges/dataloggers at fire hydrants and buildings when low pressure complaints arise, and during fire flow tests and system flushing. Average pressure is determined by using this mix of reliable data.	Reliable pressure controls separate distinct pressure zones, only very occasional open boundary valves are encountered that breach pressure zones. Well-covered telemetry monitoring of the distribution system and collect readings at representative sites across the system. The average system pressure is determined from reliable SCADA System data.	Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA System exists to monitor the water distribution system and collect readings at representative sites across the system. The average system pressure is reliably calculated from extensive, reliable, and cross-checked data.				
Improvements to obtain higher data grading for "Average Operating Pressure" component:	Employ pressure gauging and/or datalogging equipment to obtain pressure measurements from fire hydrants. Locate accurate topographical maps of service area in order to confirm ground elevations. Research pump data sheets to fine tune pressure/flow characteristics	Formalize a procedure to use pressure gauging/datalogging equipment to gather pressure data during various system events such as low pressure complaints, or operational testing. Gather pump pressure and flow data at different flow regimes. Identify faulty pressure controls (pressure reducing valves, attitude valves, partially open boundary valves) and plan to properly configure pressure zones. Make all pressure data from these efforts available to generate system-wide average pressure.	Expand the use of pressure gauging/datalogging equipment to gather pressure data at representative set of sites. Based upon pressure zones or areas, utilize pump pressure and flow data to determine supply head entering each pressure zone or district. Connect any faulty pressure controls (pressure reducing valves, attitude valves, partially open boundary valves) to ensure properly configured pressure zones. Use expanded pressure dataset from these activities to generate system-wide average pressure.	Install a Supervisory Control and Data Acquisition (SCADA) System to monitor system parameters and control operations. Set regular calibration schedule for instrumentation to insure data accuracy. Obtain accurate topographical data and utilize pressure data gathered from field surveys to provide extensive, reliable data for pressure averaging.	to qualify for 8: Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.	to qualify for 10: Continue to refine the hydraulic model of the distribution system and consider linking it with SCADA data calibration, and pressure data averaging.				

Grading										
	1	2	3	4	5	6	7	8	9	10
	COST DATA									
Total annual cost of operating water system:	Incomplete paper records and lack of documentation on many operating functions making calculation of water system operating costs a pure guessimate	Reasonably maintained, but incomplete, paper or electronic accounting provides data to estimate the major portion of water system operating costs.	Conditions between 2 and 4	Electronic, industry-standard cost accounting system in place. Gaps in data known to exist; periodic internal reviews conducted but not a structured audit.	Conditions between 4 and 6	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited periodically by utility personnel, not a Certified Public Accountant (CPA).	Conditions between 6 and 8	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited at least annually by utility personnel, and periodically by third-party CPA.	Conditions between 8 and 10	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited annually by utility personnel and by third-party CPA.
Improvements to obtain higher data grading for "Total Annual Cost of Operating the Water System" component:	<b>To qualify for 2:</b> Gather available records, institute new procedures to regularly collect and audit basic cost data and most important operations functions.	<b>To qualify for 4:</b> Implement an electronic cost accounting system, structured according to accounting standards for water utilities	<b>To qualify for 3:</b> Establish processes for periodic internal audit of water system operating costs; identify cost data gaps and institute procedures for tracking these outstanding costs.	<b>To qualify for 5:</b> Standardize the process to conduct routine financial audit on an annual basis.	<b>To qualify for 6:</b> Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.	<b>To qualify for 7:</b> Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.	<b>To qualify for 8:</b> Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.	<b>To qualify for 9:</b> Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.	<b>To qualify for 10:</b> Maintain program, stay abreast of changes and budget/track costs proactively	
Customer retail unit cost (applied to Apparent Losses):	Antiquated, cumbersome water rate structure is use, with periodic historic amendments that were poorly documented and implemented, resulting in classes of customers being billed inconsistent charges. The actual composite billing rate likely differs significantly from the published water rate structure, but a lack of auditing leaves the degree of error indeterminate.	Dated, cumbersome water rate structure, not always employed consistently in actual billing operations. The actual composite billing rate is known to differ from the published water rate structure, and a reasonably accurate estimate of the degree of error is determined, allowing a composite billing rate to be quantified.	Conditions between 2 and 4	Straight-forward water rate structure in use, but not updated in several years. Billing operations reliably employ the rate structure. The composite billing rate is derived from a single number customer class such as residential customer accounts, neglecting the effect of different rates from varying customer classes.	Customer population unmeasured. Fixed fee charged; single composite number derived from multiple customer classes.	Clearly written, up-to-date water rate structure in place and is applied reliably by billing operations. Composite customer rate is determined using a weighted average residential, commercial, industrial, etc.)	Conditions between 6 and 8	Effective water rate structure is in place and is applied reliably in billing operations. Composite customer rate is determined using a weighted average composite consumption rate (includes residential, commercial, industrial, etc.)	Conditions between 8 and 10	Third party reviewed weighted average composite consumption rate (includes residential, commercial, industrial, etc.)
Improvements to obtain higher data grading for "Customer Retail Unit Cost" component:	<b>To qualify for 2:</b> Formalize the process to implement water rates, including a secure documentation process. Create a current and path rate document and gain approval from all stakeholders.	<b>To qualify for 4:</b> Review the water rate structure and update rates as needed. Billing operations to use their actual billing rate structure.	<b>To qualify for 3:</b> Evaluate volume of water used in each usage block by residential users. Multiply volumes by full moon water X-RATES	<b>To qualify for 5:</b> Evaluate volume of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	<b>To qualify for 6:</b> Evaluates volume of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	<b>To qualify for 7:</b> Evaluates volume of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	<b>To qualify for 8:</b> Conduct a periodic third-party audit of water used in each usage block by all classifications of users. Multiply volume by full rate structure.	<b>To qualify for 9:</b> Conduct a periodic third-party audit of water used in each usage block by all classifications of users. Multiply volume by full rate structure.	<b>To qualify for 10:</b> Keep water rate structure current in addressing the water utility's revenue needs. Update the calculation of the customer unit rate as new rate components, customer classes, or other components are modified	
Variable production cost (applied to Real Losses):	If the water utility purchases/imports its entire water supply, then enter the unit purchase cost of the bulk water supply in the Reporting Worksheet with a grading of 10	Incomplete paper records and lack of documentation on primary operating functions (electric power and treatment costs most importantly) makes calculation of variable production costs a pure guessimate	Conditions between 2 and 4	Electronic, industry-standard cost accounting system in place. Electric power and treatment costs are reliably tracked and allow accurate calculation of unit variable production costs based on these two inputs only. All costs are audited internally on a periodic basis.	Conditions between 4 and 6	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Pertinent additional costs beyond power and treatment (i.e. liability, residuals management, etc.) are included in the unit variable production cost. Data audited at least annually by utility personnel.	Conditions between 6 and 8	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited at least annually by utility personnel, and periodically by third-party.	Conditions between 8 and 10	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited annually by utility personnel and periodically by third-party CPA.
Improvements to obtain higher data grading for "Variable Production Cost" component:	<b>To qualify for 2:</b> Gather available records, institute new procedures to regularly collect and audit basic cost data and most important operations functions.	<b>To qualify for 4:</b> Implement an electronic cost accounting system, structured according to accounting standards for water utilities	<b>To qualify for 3:</b> Formalize processes for regular internal audits of production costs. Assess whether additional costs (liability, residuals management, etc.) should be included to calculate a more accurate variable production cost.	<b>To qualify for 5:</b> Formalize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.). Conduct periodic third-party audits.	<b>To qualify for 6:</b> Formalize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.). Conduct periodic third-party audits.	<b>To qualify for 7:</b> Formalize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.). Conduct periodic third-party audits.	<b>To qualify for 8:</b> Formalize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.). Conduct periodic third-party audits.	<b>To qualify for 9:</b> Formalize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.). Conduct periodic third-party audits.	<b>To qualify for 10:</b> Maintain program, stay abreast of changes and budget/track costs proactively	

[Return to Reporting Worksheet](#)

**Average Length of Customer Service Line**

The three figures shown on this worksheet display the assignment of the Average Length of Customer Service Line,  $L_p$ , for the three most common piping configurations.

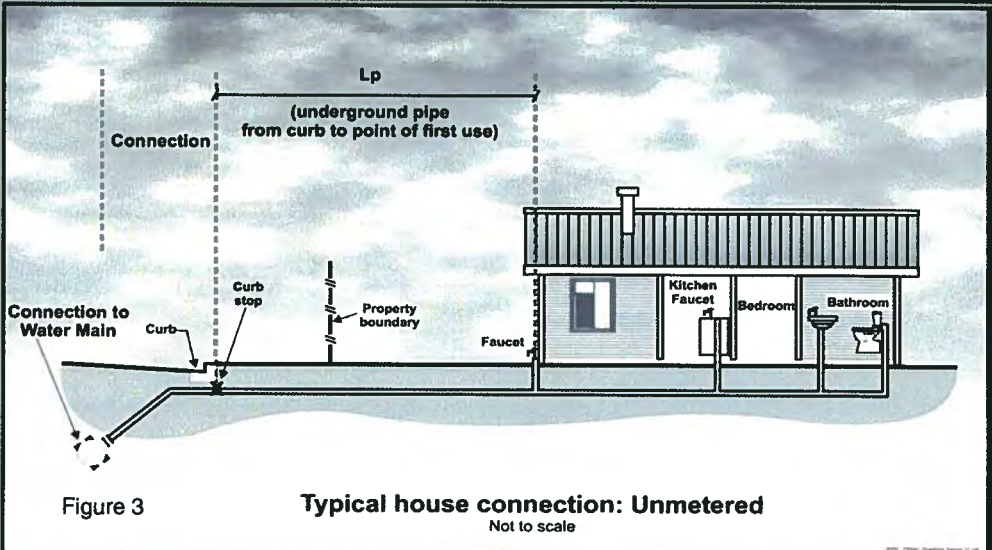
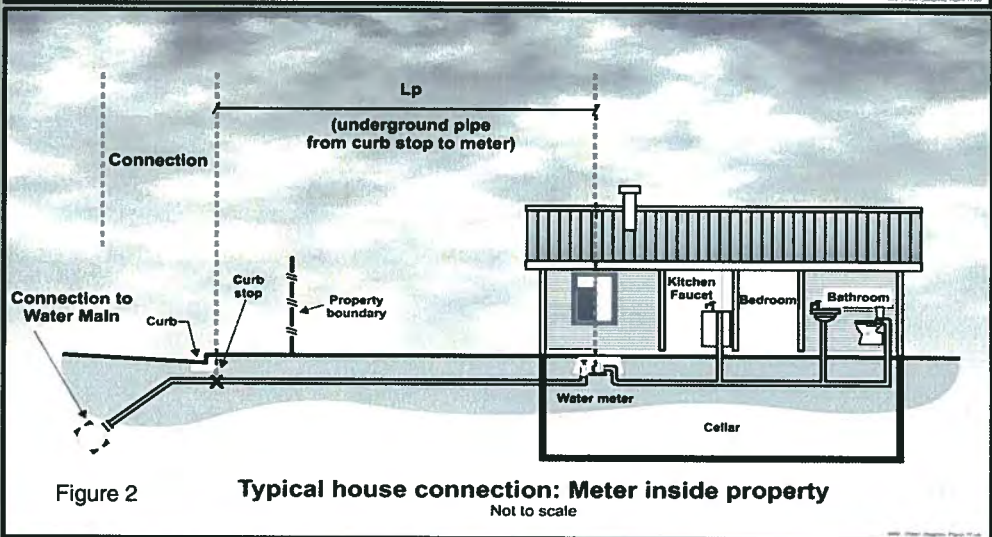
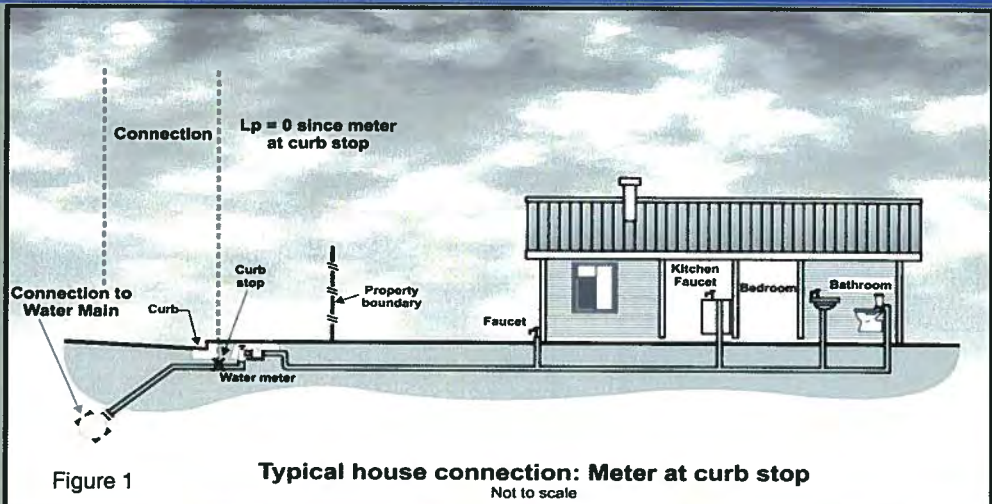
**Figure 1** shows the configuration of the water meter outside of the customer building next to the curbstop valve. In this configuration  $L_p = 0$  since the distance between the curbstop and the customer metering point is essentially zero.

**Figure 2** shows the configuration of the customer water meter located inside the customer building, where  $L_p$  is the distance from the curbstop to the water meter.

**Figure 3** shows the configuration of an unmetered customer building, where  $L_p$  is the distance from the curbstop to the first point of customer water consumption, or, more simply, the building line.

In any water system the  $L_p$  will vary notably in a community of different structures, therefore the average  $L_p$  value is used and this should be approximated or calculated if a sample of service line measurements has been gathered.


[Click for more information](#)



Item Name	Description
Apparent Losses	<p>= unauthorized consumption + meter under-registration + data handling errors</p> <p>Includes all types of inaccuracies associated with customer metering as well as data handling errors (meter reading and billing), plus unauthorized consumption (theft or illegal use).</p> <p>NOTE: Over-registration of customer meters, leads to under-estimation of Real Losses. Under-registration of customer meters, leads to over-estimation of Real Losses.</p>
AUTHORIZED CONSUMPTION	<p>= billed metered + billed unmetered + unbilled metered + unbilled unmetered</p> <p>The volume of metered and/or unmetered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorized to do so by the water supplier, for residential, commercial and industrial purposes. This does NOT include water sold to neighboring utilities (water exported).</p> <p>Authorized consumption may include items such as fire fighting and training, flushing of mains and sewers, street cleaning, watering of municipal gardens, public fountains, frost protection, building water, etc. These may be billed or unbilled, metered or unmetered.</p>
Average length of customer service line	<p>This is entered for unmetered services and in cold or other areas where meters are installed inside homes and buildings. It is the length of customer service line either between the utility's service connection (often at the curbstop) and the meter, or to the building line (first point of customer consumption) if customers are unmetered. Note that the length of service connection between the main and customer service line is owned by the utility and its length and potential leakage is accounted for in the UARL formula by the number of service connections.</p> <p><b>What role does the "Average Length of Customer Service Line" parameter serve in the Water Audit?</b></p> <p>In many water distribution systems the water utility has maintenance responsibility for a portion of the customer service piping from its connection point at the water main to the curbstop valve located midway to the customer building. The customer is responsible to maintain the customer service piping from the curbstop to the building premises. When leaks arise on customer service piping, water utilities respond faster to repair leaks than customers when the leak is on piping under their responsibility. Leak durations are longer on the customer-maintained piping than the utility-maintained piping. The total length of pipe maintained by customers is one of the components of the Unavoidable Annual Real Loss (UARL) equation and is determined by multiplying <a href="#">Click to see Service Connection Diagram</a> maintained pipe, by the number of customer service connections.</p>
Average operating pressure	<p>The average pressure may be approximated when compiling the preliminary water audit. Once routine water auditing has been established, a more accurate assessment of average pressure should be pursued. If the water utility infrastructure is recorded in a Geographical Information System (GIS) the average pressure at many locations in the distribution system can be readily obtained. If a GIS does not exist, a weighted average of pressure data can be calculated from water pressure measured at various fire hydrants scattered across the water distribution system.</p>
Billed Authorized Consumption	<p>All consumption that is billed and authorized by the utility. This may include both metered and unmetered consumption. See "Authorized Consumption" for more information.</p>
Billed metered consumption	<p>All metered consumption which is billed. This includes all groups of customers such as domestic, commercial, industrial or institutional. It does NOT include water sold to neighboring utilities (water exported) which is metered and billed. The metered consumption data can be taken directly from billing records for the water audit period. The accuracy of yearly metered consumption data can be refined by including an adjustment to account for customer meter reading lagtime, however additional analysis is necessary to determine the adjustment value, which may or may not be significant.</p>
Billed unmetered consumption	<p>All billed consumption which is calculated based on estimates or norms but is not metered. This might be a very small component in fully metered systems (for example billing based on estimates for the period a customer meter is out of order) but can be the key consumption component in systems without universal metering. It does NOT include water sold to neighboring utilities (water exported) which is unmetered but billed.</p>
Connection density	<p>=number of connections / length of mains</p>

Item Name		Description
Customer metering inaccuracies	Find	Apparent water losses caused by the collective under-registration of customer water meters. Many customer water meters will wear as large cumulative volumes of water are passed through them over time. This causes the meters to under-register. The auditor has two options for entering data for this component of the audit. The auditor can enter a percentage under-registration (typically an estimated value), this will apply the selected percentage to the two categories of metered consumption to determine the volume of water not recorded due to customer meter inaccuracy. Alternatively, if the auditor has substantial data from meter testing to arrive at their own volumes of such losses, this volume may be entered directly. Note that a value of zero will be accepted but an alert will appear asking if the customer population is unmetered. Since all metered systems have some degree of inaccuracy, then a positive value should be entered. A value of zero in this component is valid only if the water utility does not meter its customer population.
Customer retail unit cost	Find	The Customer Retail Unit Cost represents the charge that customers pay for water service. This unit cost is applied to the components of apparent loss, since these losses represent water reaching customers but not (fully) paid for. It is important to compile these costs per the same unit cost basis as the volume measure included in the water audit. For example, if all water volumes are measured in million gallons, then the unit cost should be dollars per million gallon (\$/mil gal). The software allows the user to select the units that are charged to customers (either \$/1,000 gallons, \$/hundred cubic feet or \$/1,000 litres) and automatically converts these units to the units that appear in the "WATER SUPPLIED" box. Since most water utilities have a rate structure that includes a variety of different costs based upon class of customer, a weighted average of individual costs and number of customer accounts in each class can be calculated to determine a single composite cost that should be entered into this cell.
Infrastructure Leakage Index (ILI)	Find	The ratio of the Current Annual Real Losses (Real Losses) to the Unavoidable Annual Real Losses (UARL). The ILI is a highly effective performance indicator for comparing (benchmarking) the performance of utilities in operational management of real losses.
Length of mains	Find	<p>Length of all pipelines (except service connections) in the system starting from the point of system input metering (for example at the outlet of the treatment plant). It is also recommended to include in this measure the total length of fire hydrant lead pipe. Hydrant lead pipe is the pipe branching from the water main to the fire hydrant. Fire hydrant leads are typically of a sufficiently large size that is more representative of a pipeline than a service connection. The average length of hydrant leads across the entire system can be assumed if not known, and multiplied by the number of fire hydrants in the system, which can also be assumed if not known. This value can then be added to the total pipeline length. Total length of mains can therefore be calculated as:</p> <p>Length of Mains, miles = (total pipeline length, miles) + [ (average fire hydrant lead length, ft) x (number of fire hydrants) / 5,280 ft/mile ]  or  Length of Mains, kilometres = (total pipeline length, kilometres) + [ (average fire hydrant lead length, metres) x (number of fire hydrants) / 1,000 metres/kilometre ]</p>
Master meter error adjustment	Find	An estimate or measure of the degree of any inaccuracy that exists in the master meters measuring the Volume from own sources. Please also indicate if this adjustment is because the master meters under-registered (did not capture all the flow) or over-registered (overstated the actual flow). All systems encounter some degree of error in their Master Meter data. Please enter a positive value.
NON-REVENUE WATER	Find	= Apparent Losses + Real Losses + Unbilled Metered + Unbilled Unmetered Water which does not provide any revenue to the utility
Number of active AND inactive service connections	Find	Number of service connections, main to curb stop. Please note that this includes the actual number of distinct piping connections including fire connections whether active or inactive. This may differ substantially from the number of Customers (or number of accounts)
Real Losses	Find	<p>Physical water losses from the pressurized system and the utility's storage tanks, up to the point of customer consumption. In metered systems this is the customer meter, in unmetered situations this is the first point of consumption (stop tap/tap) within the property.</p> <p>The annual volume lost through all types of leaks, breaks and overflows depends on frequencies, flow rates, and average duration of individual leaks, breaks and overflows.</p>
Revenue Water		Water which is charged to customers to provide revenue to the utility.
Systematic data handling errors	Find	Apparent water losses caused by systematic data handling errors in the meter reading and billing system.
Total annual cost of operating the water system	Find	These costs include those for operations, maintenance and any annually incurred costs for long-term upkeep of the system, such as repayment of capital bonds for infrastructure expansion or improvement. Typical costs include employee salaries and benefits, materials, equipment, insurance, fees, administrative costs and all other costs that exist to sustain the drinking water supply. These costs should not include any costs to operate wastewater, biosolids or other systems outside of drinking water.

Item Name	Description												
Unauthorized consumption	<p><a href="#">Find</a></p> <p>Includes water illegally withdrawn from hydrants, illegal connections, bypasses to consumption meter or meter reading equipment tampering. While this component has a direct impact on revenue, in most water utilities the volume is low and it is recommended that the auditor apply a default value of 0.25% of the volume from own sources. If the auditor has well validated data that indicates the volume from unauthorized consumption is substantially higher or lower than that generated by the default value then this value can be entered. However, for most water utilities it is recommended to apply the default value. Note that a value of zero will not be accepted since all water utilities have some volume of unauthorized consumption occurring in their system.</p>												
Unavoidable Annual Real Losses (UARL)	<p><a href="#">Find</a></p> <p>UARL (gallons/day)=(5.41Lm + 0.15Nc + 7.5Lc) xP, or UARL (litres/day)=(18.0Lm + 0.8Nc + 25.0Lc) xP</p> <p>where: Lm = length of mains (miles or kilometres) Nc = number of service connections Lc = total length of customer service lines (miles or km) = Nc multiplied by the average distance of customer service line, Lp (miles or km) P = Pressure</p> <p><a href="#">Click to see Service Connection Diagram</a></p> <p>The UARL is a theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied. It is a key variable in the calculation of the Infrastructure Leakage Index (ILI). It is not necessary that water utilities set this level as the target level of leakage, unless water is unusually expensive, scarce or both.</p> <p>NOTE: The UARL calculation has not yet been fully proven as effective for very small, or low pressure water distribution systems. If, <u>in gallons per day:</u> (Lm x 32) + Nc &lt; 3000 or P &lt; 35psi <u>in litres per day:</u> (Lm x 20) + Nc &lt; 3000 or P &lt; 25m then the calculated UARL value may not be valid. The software does not display a value of UARL or ILI if either of these conditions is true.</p>												
Unbilled Authorized Consumption	<p>All consumption that is unbilled, but still authorized by the utility. See 'Authorized Consumption' for more information.</p>												
Unbilled metered consumption	<p><a href="#">Find</a></p> <p>Metered Consumption which is for any reason unbilled. This might for example include metered consumption of the utility itself or water provided to institutions free of charge. It does NOT include water sold to neighboring utilities (water exported) which is metered but unbilled.</p>												
Unbilled unmetered consumption	<p><a href="#">Find</a></p> <p>Any kind of Authorized Consumption which is neither billed nor metered. This component typically includes items such as fire fighting, flushing of mains and sewers, street cleaning, frost protection, etc. In most water utilities it is a small component which is very often substantially overestimated. It does NOT include water sold to neighboring utilities (water exported) which is unmetered and unbilled - an unlikely case. This component has many sub-components of water use which are often tedious to identify and quantify. Because of this, and the fact that it is usually a small portion of the water supplied, it is recommended that the auditor apply the default value of 1.25% of the volume from own sources. Select the default percentage to enter this value. If the water utility already has well validated data that gives a value substantially higher or lower than the default volume, then the auditor should enter their own volume. However the default approach is recommended for most water utilities. Note that a value of zero is not permitted, since all water utilities have some volume of water in this component occurring in their system.</p>												
Units and Conversions	<p><a href="#">Find</a></p> <p>The user may develop an audit based on one of three unit selections: 1) Million Gallons (US) 2) Megalitres (Thousand Cubic Metres) 3) Acre-feet</p> <p>Once this selection has been made in the instructions sheet, all calculations are made on the basis of the chosen units. Should the user wish to make additional conversions, a unit converter is provided below (use drop down menus to select units from the yellow unit boxes):</p> <table border="1" data-bbox="597 1717 1430 1797"> <tr> <td>Enter Units:</td> <td>Convert From...</td> <td>=</td> <td>Converts to....</td> </tr> <tr> <td>1</td> <td>Million Gallons (US)</td> <td>=</td> <td>1 Million Gallons (US)</td> </tr> <tr> <td colspan="4" style="text-align: center;">(conversion factor = 1)</td> </tr> </table>	Enter Units:	Convert From...	=	Converts to....	1	Million Gallons (US)	=	1 Million Gallons (US)	(conversion factor = 1)			
Enter Units:	Convert From...	=	Converts to....										
1	Million Gallons (US)	=	1 Million Gallons (US)										
(conversion factor = 1)													

Item Name	Description
Use of Option Buttons	<p>To use the percent value choose this button</p> <p>To enter a value choose this button and enter the value in the cell to the right</p>  <p><b>NOTE:</b> For unbilled unmetered consumption and unauthorized consumption, a recommended default value can be applied by selecting the Percent option. The default values are based on fixed percentages of water supplied and are recommended for use in this audit unless the auditor has well validated data for their system. Default values are shown by purple cells, as shown in the example above.</p> <p>If a default value is selected, the user does not need to grade the item; a grading value of 3 is automatically applied (however, this grade will not be displayed).</p>
Variable production cost (applied to Real Losses)	<p>The cost to produce and supply the next unit of water. (E.g., \$/million gallons) This cost is determined by calculating the summed unit costs for ground and surface water treatment and all power used for pumping from the source to the customer. It should also include the unit cost of bulk water purchased as an import if applicable.</p>
Volume from own sources	<p>The volume of treated water input to system from own production facilities</p>
Water exported	<p>Bulk water sold and conveyed out of the water distribution system. Typically this is water sold to a neighboring water utility. Be sure to account for any export meter inaccuracy in reporting this volume</p>
Water imported	<p>Bulk water purchased to become part of the water supplied. Typically this is water purchased from a neighboring water utility or regional water authority. Be sure to account for any import meter inaccuracy in reporting this volume</p>
WATER LOSSES	<p>= apparent losses + real losses</p> <p>The difference between System Input and Authorized Consumption. Water losses can be considered as a total volume for the whole system, or for partial systems such as transmission or distribution systems, or individual zones. Water Losses consist of Real Losses and Apparent Losses.</p>



## Water Loss Control Planning Guide

Water Audit Data Validity Level / Score					
Functional Focus Area	Level I (0-25)	Level II (26-50)	Level III (51-70)	Level IV (71-90)	Level V (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		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.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

*For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.*

Once data has been entered into the Reporting Worksheet, the performance indicators are automatically calculated. How does a water utility operator know how well his or her system is performing? The AWWA Water Loss Control Committee provided the following table to assist water utilities in gauging an approximate Infrastructure Leakage Index (ILI) that is appropriate for their water system and local conditions. The lower the amount of leakage and real losses that exist in the system, then the lower the ILI value will be.

**Note:** this table offers an approximate guideline for leakage reduction target-setting. The best means of setting such targets include performing an economic assessment of various loss control methods. However, this table is useful if such an assessment is not possible.

**General Guidelines for Setting a Target ILI  
(without doing a full economic analysis of leakage control options)**

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 - 5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning.
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		

[Click to access definition](#)

Water Audit Report for: **Philadelphia Water Department**  
 Reporting Year: **2008** **7/2007 - 6/2008**

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 (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**

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="7"/>	<input type="text" value="94,536.900"/>	Million gallons (US)/yr (MG/Yr)
Master meter error adjustment:	<input type="text" value="10"/>	<input type="text" value="2,779.300"/>	over-registered MG/Yr
Water imported:	<input type="text" value="n/a"/>		MG/Yr
Water exported:	<input type="text" value="10"/>	<input type="text" value="7,100.400"/>	MG/Yr
<b>WATER SUPPLIED:</b>		<b>84,657.200</b>	<b>MG/Yr</b>

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="7"/>	<input type="text" value="57,242.400"/>	MG/Yr
Billed unmetered:	<input type="text" value="n/a"/>		MG/Yr
Unbilled metered:	<input type="text" value="n/a"/>		MG/Yr
Unbilled unmetered:	<input type="text" value="8"/>	<input type="text" value="764.200"/>	MG/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>58,006.600</b>	<b>MG/Yr</b>

Click here:  for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

**26,650.600** MG/Yr

**Apparent Losses**

Unauthorized consumption:	<input type="text" value="8"/>	<input type="text" value="2,086.300"/>	MG/Yr
Customer metering inaccuracies:	<input type="text" value="8"/>	<input type="text" value="190.300"/>	MG/Yr
Systematic data handling errors:	<input type="text" value="5"/>	<input type="text" value="4,674.400"/>	MG/Yr
<b>Apparent Losses:</b>		<b>6,951.000</b>	<b>MG/Yr</b>

Pcnt:  Value:

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:	<input type="text" value="19,699.600"/>	MG/Yr
<b>WATER LOSSES:</b>	<b>26,650.600</b>	<b>MG/Yr</b>

**NON-REVENUE WATER**

**NON-REVENUE WATER:**  MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="9"/>	<input type="text" value="3,137.0"/>	miles
Number of active AND inactive service connections:	<input type="text" value="7"/>	<input type="text" value="547.932"/>	
Connection density:		<input type="text" value="175"/>	conn./mile main
Average length of customer service line:	<input type="text" value="7"/>	<input type="text" value="12.0"/>	ft (pipe length between curbside and customer meter or property boundary)
Average operating pressure:	<input type="text" value="10"/>	<input type="text" value="55.0"/>	psi

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="10"/>	<input type="text" value="\$219,182,339"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="9"/>	<input type="text" value="\$4.97"/>	\$/1000 gallons (US)
Variable production cost (applied to Real Losses):	<input type="text" value="9"/>	<input type="text" value="\$215.50"/>	\$/Million gallons

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="32.4%"/>
Non-revenue water as percent by cost of operating system:	<input type="text" value="17.8%"/>
Annual cost of Apparent Losses:	<input type="text" value="\$34,546,470"/>
Annual cost of Real Losses:	<input type="text" value="\$4,245,264"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="34.76"/>	gallons/connection/day
Real Losses per service connection per day*:	<input type="text" value="98.50"/>	gallons/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per psi pressure:	<input type="text" value="1.79"/>	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	<input type="text" value="2,178.15"/>	million gallons/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="9.04"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 82 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: Billed metered**
- 3: Systematic data handling errors**

[For more information, click here to see the Grading Matrix worksheet](#)

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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Water Audit Report for: **Regional Municipality of Peel**  
 Reporting Year: **2008** 1/2008 - 12/2008

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 (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: MEGALITRES (THOUSAND CUBIC METRES) PER YEAR

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="7"/>	<input type="text" value="213,977.000"/>	Megalitres/yr (or ML/Yr)
Master meter error adjustment:	<input type="text" value="4"/>	<input type="text" value="0.000"/>	ML/Yr
Water imported:	<input type="text" value="n/a"/>	<input type="text" value="0.000"/>	ML/Yr
Water exported:	<input type="text" value="7"/>	<input type="text" value="26,457.500"/>	ML/Yr
<b>WATER SUPPLIED:</b>		<b>187,519.500</b>	ML/Yr

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="7"/>	<input type="text" value="163,665.000"/>	ML/Yr
Billed unmetered:	<input type="text" value="2"/>	<input type="text" value="433.900"/>	ML/Yr
Unbilled metered:	<input type="text" value="8"/>	<input type="text" value="1,768.400"/>	ML/Yr
Unbilled unmetered:	<input type="text" value="5"/>	<input type="text" value="230.100"/>	ML/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>166,097.400</b>	ML/Yr

Click here:  for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

**21,422.100** ML/Yr

**Apparent Losses**

Unauthorized consumption:   ML/Yr

Customer metering inaccuracies:   ML/Yr  
 Systematic data handling errors:   ML/Yr

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Apparent Losses:   ML/Yr

Pcnt:  Value:

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:   ML/Yr

**WATER LOSSES:**   ML/Yr

**NON-REVENUE WATER**

NON-REVENUE WATER:   ML/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="8"/>	<input type="text" value="4,161.0"/>	kilometers
Number of active AND inactive service connections:	<input type="text" value="9"/>	<input type="text" value="287,905"/>	
Connection density:		<input type="text" value="69"/>	conn./km main
Average length of customer service line:	<input type="text" value="5"/>	<input type="text" value="16.0"/>	metres (pipe length between curbside and customer meter or property boundary)
Average operating pressure:	<input type="text" value="6"/>	<input type="text" value="58.4"/>	metres (head)

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="3"/>	<input type="text" value="\$100,000,000"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="10"/>	<input type="text" value="\$0.64"/>	\$/1000 litres
Variable production cost (applied to Real Losses):	<input type="text" value="10"/>	<input type="text" value="\$642.00"/>	\$/Megalitre

Retail costs are less than (or equal to) production costs; please review and correct if necessary

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="12.5%"/>
Non-revenue water as percent by cost of operating system:	<input type="text" value="15.0%"/>
Annual cost of Apparent Losses:	<input type="text" value="\$2,399,668"/>
Annual cost of Real Losses:	<input type="text" value="\$11,353,321"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="35.57"/>	litres/connection/day
Real Losses per service connection per day*:	<input type="text" value="168.29"/>	litres/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per meter (head) pressure:	<input type="text" value="2.88"/>	litres/connection/day/m
Unavoidable Annual Real Losses (UARL):	<input type="text" value="8,960.91"/>	cubic meters/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="1.97"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 64 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: Master meter error adjustment
- 3: Billed unmetered

[For more information, click here to see the Grading Matrix worksheet](#)

**AWWA WLCC Free Water Audit Software: Acknowledgements**

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WAS v4.0

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AWWA Water Audit Software Version 4.0 Developed by the Water Loss Control Committee of the American Water Works Association April 2009

This software is intended to serve as a basic tool to compile a preliminary, or "top-down", water audit. It is recommended that users also refer to the 3rd Edition AWWA M36 Publication, Water Audits and Loss Control Programs, for detailed guidance on compiling a comprehensive, or "bottom-up", water audit using the same water audit methodology.

**DEVELOPED BY: ANDREW CHASTAIN-HOWLEY, Miya Water**

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**REFERENCES:**

- Alegre, H., Hirner, W., Baptista, J. and Parena, R. Performance Indicators for Water Supply Services. IWA Publishing 'Manual of Best Practice' Series, 2000. ISBN 1 900222 272
- Kunkel, G. et al, 2003. Water Loss Control Committee Report: Applying Worldwide Best Management Practices in Water Loss Control. Journal AWWA, 95:8:65
- AWWA Water Audits and Loss Control Programs, M36 Publication, 3<sup>rd</sup> Edition, 2009
- Service Connection Diagrams courtesy of Ronnie McKenzie, WRP Pty Ltd.

# AWWA Water Loss Control Committee (WLCC) Free Water Audit Software v4.0

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WAS v4.0

**PURPOSE:** 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.

**USE:** The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons on the left below. Descriptions of each sheet are also given below.

**THE FOLLOWING KEY APPLIES THROUGHOUT:**

- Value can be entered by user
- Value calculated based on input data
- These cells contain recommended default values

Please begin by providing the following information, then proceed through each sheet in the workbook:

NAME OF CITY OR UTILITY:  COUNTRY:

REPORTING YEAR:  START DATE (MM/YYYY):  END DATE (MM/YYYY):

NAME OF CONTACT PERSON:  E-MAIL:  TELEPHONE:  Ext.

PLEASE SELECT PREFERRED REPORTING UNITS FOR WATER VOLUME:

Click to advance to sheet...

- 
- 
- 
- 
- 
- 
- 

The current sheet

Enter the required data on this worksheet to calculate the water balance

The values entered in the Reporting Worksheet are used to populate the water balance

Depending on the confidence of audit inputs, a grading is assigned to the audit score

Diagrams depicting possible customer service connection configurations

Use this sheet to understand terms used in the audit process

Use this sheet to interpret the results of the audit validity score and performance indicators

**Comments:**

Add comments here to track additional supporting information, sources or names of participants

If you have questions or comments regarding the software please contact us at: [wfc@awwa.org](mailto:wfc@awwa.org)



Water Exported		Billed Water Exported		Revenue Water
Own Sources (Adjusted for known errors)	<b>21,858.000</b>	Billed Authorized Consumption	<b>29,937.000</b>	<b>29,937.000</b>
		Authorized Consumption	<b>29,976.000</b>	
		Unbilled Authorized Consumption	<b>0.000</b>	
		Unbilled Authorized Consumption	<b>39.000</b>	
Water Supplied	<b>31,631.000</b>	Apparent Losses	<b>10.000</b>	
		Water Losses	<b>500.000</b>	
		Real Losses	<b>1,144.000</b>	
Water Imported	<b>9,773.000</b>	Leakage on Transmission and/or Distribution Mains	<b>Not broken down</b>	
		Leakage and Overflows at Utility's Storage Tanks	<b>Not broken down</b>	
		Leakage on Service Connections	<b>Not broken down</b>	
		Systematic Data Handling Errors	<b>1.000</b>	
		Unauthorized Consumption	<b>39.000</b>	
		Customer Metering Inaccuracies	<b>500.000</b>	
		Billed Metered Consumption (inc. water exported)	<b>29,937.000</b>	
		Billed Unmetered Consumption	<b>0.000</b>	
		Unbilled Metered Consumption	<b>0.000</b>	
		Unbilled Unmetered Consumption	<b>39.000</b>	
		Non-Revenue Water (NRW)		<b>1,694.000</b>



In the Reporting Worksheet, grades were assigned to each component of the audit to describe the confidence and accuracy of the input data. The grading assigned to each audit component and the corresponding recommended improvements and actions are highlighted in yellow. Audit accuracy is likely to be improved by prioritizing those items shown in red

Grading

	1	2	3	4	5	6	7	8	9	10
Volume from own sources:	Less than 25% of water production sources are metered, remaining sources are estimated. No regular meter accuracy testing.	25% - 50% of water production sources are metered; other sources estimated. No regular meter accuracy testing.	Conditions between 2 and 4	50% - 75% of water production sources are metered, other sources estimated. Occasional meter accuracy testing	Conditions between 4 and 6	At least 75% of 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 conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 8 and 8	100% of water supply sources are metered, meter accuracy testing and electronic calibration conducted annually, less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of water production sources are metered, meter accuracy testing and electronic calibration conducted semi-annually, with less than 10% found outside of +/- 5% accuracy.
Improvements to attain higher data grading for "Volume from own Sources" component:	<b>To qualify for 2:</b> Organize efforts to begin to collect data for determining volume from own sources	<b>To qualify for 4:</b> Locate all water production sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered water production sources and replace any obsolete/defective meters	<b>To qualify for 4:</b> No automatic datalogging of production volumes; daily readings are scribed on paper records. Tank/storage elevation changes are not employed in calculating "Volume from own sources" component. Data is adjusted only when grossly evident data error occurs.	<b>To qualify for 6:</b> Formalize annual meter accuracy testing for all source meters. Complete installation of meters on unmetered water production sources and complete replacement of all obsolete/defective meters.	<b>To qualify for 8:</b> Conduct annual meter accuracy testing on all meters. Complete project to install new, or replace defective existing, meters so that entire production meter population is metered. Repair or replace meters outside of +/- 6% accuracy.	<b>To qualify for 10:</b> Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology, pilot one or more replacements with innovative meters in attempt to improve meter accuracy.	<b>To qualify for 10:</b> Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/pilot improving metering technology.			
Master meter error adjustment:	Select n/a only if the water utility fails to have meters on its sources of supply, either its own sources, and/or imported (purchased) water sources	Inventories information on meters and paper records of measured volumes in crude condition; data error cannot be determined	Production meter data is logged automatically in electronic format and reviewed at least on a monthly basis. "Volume from own sources" tabulations include estimates of daily changes in tank/storage facilities. Meter data is adjusted when gross data errors occur, or occasional meter testing deems this necessary	<b>To qualify for 6:</b> Hourly production meter data logged automatically & reviewed on at least a weekly basis. Data adjusted to correct gross error from equipment malfunction and error confirmed by meter accuracy testing. Tank/storage facility elevation changes are automatically used in calculating a balanced "Volume from own sources" component.	<b>To qualify for 8:</b> Hourly production meter data logged automatically & reviewed on at least a weekly basis. Data adjusted to correct gross error from equipment malfunction and error confirmed by meter accuracy testing. Tank/storage facility elevation changes are automatically used in calculating a balanced "Volume from own sources" component.	<b>To qualify for 10:</b> Computerized system (SCADA or similar) automatically balances flows from all sources and stores; results reviewed daily. Mass balance technique compares production meter data to raw (untreated) water and treatment volumes to detect anomalies. Regular calibrations between SCADA and sources meters ensures minimal data transfer error.				
Improvements to attain higher data grading for "Master meter error adjustment" component:	<b>To qualify for 2:</b> Develop plan to meterize water sources; begin to capture all flow data; set procedure to review data daily to detect input errors	<b>To qualify for 4:</b> Install automatic datalogging equipment on production meters. Identify tank/storage facilities and include estimated daily volume of water added to, or subtracted from, "Water Supplier" volume based upon changes in storage	<b>To qualify for 6:</b> Review hourly production meter data for gross error on, at least, a weekly basis. Begin to install instrumentation on tank/storage facilities to record elevation changes. Use daily net storage change to balance flows in calculating "Water Supplier" volume	<b>To qualify for 8:</b> Complete installation of elevation instrumentation on all tank/storage facilities. Continue to use daily net storage change in calculating balanced "Volume from own sources" component. Hourly production meter data for gross error and frequency confirmed by testing.	<b>To qualify for 10:</b> Link all production and tank/storage facility elevation change data to a Supervisory Control & Data Acquisition (SCADA) System, or similar computerized monitoring/control system, and establish automatic flow balancing algorithm and regularly calibrate between SCADA and source meters.					
Water imported:	Less than 25% of imported water remaining sources are metered. No regular meter accuracy testing.	25% - 50% of imported water sources are metered; other sources estimated. No regular meter accuracy testing.	Conditions between 2 and 4	50% - 75% of imported water sources are metered; other sources estimated. Occasional meter accuracy testing	Conditions between 4 and 6	At least 75% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 8 and 8	100% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted semi-annually, with less than 10% found outside of +/- 5% accuracy	Conditions between 8 and 10	100% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted semi-annually, with less than 10% found outside of +/- 5% accuracy
Improvements to attain higher data grading for "Water Imported Volume" component:	<b>To qualify for 2:</b> Review bulk water purchase agreements with partner suppliers; confirm requirements for use and maintenance of accurate metering. Identify needs for new or replacement meters with goal to meter all imported water sources.	<b>To qualify for 4:</b> Locate all imported water sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered imported water interconnections and replace obsolete/defective meters	<b>To qualify for 6:</b> Formalize annual meter accuracy testing for all imported water meters. Continue installation of interconnections and replacement of obsolete/defective meters.	<b>To qualify for 8:</b> Formalize annual meter accuracy testing for all source meters. Complete installation of meters on unmetered water production sources and complete replacement of all obsolete/defective meters.	<b>To qualify for 10:</b> Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology, pilot one or more replacements with innovative meters in attempt to improve meter accuracy.					

Grading										
	1	2	3	4	5	6	7	8	9	10
Water Exported	Select n/a if the water utility sells no bulk water to neighboring water utilities (no exported water sales)	25% - 50% of exported water sources are metered, other sources estimated. No regular meter accuracy testing.	Conditions between 2 and 4	50% - 75% of exported water sources are metered, other sources estimated. Occasional meter accuracy testing.	Conditions between 4 and 8	At least 75% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of meters are found outside of +/- 6% accuracy.	Conditions between 8 and 9	100% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, with less than 10% found outside of +/- 6% accuracy.	Conditions between 8 and 10	100% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, with less than 10% found outside of +/- 3% accuracy.
Improvements to obtain higher data grading for "Water Exported Volume" component:	To qualify for 2: Review bulk water sales agreements with partner suppliers; confirm requirements for use & upkeep of accurate metering. Identify needs to install new, or replace defective meters as needed.	To qualify for 3: Locate all exported water sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetred exported water interconnections and replace obsolete/defective meters.	To qualify for 4: Formalize annual meter accuracy testing for all exported water meters. Continue installation of interconnections and replacement of obsolete/defective meters.	To qualify for 5: Complete project to install meter accuracy testing for all defective meters on all exported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	To qualify for 6: Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology, pilot one or more replacements with innovative meters in attempt to improve meter accuracy.	To qualify for 7: Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/pilot improving metering technology.				
Billed metered:	Select n/a only if the customer population is not metered, and is not billed for water service on a flat or fixed rate basis	At least 50% of customers with volume-based billing from meter reads; flat or fixed rate billed for remainder. Manual meter reading used, at least 50% meter read success rate, failed reads are estimated. Limited customer meter records, no regular meter testing or replacement. Billing data maintained on paper records, with no auditing.	Conditions between 2 and 4	At least 75% of customers with volume-based billing from meter reads; flat or fixed rate billed for remainder. Manual meter reading used, at least 50% meter read success rate, failed reads are estimated. Purchase records verify age of customer meters; only very limited meter accuracy testing is conducted. Customer meters replaced only upon complete failure. Computerized billing records, but only periodic internal auditing conducted.	Conditions between 4 and 6	At least 90% of customers with volume-based billing from meter reads; remaining accounts are estimated. Manual customer meter reading gives at least 80% success rate, failed reads are estimated. Good customer meter records, regular replacement of oldest meter accuracy testing, regular computerized billing records with routine auditing of global statistics.	Conditions between 6 and 8	At least 97% of customers with volume-based billing from meter reads. At least 90% customer meter read success rate, or minimum 80% read success rate with planning and budgeting for Meter Reading (AMR) trials underway. Satisfactorily significant customer meter testing and replacement program in place. Computerized billing with routine auditing, including routine investigation of representative sample of accounts. Annual audit verification by third party.	Conditions between 8 and 10	At least 99% of customers with volume-based billing from meter reads. At least 95% customer meter read success rate, or minimum 80% meter reading success rate, with Automatic Meter Reading (AMR) trials underway. Satisfactorily significant customer meter testing and replacement program in place. Computerized billing with routine auditing, including routine investigation of representative sample of accounts. Annual audit verification by third party.
Improvements to obtain higher data grading for "Water Metered Consumption" component:	If n/a is selected because the customer population is unmetred, consider establishing a new policy to meter the customer population and employ water rates based upon metered volumes.	To qualify for 2: Conduct investigations or trials of customer meter models. Budget funding for meter installations. Investigate volume based water rate structures.	To qualify for 3: Purchase and install meters on unmetred accounts. Implement policies to improve meter reading success. Casing meter information during meter read visits to identify age/models of existing meters. Test a minimal number of meters for accuracy, install computerized billing system.	To qualify for 4: Purchase and install meters on unmetred accounts. Eliminate flat fee billing and establish appropriate water rate structure based upon measured consumption. Continue to achieve verifiable success in removing manual meter reading barriers. Expand meter accuracy testing. Launch regular meter replacement program. Conduct routine audit of global statistics.	To qualify for 5: Purchase and install meters on unmetred accounts. Assess cost-effectiveness of AMR system for entire system, or achieve ongoing improvements in manual meter reading success rate. Refine meter accuracy testing upon accuracy test results. Refine routine auditing procedures based upon third party guidance.	To qualify for 6: Purchase and install meters on unmetred accounts. Launch Automatic Meter Reading (AMR) system trials if manual meter reading success rate of at least 80% is not achieved within a five-year program. Continue meter accuracy testing program. Conduct planning and budgeting for large scale meter replacement based upon meter life cycle analysis using cumulative flow target. Continue routine auditing and require annual third party review.	To qualify for 7: Regular internal and third party metering, and meter accuracy testing on unmetred customers. Obtain accurate customer metering data for volume based billing. Stay abreast of improvements in Advanced Metering Infrastructure (AMI) and information management. Plan and budget for justified upgrades in metering, meter reading and billing data management.			
Billed unmetred:	Select n/a if the utility policy to meter all customers and it has been confirmed that all customers do indeed have a water meter; i.e. no unmetred accounts exist	Water utility policy does not require customer metering; flat or fixed fee billed. Some metered accounts exist in parts of the system (pilot areas or District Metered Areas) with consumption recorded on portable dataloggers. Data from these sample meters are used to infer consumption for the total customer population. Site specific estimation methods are used for unusual buildings/water uses.	Water utility policy does require metering and volume based billing but lacks written procedures and employs casual oversight, resulting in up to 20% of billed accounts believed to be unmetred. A rough estimate of the annual consumption for all unmetred accounts is included in the annual water audit, with no inspection of individual unmetred accounts.	Water utility policy does require metering and volume based billing but accounts exist for a portion of buildings. As many as 15% of billed accounts are unmetred due to this exemption or meter installation difficulties. Only a group estimate of annual consumption for all unmetred accounts is included in the annual water audit, with no inspection of individual unmetred accounts.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 5% of billed accounts unmetred and existing because meter installation is hindered by unusual circumstances. The goal is to minimize the number of unmetred accounts. Reliable estimates of consumption are obtained for unmetred accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Less than 2% of billed accounts are unmetred and exist because meter installation is hindered by unusual circumstances. The goal exists to minimize the number of unmetred accounts to the extent that is economical. Reliable estimates of consumption are obtained at these accounts via site specific estimation methods.				

Grading										
	1	2	3	4	5	6	7	8	9	10
Improvements to attain higher data grading for "Unmetered Consumption" component:	<p><b>To qualify for 2:</b> Investigate a new water utility policy to require metering of the customer population, and a study to include several different meter types, which will provide data for economic assessment of full scale metering options. Assess sites with access difficulties to devise means to obtain water consumption volumes, means to obtain water consumption volumes, means to obtain water consumption volumes.</p>	<p><b>To qualify for 4:</b> Implement a new water utility policy requiring customer metering. Expand pilot metering study to include several different meter types, which will provide data for economic assessment of full scale metering options. Assess sites with access difficulties to devise means to obtain water consumption volumes, means to obtain water consumption volumes, means to obtain water consumption volumes.</p>	<p><b>To qualify for 6:</b> Budget for staff resources to review billing records to identify unmetered accounts. Specify metering needs and funding requirements to install sufficient meters to significantly reduce the number of unmetered accounts.</p>	<p><b>To qualify for 8:</b> Install customer meters on a full scale basis. Refine metering policy and procedures to ensure that all accounts, including municipal properties, are designated for metering. Implement procedures to obtain reliable consumption estimates for unmetered accounts awaiting meter installation.</p>	<p><b>To qualify for 10:</b> Continue customer meter installation throughout the service area, with a goal to minimize unmetered accounts. Sustain the effort to investigate accounts with access difficulties to devise means to install water meters or otherwise measure water consumption.</p>	<p><b>To maintain 10:</b> Continue to refine estimation methods for unmetered consumption and explore means to establish metering, for as many unmetered accounts as is economically feasible.</p>				
Unbilled metered:	<p>Billing practices exempt certain accounts, such as municipal buildings, but written policies do not exist; and a reliable count of unbilled metered accounts is unavailable. Meter replacement and meter reading occurs on an as-needed basis. The total annual water metered accounts is estimated based upon approximating the number of accounts and assigning consumption from actively billed accounts of same meter size</p>	<p>Billing practices exempt certain accounts, such as municipal buildings, but written directives exist to justify this practice. A reliable count of unbilled metered accounts is unavailable. Sporadic meter replacement and meter reading occurs on an as-needed basis. The total annual water metered accounts is estimated based upon approximating the number of accounts and assigning consumption from actively billed accounts of same meter size</p>	<p>Dated written procedures permit billing exemption for specific accounts, such as municipal properties, but are unclear regarding certain other types of accounts. Meter reading is given low priority and is sporadic. Consumption is quantified from meter readings where available. The total number of unbilled, unmetered accounts must be estimated along with consumption volumes.</p>	<p>Written policies regarding billing exemptions exist but adherence in practice is questionable. Metering buildings is reliable for specific accounts. Periodic auditing of such accounts is conducted. Water consumption is quantified directly from meter readings where available, but the majority of the consumption is estimated.</p>	<p>Written policy identifies the types of accounts granted a billing exemption. Customer meter management and meter reading are considered secondary priorities. Meter reading is conducted for the majority of the annual water audit. High level auditing of billing records ensures that a reliable census of such accounts exists.</p>	<p>Clearly written policy identifies the types of accounts given a billing exemption, with emphasis on keeping such accounts to a minimum. Customer meter management and meter reading for these accounts is given proper priority and is reliably conducted. Periodic auditing of billing records ensures that a reliable census of such accounts is taken from reliable readings from accurate meters.</p>				
Improvements to attain higher data grading for "Unbilled metered Consumption" component:	<p><b>To qualify for 2:</b> Reassess the water utility's policy allowing certain accounts to be granted a billing exemption. Draft an outline of a new written policy for billing exemptions, with clear justification as to why any accounts should be exempt from billing, and with the intention to keep the number of such accounts to a minimum.</p>	<p><b>To qualify for 4:</b> Review historic written directives and policy documents allowing certain accounts to be billing-exempt. Draft an outline of a written policy for billing exemptions, identify criteria that grants an exemption, with a goal of keeping this number of accounts to a minimum.</p>	<p><b>To qualify for 6:</b> Draft a new written policy regarding billing exemptions based upon consensus criteria allowing this occurrence. Assign resources to audit meter records and billing records to obtain census of unbilled metered accounts.</p>	<p><b>To qualify for 8:</b> Communicate billing exemption policy throughout the organization and implement procedures that ensure proper account management. Conduct inspections of accounts confirmed in unbilled metered status and verify that accurate meters exist and are scheduled for routine meter readings.</p>	<p><b>To qualify for 10:</b> Ensure that meter management (meter accuracy testing, meter replacement) and meter reading activities are accorded the same priority as billed accounts. Establish ongoing annual auditing process to ensure that water consumption is reliably collected and provided to the annual water audit process.</p>	<p><b>To maintain 10:</b> Reassess philosophy in allowing any water uses to go "unbilled", it is possible to meter and bill all accounts, even if the fee charged for water consumption is dis-incentive or waived. Metering all accounts ensures that water consumption is tracked and water bills from plumbing leads is detected and minimized.</p>				
Unbilled unmetered:	<p>Extent of unbilled, unmetered consumption is unknown due to unclear policies and poor recordkeeping. Total consumption is quantified based upon a purely subjective estimate.</p>	<p>Clear extent of unbilled, unmetered consumption is partially known, but a number of events are randomly documented each year, confirming existence of such consumption, but without sufficient documentation to quantify an accurate estimate of the annual volume consumed.</p>	<p>Extent of unbilled, unmetered consumption is partially known, and procedures exist to document certain events such as miscellaneous fire hydrant uses. Formulae is used to quantify the consumption from such events (time running x typical flowrate x number of events).</p>	<p>Coherent policies exist for some forms of unbilled, unmetered consumption but others await closer evaluation. Reasonable recordkeeping for the managed uses exists and allows for annual volumes to be quantified by inference, but unsupervised uses are guesstimated.</p>	<p>Clear policies and good recordkeeping exist for some uses (unmetered fire hydrants, but other uses for municipal buildings or fire hydrants) have limited oversight. Total consumption is a mix of well quantified uses such as formulae (time x typical flow) or temporary meters, and relatively subjective estimates of less regulated uses.</p>	<p>Clear policies exist to identify permitted use of water in unbilled, unmetered fashion, with the intention of minimizing the type of consumption. Good records document each occurrence and consumption is quantified via formulae (time x typical flow) or use of temporary meters.</p>				

**Grading**

	1	2	3	4	5	6	7	8	9	10
Improvements to attain higher data grading for "Unauthorized Consumption" component:	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unbillable and unmetered. Consider tracking use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 3:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 4:</b> Evaluate the documentation of events that have been observed. Meet with user groups (ex: fire hydrants - fire departments, contractors to ascertain their need for water from fire hydrants).</p>	<p><b>To qualify for 5:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of all such use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.</p>	<p><b>To qualify for 6:</b> Assess water utility policy and procedures to ensure that fire hydrant permits are issued for use by persons outside of the utility. Create written procedures for use and documentation of the hydrants by water utility personnel.</p>	<p><b>To qualify for 7:</b> Refine written procedures that all uses of unbilled, metered water are created by a structured permitting process managed by water utility personnel. Reassess policy to determine if some of these uses have value in being converted to billed and/or metered status.</p>	<p><b>To maintain 10:</b> Continue to refine policy and procedures with intention of increasing the number of billable uses of water in unbilled and unbilled water. Assess areas that can feasibly become billed and metered should the context eventually.</p>				
<b>APPARENT LOSSES</b>										
Unauthorized consumption:	<p>Extent of unauthorized consumption is unknown due to unclear policies and poor recordkeeping. Total unauthorized consumption is underestimated.</p>	<p>Unauthorized consumption is a known occurrence, but its extent is a mystery. There are no requirements to document observed events, but periodic field reports capture some of these occurrences. Total unauthorized consumption is approximated from this limited data.</p>	<p>Procedures exist to document some unauthorized consumption such as observed unauthorized fire hydrant openings. Use formulae to quantify this consumption (time running x typical flowrate x number of events)</p>	<p>Default value of 0.25% of system input volume is employed</p>	<p>Coherent policies exist for some forms of unauthorized consumption but others await clear evaluation. Reasonable surveillance and recordkeeping exist for occurrences that fall under the policy. Volumes quantified by inference from these records. Unsupervised uses are guesstimated.</p>	<p>Clear policies and good recordkeeping exist for certain meters (ex: tampering with water meters), other occurrences have limited oversight. Total consumption is a combination of typical flow (time x typical flow) and subjective estimates of unconfirmed consumption.</p>	<p>Conditions between 8 and 10</p>	<p>Clear policies exist to identify all known unauthorized uses of water. Staff and procedures exist to provide enforcement of policies and detect violations. Each occurrence is quantified via formulae (time x typical flow) or similar methods.</p>		
Improvements to attain higher data grading for "Unauthorized Consumption" component:	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p>Use accepted default of 0.25% of system input volume</p> <p><b>To qualify for 3:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p>Utilize accepted default value of 0.25% of system input volume as an expedient means to gain a reasonable quantification of all such use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.</p>	<p><b>To qualify for 4:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 5:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p>Assess water utility policies to ensure that all known occurrences of unauthorized consumption are outlined, and that appropriate penalties are prescribed. Create written procedures for use and documentation of various occurrences of unauthorized consumption as they are uncovered.</p>	<p><b>To qualify for 6:</b> Refine written procedures and assign staff to seek out likely occurrences of unauthorized consumption. Explore new locking devices, monitors and other technologies designed to detect and thwart unauthorized consumption.</p>	<p><b>To qualify for 7:</b> Continue to refine policy and procedures to address any loopholes that allow or tacitly encourage unauthorized consumption. Continue to be vigilant in documentation and enforcement efforts.</p>		
Customer metering inaccuracies:	<p>Customer meters exist, but records on meters, no meter accuracy testing or meter replacement program. Workflow is driven exclusively by customer complaints with no proactive management. Loss volume due to aggregate meter inaccuracy is guesstimated.</p>	<p>Poor recordkeeping and meter oversight is recognized by water utility management who has allotted staff and funding resources to organize improved recordkeeping and start meter accuracy testing. Existing paper records gathered and organized to provide cursory disposition of meter population.</p>	<p>Reliable recordkeeping exists; meter information is improving as meters are replaced. Meter accuracy testing is conducted annually for a small number of meters. Limited number of oldest meters replaced each year. Inaccuracy volume is largely an estimate, but refined based upon limited testing data.</p>	<p>Conditions between 4 and 6</p>	<p>A reliable electronic recordkeeping system for meters exists. Population includes a mix of new high performing meters and dated meters with suspect accuracy. Routine, but limited, meter accuracy testing and meter replacement occur. Inaccuracy volume is quantified using a mix of reliable and less certain data.</p>	<p>Ongoing meter replacement and accuracy testing result in highly accurate customer meter population. Testing is conducted on samples of meters at varying lifespans to determine optimum replacement time for various types of meters.</p>	<p>Conditions between 8 and 10</p>	<p>Good records of number, type and size of customer meters; ongoing meter replacement occurs. Regular meter accuracy testing gives reliable measure of composite accuracy volume for the system. New metering technology is embraced to keep overall accuracy improving.</p>		
Improvements to attain higher data grading for "Customer meter inaccuracy volume" component:	<p><b>To qualify for 1:</b> Gather available meter purchase records. Conduct testing on a small number of meters believed to be the most inaccurate. Review staffing needs of metering group and budget for necessary resources to better manage meter management.</p>	<p><b>To qualify for 2:</b> Implement a reliable record keeping system for customer meter histories, preferably using electronic methods typically linked to, or part of, the Customer Billing System or Customer Information System. Expand meter accuracy testing to a larger group of meters.</p>	<p>Standardize procedures for meter recordkeeping with the electronic information system. Accelerate meter accuracy testing and meter replacements guided by testing results.</p>	<p>Expand annual meter accuracy testing to evaluate a statistically significant number of meter make/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p><b>To qualify for 3:</b> Expand annual meter accuracy testing to evaluate a statistically significant number of meter make/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p>Continuous efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Evaluate new meter types and install one or more types in 5-10 customer accounts each year in order to pilot improving metering technology.</p>	<p><b>To qualify for 10:</b> Increase the number of meters tested and replaced as justified by meter accuracy as tested. Continually monitor development of new technology in Advanced Metering Infrastructure (AMI) to grasp opportunities for greater accuracy in metering and customer consumption data.</p>			

Grading										
	1	2	3	4	5	6	7	8	9	10
select via only if the customer population is billed a lot of fixed rate charge that is not based upon measured volumes of water consumption (unmetered population)	Vague policy for permitting (creating new customer accounts) and billing. Billing data maintained on paper records which are in disarray. No audits conducted to confirm billing data handling efficiency. Unknown number of customers escape routine billing due to lack of billing process oversight.	Policy for permitting and billing exists but needs refinement. Billing data maintained on paper records or insufficiently capable electronic database. Only periodic unstructured auditing work conducted to confirm billing data handling efficiency. Volume of unbilled water due to billing lapses is a guess.	Conditions between 2 and 4	Policy and procedures for permitting and billing exist but needs refinement. Computerized billing system in use with basic reporting available. Any effect of billing adjustments on measured consumption volumes is well understood. Internal checks of billing data error conducted annually. Reasonably accurate quantification of consumption volume lost to billing lapses is obtained.	Conditions between 4 and 8	Policy for permitting and billing is adequate and reviewed periodically. Computerized billing system in use with basic reporting available. Any effect of billing adjustments on measured consumption volumes is well understood. Internal checks of billing data error conducted annually. Reasonably accurate quantification of consumption volume lost to billing lapses is obtained.	Conditions between 6 and 8	Permitting and billing policy reviewed at least biannually. Computerized billing system includes an array of reports to confirm billing data and system functionality. Annual internal checks conducted with periodic third party audit. Accountability checks flag billing lapses. Consumption lost to billing lapses is well quantified and reducing year-by-year.	Conditions between 6 and 10	Sound policy exists for permitting of all customer billing accounts. Robust computerized billing system gives high functionality and reporting capabilities. Assessment of policy and data handling errors conducted internally and audited by third party annually, ensuring consumption lost to billing lapses is minimized and detected as it occurs.
Improvements to obtain higher data grading for 'Systematic Data Handling Error' component:	<b>To qualify for 2:</b> Draft written policy for permitting and billing. Investigate and budget for computerized customer billing system. Conduct initial audit of billing records by flow-charting the basic business processes of the customer account/billing function.	<b>To qualify for 4:</b> Finalize written policy for permitting and billing system. Conduct initial audit of billing records as part of this process.	<b>To qualify for 6:</b> Refine permitting and billing procedures and ensure consistency with the utility policy regarding billing. Upgrade or replace customer billing system for needed functionality. Ensure that billing adjustments don't corrupt the value of consumption volumes. Procedures internal annual audit process.	<b>To qualify for 8:</b> Formalize regular review of permitting and billing practices. Enhance reporting capability of computerized billing system. Formalize regular auditing process to reveal scope of data handling error.	<b>To qualify for 10:</b> Close policy/procedure loopholes that allow some customer go un-metered, or data handling errors to exist. Ensure that manual and third party audits are conducted annually.	<b>To maintain 10:</b> Stay abreast of customer information management developments and innovations. Monitor developments of Advanced Metering Infrastructure (AMI) and integrate technology to ensure that customer endpoint information is well monitored and error/lapses are at an economic minimum.				
<b>SYSTEM DATA</b>										
Length of mains:	Poorly assembled and maintained paper as-built records of existing water main installations makes accurate determination of system pipe length impossible. Length of mains is guesstimated.	Paper records in poor condition (no annual tracking of installations & abandonments). Poor procedures to ensure that new water mains installed by developers are accurately documented.	Conditions between 2 and 4	Sound policy and procedures for permitting and documenting new water main installations, but gaps in management result in uncertain degree of error in tabulation of mains length.	Conditions between 4 and 6	Sound policy and procedures exist for permitting and commissioning new water mains. Highly accurate paper records with regular field validation; or electronic field records and asset management system in good condition. Includes system backup.	Conditions between 6 and 8	Sound policy and procedures exist for permitting and commissioning new water mains. Electronic recordkeeping and asset management system are used to store and manage data.	Conditions between 8 and 10	Sound policy exists for managing water mains extensions and replacements. Geographic Information System (GIS) data and asset management database agree and random field validation proves truth of databases.
Improvements to obtain higher data grading for 'Length of Water Mains' component:	<b>To qualify for 2:</b> Assign personnel to inventory current as-built records and system plans. Assemble policy documents regarding permitting and documentation of water main installations by the utility and by others who develop/operate. Identify gaps in procedures that result in poor documentation.	<b>To qualify for 4:</b> Complete inventory of paper records of water main installations & abandonments for a number of years prior to audit year. Review policy and procedures for commissioning and documenting new water main installation and abandonments.	<b>To qualify for 6:</b> Finalize update/improvements to policy and procedures for permitting/commissioning new main installations. Confirm inventory of records for five years prior to audit year; correct any errors or omissions.	<b>To qualify for 8:</b> Launch random field checks of limited number of locations. Convert to electronic databases with backup as justified.	<b>To qualify for 10:</b> Link Geographic Information System (GIS) and asset management databases, conduct field verification of data.	<b>To maintain 10:</b> Continue with standardization and random field validation to improve knowledge of system.				
Number of active AND inactive service connections:	Vague permitting (of new service connections) policy and poor paper recordkeeping of customer connections/billings result in suspect determination of the number of service connections, which may be 10-15% in error from actual count.	General permitting policy exists but paper records, procedural questionnaire total for number of connections, which may vary 5-10% of actual count.	Conditions between 4 and 8	Permitting policy and procedures exist, but with some gaps in performance and oversight. Computerized information management system is being brought online to replace dated paper recordkeeping system. Reasonably accurate tracking of service connection installations & abandonments; but count can be up to 5% in error from actual total.	Conditions between 4 and 8	Permitting policy and procedures are adequate and reviewed periodically. Computerized information management system & abandonments tabulated. Very limited field verifications and audits. Error in count of number of service connections is believed to be no more than 3%.	Conditions between 6 and 8	Permitting policy and procedures reviewed at least biannually. Well managed computerized information management system and routine, periodic field checks and internal system audits allow counts of connections that is no more than 2% in error.	Conditions between 6 and 10	Sound permitting policy and well managed and audited procedures ensure reliable management of service connection population. Computerized information management system and Geographic Information System (GIS) information agree, field validation proves truth of databases. Count of connections believed to be in error by less than 1%.
Improvements to obtain higher data grading for 'Number of Active and Inactive Customer Service Connections' component:	<b>To qualify for 2:</b> Draft new policy and procedures for permitting and billing. Research and collect paper records of installations & abandonments for several years prior to audit year.	<b>To qualify for 4:</b> Refine policy and procedures for permitting and billing. Refine computerized recordkeeping system or Customer Billing System or Computerized Billing System to improve documentation format for service connections.	<b>To qualify for 6:</b> Refine procedures to ensure consistency with permitting policy to establish new service connections or decommission existing ones. Improve process for tracking all bills for at least five years prior to audit year.	<b>To qualify for 8:</b> Formalize regular review of permitting policy and procedures. Launch random field checks of limited number of locations. Develop reports and auditing mechanisms for computerized information management system.	<b>To qualify for 10:</b> Close any procedural loopholes that allow installations to go undocumented. Link with Geographic Information System (GIS) and formalize field inspection and information system auditing processes. Documentation of new or decommissioned service connections encounters several levels of checks and balances.	<b>To maintain 10:</b> Continue with standardization and random field validation to improve knowledge of system.				

**Grading**

	1	2	3	4	5	6	7	8	9	10
	n/a									
Average length of customer service line	Grading 1-9 apply if customer meters exist and are located inside the customer building premises, or if the water utility owns and is responsible for the entire service connection piping from the water main to the customer building. In any of these cases the average distance between the curbside or boundary separating utility/customer responsibility for piping from the water main to the customer meter (exc. faucet) or the customer meter must be quantified. Grading 1-9 are used to grade the validity of the means to quantify this value. (See the "Service Connection Diagram" worksheet)	Policy requires that the curbside serves as the delineation point between water utility ownership and customer ownership of the service connection piping. The curbside is the property of the water utility, and the piping from the curbside to the customer building is owned by the customer. Most curbsides are well-documented. Their location varies widely from site-to-site, and estimating this distance is arbitrary due to the unknown location of many curbsides.	Conditions between 2 and 4	Good policy requires that the curbside serves as the delineation point between water utility ownership and customer ownership of the service connection piping. Curbsides are generally installed as needed and are reasonably documented. Their location varies widely from site-to-site, and an estimate of this distance is indicated by the availability of paper records.	Conditions between 4 and 6	Clear policy exists to define utility/customer responsibility for service connection piping. Accurate, well-maintained paper or basic electronic recordkeeping systems exist. Periodic field checks confirm piping lengths for a sample of customer properties.	Conditions between 6 and 8	Clearly worded policy standardizes the location of curbsides and meters, which are inspected upon installation. Accurate and well maintained electronic records exist with periodic field checks to confirm locations of service lines, curbsides and customer meter pits. An accurate number of customer properties from the customer billing system allows for reliable averaging of this length.	Conditions between 8 and 10	Either of two conditions can be met to obtain a grading of 10: a) The customer water meter is located outside of the customer building adjacent to the curbside or boundary separating utility/customer responsibility for the service connection piping. In this case enter a value of zero in the Reporting Worksheet with a grading of 10. b) Customer water meters are located inside customer buildings, or the properties are unimproved, in either case the distance is highly reliable since data is drawn from a Geographic Information System (GIS) and confirmed by routine field checks.
Improvements to obtain higher data grading for "Average Length of Customer Service Line" component:	Research and collect paper records of service line installations. Inspect several sites in the field using pipe locators to locate curbsides. Obtain the length of this small sample of connections in this manner.	Formalize and communicate policy delineating utility/customer responsibilities for service connection piping. Assess accuracy of paper records by field inspection of a small sample of service connections using pipe locators as needed. Research the potential migration to a computerized information management system to store service connection data.	To qualify for 4: Establish coherent procedures to ensure that policy for curbside, meter installation and documentation is followed. Gain consensus within the water utility for the establishment of a computerized information management system.	To qualify for 5: Implement an electronic means of recordkeeping, typically via a customer information system or customer billing system. Standardize the process to conduct field checks of limited number of locations.	To qualify for 6: Link customer information management system and Geographic Information System (GIS), standardize process for field verification of data					to maintain 10: Continue with standardization and random field validation to improve knowledge of system.
Average operating pressure:	Available records are poorly assembled and maintained paper records of supply pump characteristics and water distribution system operating conditions. Average pressure is guessed based upon elevations from crude topographical maps. Widely varying distribution system pressures due to undulating terrain, high system head loss and weak/erratic pressure controls further compromise the validity of the average pressure calculation.	Limited telemetry monitoring of scattered sites provides some static pressure data, which is recorded in handwritten logbooks. Pressure data is gathered at individual sites only when low pressure complaints arise. Average pressure is determined by averaging selected data, and is affected by significant variation in ground elevations, system head loss and gaps in pressure controls at points in the distribution system.	Effective pressure controls separate different pressure zones; moderate pressure variation across the system, occasional open boundary valves are discovered that breach pressure zones. Basic telemetry monitoring of the distribution system logs pressure data electronically. Pressure data gathered by field visits to high rise or buildings with low pressure complaints arise, and during flow tests and system flushing. Reliable topographical data exists. Average pressure is calculated using this mix of data.	Reliable pressure controls separate distinct pressure zones; only very occasional open boundary valves are encountered that breach pressure zones. Well-covered telemetry monitoring of the distribution system logs electronic pressure data gathered by field visits to high rise or buildings with low pressure complaints arise, and during flow tests and system flushing. Average pressure is determined by using this mix of reliable data.	Reliable pressure controls separate distinct pressure zones; only very occasional open boundary valves are encountered that breach pressure zones. Well-covered telemetry monitoring of the distribution system logs electronic pressure data gathered by field visits to high rise or buildings with low pressure complaints arise, and during flow tests and system flushing. Average pressure is determined by using this mix of reliable data.	Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA distribution system and collect data, including real time pressure readings at representative sites across the system. The average system pressure is determined from reliable SCADA System data.	Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA distribution system and collect data, including real time pressure readings at representative sites across the system. The average system pressure is determined from reliable SCADA System data.	Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA distribution system and collect data, including real time pressure readings at representative sites across the system. The average system pressure is determined from reliable SCADA System data.	Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA distribution system and collect data, including real time pressure readings at representative sites across the system. The average system pressure is determined from reliable SCADA System data.	Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA distribution system and collect data, including real time pressure readings at representative sites across the system. The average system pressure is determined from reliable SCADA System data.
Improvements to obtain higher data grading for "Average Operating Pressure" component:	Employ pressure gauging and/or datalogging equipment to obtain pressure measurements from the hydraulic model of the distribution system in order to confirm ground elevations, system head loss, and pump characteristics to find pressure/flow characteristics	Formalize a procedure to use pressure gauging/datalogging equipment to gather pressure data during various system events such as low pressure complaints, or operational loading. Gather pump pressure and flow data at different flow regimes. Identify faulty pressure controls (pressure reducing valves, etc.) and plan to properly configure pressure zones. Make all pressure data from these efforts available to generate system-wide average pressure.	Expand the use of pressure gauging/datalogging equipment to gather scattered pressure data at a representative set of sites, based upon pressure zones or areas. Utilize pump pressure and flow data to determine supply head entering each pressure zone or district. Correct any faulty pressure controls (pressure reducing valves, attribute valves, partially open boundary valves) to ensure properly configured pressure zones. Use expanded pressure dataset from these activities to generate system-wide average pressure.	Install a Supervisory Control and Data Acquisition (SCADA) System to monitor system parameters and control operations. Set regular calibration schedule for instrumentation to ensure data accuracy. Obtain accurate topographical data. Obtain accurate pressure data from field surveys to provide estimate, reliable data for pressure averaging.	Acquisition (SCADA) System to monitor system parameters and control operations. Set regular calibration schedule for instrumentation to ensure data accuracy. Obtain accurate topographical data. Obtain accurate pressure data from field surveys to provide estimate, reliable data for pressure averaging.	Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.	Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.	Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.	Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.	Continue to refine the hydraulic model of the distribution system and consider aming it with SCADA System for real-time pressure data calibration, and averaging.

Grading											
	1	2	3	4	5	6	7	8	9	10	
COST DATA											
Total annual cost of operating water system:	Incomplete paper records and lack of documentation on many operating functions making calculation of water system operating costs a pure guessimate	Reasonably maintained, but incomplete, paper or electronic accounting provides data to estimate the major portion of water system operating costs.	Conditions between 2 and 4	Electronic, industry-standard cost accounting system in place. Gaps in data known to cost, periodic internal reviews conducted but not a structured audit.	Conditions between 4 and 8	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited periodically by utility personnel, not a Certified Public Accountant (CPA).	Conditions between 8 and 8	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited at least annually by utility personnel, and periodically by third-party CPA.	Conditions between 8 and 10	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited annually by utility personnel, and periodically by third-party CPA.	
Improvements to attain higher data grading for "Total Annual Cost of Operating the Water System" component:	To qualify for 2: Gather available records, institute new procedures to regularly collect and audit basic cost data of most important operations functions.	To qualify for 4: Implement an electronic cost accounting system, structured according to standards for water utilities	Conditions between 2 and 4	Establish process for periodic internal audit of water system operating costs; identify cost data gaps and institute procedures for tracking these outstanding costs.	To qualify for 6: Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.	Conditions between 6 and 8	Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.	To qualify for 10: Maintain program, stay abreast of changes and budget/track costs proactively	Conditions between 8 and 10	Maintain program, stay abreast of changes and budget/track costs proactively	
Customer retail unit cost (applied to Apparent Losses):	Antiquated, cumbersome water rate structure is use, with periodic historic amendments that were poorly documented and implemented, resulting in billed inconsistent charges. The actual composite billing rate likely differs significantly from the published water rate structure, but a lack of auditing leaves the degree of error indeterminate.	Dated, cumbersome water rate structure, not always employed consistently in actual billing operations. The actual composite billing rate is known to differ from the published water rate structure, and a reasonably accurate estimate of the degree of error is determined, allowing a composite billing rate to be quantified.	Conditions between 2 and 4	Straight-forward water rate structure in use, but not updated in several years. Billing operations reliably employ the rate structure. The composite billing rate is derived from a single customer class such as residential customer accounts, neglecting the effect of different rates from varying customer classes.	Customer population unmeasured. Fixed fee charged: single composite number derived from multiple customer classes.	Clearly written, up-to-date water rate structure is in force and is applied reliably in billing operations. Composite customer rate is determined using a weighted average composite consumption rate, including residential, commercial, industrial and any other customer classes within the water rate structure.	Conditions between 8 and 10	Effective water rate structure is in force and is applied reliably in billing operations. Composite customer rate is determined using a weighted average composite consumption rate, including residential, commercial, industrial and any other customer classes within the water rate structure.	Conditions between 8 and 10	Third party reviewed weighted average composite consumption rate (includes residential, commercial, industrial, etc.)	
Improvements to attain higher data grading for "Customer Retail Unit Cost" component:	To qualify for 2: Formalize the process to implement water rates, including a secure documentation procedure. Create a current, formal water rate document and gain approval from all stakeholders.	To qualify for 4: Review the water rate structure and update/formalize as needed. Assess billing operations to ensure their actual billing rate structure.	Conditions between 2 and 4	Evaluate volume of water used in each usage block by residential users. Multiply volumes by full rate structure.	Meter, custodial, and change meter based on water volumes	Evaluate volume of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	Conditions between 6 and 8	Conduct a periodic third-party audit of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	To qualify for 10: Keep water rate structure current in addressing the water utility's revenue needs. Update the calculation of the customer unit rate as new rate components, customer classes, or other components are modified.	Conditions between 8 and 10	Keep water rate structure current in addressing the water utility's revenue needs. Update the calculation of the customer unit rate as new rate components, customer classes, or other components are modified.
Variable production cost (applied to Real Losses):	If the water utility purchases/imports its entire water supply, then enter the unit purchase cost of the bulk water supply in the Reporting Worksheet with a grading of 10	Reasonably maintained, but incomplete, paper or electronic accounting provides data to roughly estimate the basic operations costs (pumping power costs and treatment costs) and calculate a unit variable production cost.	Conditions between 2 and 4	Electronic, industry-standard cost accounting system in place. Electric power and treatment costs are reliably tracked and allow accurate calculation of unit variable production costs based on these two inputs only. All costs are audited internally on a periodic basis.	Conditions between 4 and 8	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Pertinent additional costs beyond power and treatment (ex: liability, residuals management, etc.) are included in the unit variable production cost. Data audited at least annually by utility personnel.	Conditions between 8 and 10	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited at least annually by utility personnel, and periodically by third-party.	Conditions between 8 and 10	Either of two conditions can be met in a third-party CPA audit of all components on secondary basis: 1) Water supply is entirely purchased as bulk imported water, and unit purchase cost serves as the variable production cost. 2) Water supply is entirely purchased as bulk imported water, and unit purchase cost serves as the variable production cost.	
Improvements to attain higher data grading for "Variable Production Cost" component:	To qualify for 2: Gather available records, institute new procedures to regularly collect and audit basic cost data and most important operations functions.	To qualify for 4: Implement an electronic cost accounting system, structured according to standards for water utilities	Conditions between 2 and 4	Formalize process for regular internal audits of production costs. Assess whether additional costs (liability, residuals management, etc.) should be included to calculate a more accurate variable production cost.	To qualify for 6: Formalize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.) Conduct periodic third-party audits.	Conditions between 6 and 8	Standardize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.) Conduct periodic third-party audits.	To qualify for 10: Maintain program, stay abreast of changes and budget/track costs proactively	Conditions between 8 and 10	Maintain program, stay abreast of changes and budget/track costs proactively	

## Water Loss Control Planning Guide

Water Audit Data Validity Level / Score					
Functional Focus Area	Level I (0-25)	Level II (26-50)	Level III (51-70)	Level IV (71-90)	Level V (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		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.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

*For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.*



Once data has been entered into the Reporting Worksheet, the performance indicators are automatically calculated. How does a water utility operator know how well his or her system is performing? The AWWA Water Loss Control Committee provided the following table to assist water utilities in gauging an approximate Infrastructure Leakage Index (ILI) that is appropriate for their water system and local conditions. The lower the amount of leakage and real losses that exist in the system, then the lower the ILI value will be.

**Note:** this table offers an approximate guideline for leakage reduction target-setting. The best means of setting such targets include performing an economic assessment of various loss control methods. However, this table is useful if such an assessment is not possible.

**General Guidelines for Setting a Target ILI  
(without doing a full economic analysis of leakage control options)**

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 -5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning.
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0			If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.

[Click to access definition](#)

Water Audit Report for: **Philadelphia Water Department**  
 Reporting Year: **2008** **7/2007 - 6/2008**

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 (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**

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	7	94,536.900	Million gallons (US)/yr (MG/Yr)
Master meter error adjustment:	10	2,779.300	over-registered MG/Yr
Water imported:	n/a		MG/Yr
Water exported:	10	7,100.400	MG/Yr
<b>WATER SUPPLIED:</b>		<b>84,657.200</b>	<b>MG/Yr</b>

**AUTHORIZED CONSUMPTION**

Billed metered:	7	57,242.400	MG/Yr
Billed unmetered:	n/a		MG/Yr
Unbilled metered:	n/a		MG/Yr
Unbilled unmetered:	8	764.200	MG/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>58,006.600</b>	<b>MG/Yr</b>

Click here: [?](#) for help using option buttons below

Pcnt:  Value:  764.200

Use buttons to select percentage of water supplied OR value

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

26,650.600 MG/Yr

**Apparent Losses**

Unauthorized consumption:	8	2,086.300	MG/Yr
Customer metering inaccuracies:	8	190.300	MG/Yr
Systematic data handling errors:	5	4,674.400	MG/Yr
<b>Apparent Losses:</b>		<b>6,951.000</b>	<b>MG/Yr</b>

Pcnt:  Value:  2,086.300

190.300

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:		19,699.600	MG/Yr
<b>WATER LOSSES:</b>		<b>26,650.600</b>	<b>MG/Yr</b>

**NON-REVENUE WATER**

NON-REVENUE WATER: 27,414.800 MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	9	3,137.0	miles
Number of active AND inactive service connections:	7	547,932	
Connection density:		175	conn./mile main
Average length of customer service line:	7	12.0	ft (pipe length between curbside and customer meter or property boundary)
Average operating pressure:	10	55.0	psi

**COST DATA**

Total annual cost of operating water system:	10	\$219,182,339	\$/Year
Customer retail unit cost (applied to Apparent Losses):	9	\$4.97	\$/1000 gallons (US)
Variable production cost (applied to Real Losses):	9	\$215.50	\$/Million gallons

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	32.4%
Non-revenue water as percent by cost of operating system:	17.8%
Annual cost of Apparent Losses:	\$34,546,470
Annual cost of Real Losses:	\$4,245,264

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	34.76	gallons/connection/day
Real Losses per service connection per day*:	98.50	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	1.79	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	2,178.15	million gallons/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	9.04	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 82 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: Billed metered
- 3: Systematic data handling errors

[For more information, click here to see the Grading Matrix worksheet](#)

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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WAS v4.0

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Water Audit Report for: **Regional Municipality of Peel**  
 Reporting Year: **2008** 1/2008 - 12/2008

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 (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: MEGALITRES (THOUSAND CUBIC METRES) PER YEAR

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="7"/>	<input type="text" value="213,977.000"/>	Megalitres/yr (or ML/Yr)
Master meter error adjustment:	<input type="text" value="4"/>	<input type="text" value="0.000"/>	ML/Yr
Water imported:	<input type="text" value="n/a"/>	<input type="text" value="0.000"/>	ML/Yr
Water exported:	<input type="text" value="7"/>	<input type="text" value="26,457.500"/>	ML/Yr
<b>WATER SUPPLIED:</b>		<b>187,519.500</b>	ML/Yr

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="7"/>	<input type="text" value="163,665.000"/>	ML/Yr
Billed unmetered:	<input type="text" value="2"/>	<input type="text" value="433.900"/>	ML/Yr
Unbilled metered:	<input type="text" value="8"/>	<input type="text" value="1,768.400"/>	ML/Yr
Unbilled unmetered:	<input type="text" value="5"/>	<input type="text" value="230.100"/>	ML/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>166,097.400</b>	ML/Yr

Click here:  for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

**21,422.100** ML/Yr

**Apparent Losses**

Unauthorized consumption:	<input type="text" value="5"/>	<input type="text" value="886.800"/>	ML/Yr
Customer metering inaccuracies:	<input type="text" value="7"/>	<input type="text" value="2,851.000"/>	ML/Yr
Systematic data handling errors:	<input type="text" value="7"/>	<input type="text" value="0.000"/>	ML/Yr
<b>Apparent Losses:</b>		<b>3,737.800</b>	ML/Yr

Pcnt:  Value:

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:  ML/Yr

**WATER LOSSES:** **21,422.100** ML/Yr

**NON-REVENUE WATER**

**NON-REVENUE WATER:**  ML/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="8"/>	<input type="text" value="4,161.0"/>	kilometers
Number of active AND inactive service connections:	<input type="text" value="9"/>	<input type="text" value="287,905"/>	
Connection density:		<input type="text" value="69"/>	conn./km main
Average length of customer service line:	<input type="text" value="5"/>	<input type="text" value="16.0"/>	metres
Average operating pressure:	<input type="text" value="6"/>	<input type="text" value="58.4"/>	metres (head)

(pipe length between curbtop and customer meter or property boundary)

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="3"/>	<input type="text" value="\$100,000,000"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="10"/>	<input type="text" value="\$0.64"/>	\$/1000 litres
Variable production cost (applied to Real Losses):	<input type="text" value="10"/>	<input type="text" value="\$642.00"/>	\$/Megalitre

Retail costs are less than (or equal to) production costs; please review and correct if necessary

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="12.5%"/>
Non-revenue water as percent by cost of operating system:	<input type="text" value="15.0%"/>
Annual cost of Apparent Losses:	<input type="text" value="\$2,399,668"/>
Annual cost of Real Losses:	<input type="text" value="\$11,353,321"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="35.57"/>	litres/connection/day
Real Losses per service connection per day*:	<input type="text" value="168.29"/>	litres/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per meter (head) pressure:	<input type="text" value="2.88"/>	litres/connection/day/m
Unavoidable Annual Real Losses (UARL):	<input type="text" value="8,960.91"/>	cubic meters/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="1.97"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 64 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: Master meter error adjustment
- 3: Billed unmetered

[For more information, click here to see the Grading Matrix worksheet](#)

## AWWA WLCC Free Water Audit Software: Acknowledgements

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WAS v4.0

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AWWA Water Audit Software Version 4.0 Developed by the Water Loss Control Committee of the American Water Works Association April 2009

This software is intended to serve as a basic tool to compile a preliminary, or "top-down", water audit. It is recommended that users also refer to the 3rd Edition AWWA M36 Publication, Water Audits and Loss Control Programs, for detailed guidance on compiling a comprehensive, or "bottom-up", water audit using the same water audit methodology.

### DEVELOPED BY: ANDREW CHASTAIN-HOWLEY, Miya Water

DAVID GOFF, P.E. Goff Water Audits & Engineering

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ALAIN LALONDE, Veritec Consulting

DAVID SAYERS, Delaware River Basin Commission

### REFERENCES:

- Alegre, H., Hirner, W., Baptista, J. and Parena, R. Performance Indicators for Water Supply Services. IWA Publishing 'Manual of Best Practice' Series, 2000. ISBN 1 900222 272
- Kunkel, G. et al, 2003. Water Loss Control Committee Report: Applying Worldwide Best Management Practices in Water Loss Control. Journal AWWA, 95:8:65
- AWWA Water Audits and Loss Control Programs, M36 Publication, 3<sup>rd</sup> Edition, 2009
- Service Connection Diagrams courtesy of Ronnie McKenzie, WRP Pty Ltd.

# AWWA Water Loss Control Committee (WLCC) Free Water Audit Software v4.0

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WAS v4.0

**PURPOSE:** 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.

**USE:** The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons on the left below. Descriptions of each sheet are also given below.

**THE FOLLOWING KEY APPLIES THROUGHOUT:**

- Value can be entered by user
- Value calculated based on input data
- These cells contain recommended default values

Please begin by providing the following information, then proceed through each sheet in the workbook:

NAME OF CITY OR UTILITY:  COUNTRY:

REPORTING YEAR:  START DATE(MM/YYYY):  END DATE(MM/YYYY):

NAME OF CONTACT PERSON:  E-MAIL:  TELEPHONE:  Ext.:

PLEASE SELECT PREFERRED REPORTING UNITS FOR WATER VOLUME:

Click to advance to sheet...

- [Instructions](#)
- [Reporting Worksheet](#)
- [Water Balance](#)
- [Grading Matrix](#)
- [Service Connections](#)
- [Definitions](#)
- [Loss Control Planning](#)

The current sheet

Enter the required data on this worksheet to calculate the water balance

The values entered in the Reporting Worksheet are used to populate the water balance

Depending on the confidence of audit inputs, a grading is assigned to the audit score

Diagrams depicting possible customer service connection configurations

Use this sheet to understand terms used in the audit process

Use this sheet to interpret the results of the audit validity score and performance indicators

**Comments:**

Add comments here to track additional supporting information, sources or names of participants

If you have questions or comments regarding the software please contact us at: [wlc@awwa.org](mailto:wlc@awwa.org)

[Click to access definition](#)

Water Audit Report for: **Laguna Beach County Water District**

Reporting Year: **2007** 7/2006 - 6/2007

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 (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: ACRE-FEET PER YEAR

**WATER SUPPLIED** << Enter grading in column 'E'

Volume from own sources:	<input type="text" value="0.000"/>	acre-ft/yr
Master meter error adjustment (enter positive value):	<input type="text"/>	acre-ft/yr
Water imported:	<input type="text" value="4,569.480"/>	acre-ft/yr
Water exported:	<input type="text" value="0.000"/>	acre-ft/yr
<b>WATER SUPPLIED:</b>	<b>4,569.480</b>	acre-ft/yr

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="4,457.450"/>	acre-ft/yr
Billed unmetered:	<input type="text"/>	acre-ft/yr
Unbilled metered:	<input type="text"/>	acre-ft/yr
Unbilled unmetered:	<input type="text" value="8.770"/>	acre-ft/yr
<b>AUTHORIZED CONSUMPTION:</b>	<b>4,466.220</b>	acre-ft/yr

Click here: [?](#) for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

**WATER LOSSES (Water Supplied - Authorized Consumption)**  acre-ft/yr

**Apparent Losses**

Unauthorized consumption:	<input type="text" value="11.424"/>	acre-ft/yr
Customer metering inaccuracies:	<input type="text" value="0.000"/>	acre-ft/yr
Systematic data handling errors:	<input type="text"/>	acre-ft/yr
<b>Apparent Losses:</b>	<b>11.424</b>	acre-ft/yr

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

Pcnt:  Value:

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:	<input type="text" value="91.836"/>	acre-ft/yr
<b>WATER LOSSES:</b>	<b>103.260</b>	acre-ft/yr

**NON-REVENUE WATER**

NON-REVENUE WATER:	<input type="text" value="112.030"/>	acre-ft/yr
--------------------	--------------------------------------	------------

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="135.0"/>	miles
Number of active AND inactive service connections:	<input type="text" value="8,513"/>	
Connection density:	<input type="text" value="63"/>	conn./mile main
Average length of customer service line:	<input type="text" value="30.0"/>	ft (pipe length between curbside and customer meter or property boundary)
Average operating pressure:	<input type="text" value="65.0"/>	psi

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="\$6,900,000"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="\$3.20"/>	\$/100 cubic feet (ccf)
Variable production cost (applied to Real Losses):	<input type="text" value="\$519.00"/>	\$/acre-ft/yr

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input text"="" type="text" value="\$15,924"/>
Annual cost of Real Losses:	<input type="text" value="\$47,663"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="1.20"/>	gallons/connection/day
Real Losses per service connection per day*:	<input type="text" value="9.63"/>	gallons/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per psi pressure:	<input type="text" value="0.15"/>	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	<input type="text" value="56.23"/>	million gallons/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="0.53"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**Add a grading value for 11 parameter(s) to enable an audit score to be calculated**

**PRIORITY AREAS FOR ATTENTION:**

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

- 1: Water imported
- 2: Billed metered
- 3: Customer metering inaccuracies

[For more information, click here to see the Grading Matrix worksheet](#)

Water Exported		Billed Water Exported		Revenue Water
Own Sources (Adjusted for known errors)	<b>0.000</b>	Billed Authorized Consumption	<b>4,457.450</b>	<b>4,457.450</b>
		Authorized Consumption	<b>4,466.220</b>	
		Unbilled Authorized Consumption	<b>8.770</b>	
		Unbilled Metered Consumption	<b>0.000</b>	
		Unbilled Unmetered Consumption	<b>8.770</b>	
		Unauthorized Consumption		
		Apparent Losses	<b>11.424</b>	
		Customer Metering Inaccuracies	<b>0.000</b>	
		Systematic Data Handling Errors	<b>0.000</b>	
		Leakage on Transmission and/or Distribution Mains		
		Real Losses	<b>91.836</b>	
		Leakage and Overflows at Utility's Storage Tanks	<b>Not broken down</b>	
		Leakage on Service Connections	<b>Not broken down</b>	
			<b>Not broken down</b>	
Water Imported	<b>4,569.480</b>	Water Supplied	<b>4,569.480</b>	Non-Revenue Water (NRW)
				<b>112.030</b>

Grading

	1	2	3	4	5	6	7	8	9	10
Improvements to obtain higher data grading for "Unlabeled Unmetered Consumption" component:	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unmetered. Consider tracking use (e.g. fire hydrant flushings).</p>	<p><b>To qualify for 3:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 4:</b> Evaluate the documentation of events that have been observed. Meet with user groups (e.g. for fire hydrants - fire departments, contractors to ascertain their need for water from the hydrants).</p>	<p><b>To qualify for 5:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p>	<p><b>To qualify for 6:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.</p>	<p><b>To qualify for 7:</b> Assess water utility policy and procedures to ensure that fire hydrant permits are issued for use by persons outside of the utility. Create written procedures for use and documentation of fire hydrants by water utility personnel.</p>	<p><b>To qualify for 8:</b> Refine written procedures to ensure that all uses of unlabeled unmetered water are overseen by a structured permitting process managed by water utility personnel.</p> <p><b>To qualify for 9:</b> Determine if any of these uses have not been converted to billed and/or metered status eventually.</p>	<p><b>To maintain 10:</b> Continue to refine policy and procedures with intention of reducing the number of allowable uses of water in unlabeled and unmetered stations. Any uses that can feasibly become billed and metered should be converted eventually.</p>			
Unauthorized consumption:	<p><b>To qualify for 1:</b> Extent of unauthorized consumption is unknown due to unclear policies and poor recordkeeping. Total unauthorized consumption is guesstimated.</p>	<p><b>To qualify for 2:</b> Unauthorized consumption is a known occurrence, but its extent is in question. There are no reports capturing but few of these occurrences. Total unauthorized consumption is approximated from this limited data.</p>	<p><b>To qualify for 3:</b> Unauthorized consumption is a known occurrence, but its extent is in question. There are no reports capturing but few of these occurrences. Total unauthorized consumption is approximated from this limited data.</p>	<p><b>To qualify for 4:</b> Procedures exist to document some unauthorized consumption such as observed unauthorized fire hydrant openings. Use formulae to quantify this consumption (time running x typical flowrate x number of events).</p>	<p><b>To qualify for 5:</b> Default value of 0.25% of system input volume is employed.</p>	<p><b>To qualify for 6:</b> Coherent policies exist for some forms of unauthorized consumption but others await closer evaluation. Reasonable surveillance and recordkeeping exist for occurrences that fall under the policy. Volumes quantified by inference from these records. Unsupervised uses are guesstimated.</p>	<p><b>To qualify for 7:</b> Clear policies and good recordkeeping exist for certain events (e.g. tampering with water meters), other occurrences have limited oversight. Total consumption is a combination of volumes from formulae (time x typical flow) and subjective estimates of unconfirmed consumption.</p>	<p><b>To qualify for 8:</b> Clear policies exist to identify all known unauthorized uses of water. Staff and procedures exist to provide enforcement of policies and detect violations. Each occurrence is quantified via formulae (time x typical flow) or similar methods.</p>		
Improvements to obtain higher data grading for "Unauthorized Consumption" component:	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (e.g. unauthorized fire hydrant openings).</p>	<p><b>To qualify for 3:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 4:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (e.g. unauthorized fire hydrant openings).</p>	<p><b>To qualify for 5:</b> Use accepted default value of 0.25% of system input volume as an expedient means to gain a reasonable quantification of all such uses. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.</p>	<p><b>To qualify for 6:</b> Reliable recordkeeping exists; meter information is improving as meters are replaced. Meter accuracy testing is conducted annually for a small number of meters. Limited number of oldest meters replaced each year. Inaccuracy volume is largely an estimate, but refined based upon limited testing data.</p>	<p><b>To qualify for 7:</b> Assess water utility policy to ensure that all known occurrences of unauthorized consumption are understood, and that appropriate penalties are prescribed. Create written procedures for use and documentation of various occurrences of unauthorized consumption as they are uncovered.</p>	<p><b>To qualify for 8:</b> Refine written procedures and assign staff to seek out likely occurrences of unauthorized consumption. Explore new locking devices, monitors, and other technologies designed to detect and thwart unauthorized consumption.</p>	<p><b>To maintain 10:</b> Continue to refine policy and procedures to ensure utility improves its meter accuracy through ongoing monitoring. Continue to be vigilant in documentation and enforcement efforts.</p>			
Customer meters: Inaccuracies:	<p>Customer meters exist, but with unorganized paper records on meters; no meter accuracy testing or meter replacement program. Workflow is driven chaotically by customer complaints with no proactive management. Loss volume due to aggregate meter inaccuracy is guesstimated.</p>	<p>Poor recordkeeping and meter oversight is recognized by water utility management who has allocated staff and funding resources to organize improved recordkeeping and start meter accuracy testing. Existing paper records gathered and organized to provide cursory disposition of meter population.</p>	<p>Reliable recordkeeping exists; meter information is improving as meters are replaced. Meter accuracy testing is conducted annually for a small number of meters. Limited number of oldest meters replaced each year. Inaccuracy volume is largely an estimate, but refined based upon limited testing data.</p>	<p>A reliable electronic recordkeeping system for meters exists. Population includes a mix of new high performing meters and dated meters with suspect accuracy. Routine, but limited, meter accuracy testing and meter replacement occur. Inaccuracy volume is quantified using a mix of reliable and less certain data.</p>	<p>Conditions between 4 and 6</p>	<p>Conditions between 6 and 8</p>	<p>On-going meter replacement and accuracy testing result in highly accurate customer meter population. Testing is conducted on samples of meters at varying lifespans to determine optimum replacement time for various types of meters.</p>	<p>Good records of number, type and size of customer meters; ongoing meter replacement occurs. Regular meter accuracy testing gives reliable measure of composite inaccuracy volume for the system. New metering technology is embraced to keep overall inaccuracy improving.</p>		
Improvements to obtain higher data grading for "Customer meter inaccuracy volume" component:	<p><b>To qualify for 1:</b> Gather available meter purchase records. Conduct testing on a small number of meters believed to be the most inaccurate. Review staffing needs of metering group and budget for necessary resources to better organize meter management.</p>	<p><b>To qualify for 2:</b> Implement a reliable record keeping system for customer meter histories, preferably using electronic methods typically linked to, or part of, the Customer Billing System or Customer Information System. Expand meter accuracy testing to a larger group of meters.</p>	<p><b>To qualify for 3:</b> Standardize procedures for meter recordkeeping. Accommodate meter information and meter replacements guided by testing results.</p>	<p><b>To qualify for 4:</b> Expand annual meter accuracy testing to evaluate a statistically significant number of meter makes/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p><b>To qualify for 5:</b> Continue efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Evaluate new meter types and install one or more types in 8-10 customer accounts each year in order to pilot improving metering technology.</p>	<p><b>To qualify for 6:</b> Expand annual meter accuracy testing to evaluate a statistically significant number of meter makes/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p><b>To qualify for 7:</b> Continue efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Evaluate new meter types and install one or more types in 8-10 customer accounts each year in order to pilot improving metering technology.</p>	<p><b>To maintain 10:</b> Increase the number of meters tested and replaced as justified by meter accuracy test data. Continually monitor development of new technology in Advanced Metering Infrastructure (AMI) to grasp opportunity for greater accuracy in metering and customer consumption data.</p>		

APPENDIX: LOSSES



## Water Loss Control Planning Guide

### Water Audit Data Validity Level / Score

Functional Focus Area	Level I (0-25)	Level II (26-50)	Level III (51-70)	Level IV (71-90)	Level V (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		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.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

*For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.*

Once data has been entered into the Reporting Worksheet, the performance indicators are automatically calculated. How does a water utility operator know how well his or her system is performing? The AWWA Water Loss Control Committee provided the following table to assist water utilities in gauging an approximate Infrastructure Leakage Index (ILI) that is appropriate for their water system and local conditions. The lower the amount of leakage and real losses that exist in the system, then the lower the ILI value will be.

Note: this table offers an approximate guideline for leakage reduction target-setting. The best means of setting such targets include performing an economic assessment of various loss control methods. However, this table is useful if such an assessment is not possible.

**General Guidelines for Setting a Target ILI  
(without doing a full economic analysis of leakage control options)**

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 - 5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning.
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		

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Water Audit Report for: **Philadelphia Water Department**  
 Reporting Year: **2008** 7/2007 - 6/2008

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 (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**

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	7	94,536.900	Million gallons (US)/yr (MG/Yr)
Master meter error adjustment:	10	2,779.300	over-registered MG/Yr
Water imported:	n/a		MG/Yr
Water exported:	10	7,100.400	MG/Yr
<b>WATER SUPPLIED:</b>		<b>84,657.200</b>	<b>MG/Yr</b>

**AUTHORIZED CONSUMPTION**

Billed metered:	7	57,242.400	MG/Yr
Billed unmetered:	n/a		MG/Yr
Unbilled metered:	n/a		MG/Yr
Unbilled unmetered:	8	764.200	MG/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>58,006.600</b>	<b>MG/Yr</b>

Click here: [?](#) for help using option buttons below

Pcnt:  Value:  764.200

Use buttons to select percentage of water supplied OR value

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

26,650.600 MG/Yr

**Apparent Losses**

Unauthorized consumption:	8	2,086.300	MG/Yr
Customer metering inaccuracies:	8	190.300	MG/Yr
Systematic data handling errors:	5	4,674.400	MG/Yr
<b>Apparent Losses:</b>		<b>6,951.000</b>	<b>MG/Yr</b>

Pcnt:  Value:  2,086.300

190.300

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses: 19,699.600 MG/Yr

**WATER LOSSES:** 26,650.600 MG/Yr

**NON-REVENUE WATER**

NON-REVENUE WATER: 27,414.800 MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	9	3,137.0	miles
Number of active AND inactive service connections:	7	547,932	
Connection density:		175	conn./mile main
Average length of customer service line:	7	12.0	ft (pipe length between curbside and customer meter or property boundary)
Average operating pressure:	10	55.0	psi

**COST DATA**

Total annual cost of operating water system:	10	\$219,182,339	\$/Year
Customer retail unit cost (applied to Apparent Losses):	9	\$4.97	\$/1000 gallons (US)
Variable production cost (applied to Real Losses):	9	\$215.50	\$/Million gallons

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	32.4%
Non-revenue water as percent by cost of operating system:	17.8%
Annual cost of Apparent Losses:	\$34,546,470
Annual cost of Real Losses:	\$4,245,264

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	34.76	gallons/connection/day
Real Losses per service connection per day*:	98.50	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	1.79	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	2,178.15	million gallons/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	9.04	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 82 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: Billed metered
- 3: Systematic data handling errors

For more information, click here to see the Grading Matrix worksheet

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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WAS v4.0

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Water Audit Report for: **Regional Municipality of Peel**

Reporting Year: **2008** 1/2008 - 12/2008

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 (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: MEGALITRES (THOUSAND CUBIC METRES) PER YEAR

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="7"/>	<input type="text" value="213,977.000"/>	Megalitres/yr (or ML/Yr)
Master meter error adjustment:	<input type="text" value="4"/>	<input type="text" value="0.000"/>	ML/Yr
Water imported:	<input type="text" value="n/a"/>	<input type="text" value="0.000"/>	ML/Yr
Water exported:	<input type="text" value="7"/>	<input type="text" value="26,457.500"/>	ML/Yr
<b>WATER SUPPLIED:</b>		<b>187,519.500</b>	ML/Yr

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="7"/>	<input type="text" value="163,665.000"/>	ML/Yr
Billed unmetered:	<input type="text" value="2"/>	<input type="text" value="433.900"/>	ML/Yr
Unbilled metered:	<input type="text" value="8"/>	<input type="text" value="1,768.400"/>	ML/Yr
Unbilled unmetered:	<input type="text" value="5"/>	<input type="text" value="230.100"/>	ML/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>166,097.400</b>	ML/Yr

Click here:  for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

**21,422.100** ML/Yr

**Apparent Losses**

Unauthorized consumption:	<input type="text" value="5"/>	<input type="text" value="886.800"/>	ML/Yr
Customer metering inaccuracies:	<input type="text" value="7"/>	<input type="text" value="2,851.000"/>	ML/Yr
Systematic data handling errors:	<input type="text" value="7"/>	<input type="text" value="0.000"/>	ML/Yr
<b>Apparent Losses:</b>		<b>3,737.800</b>	ML/Yr

Pcnt:  Value:

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:  ML/Yr

**WATER LOSSES:** **21,422.100** ML/Yr

**NON-REVENUE WATER**

NON-REVENUE WATER:  ML/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="8"/>	<input type="text" value="4,161.0"/>	Kilometers
Number of active AND inactive service connections:	<input type="text" value="9"/>	<input type="text" value="287,905"/>	
Connection density:		<input type="text" value="69"/>	conn./km main
Average length of customer service line:	<input type="text" value="5"/>	<input type="text" value="16.0"/>	metres (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	<input type="text" value="6"/>	<input type="text" value="58.4"/>	metres (head)

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="3"/>	<input type="text" value="\$100,000,000"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="10"/>	<input type="text" value="\$0.64"/>	\$/1000 litres
Variable production cost (applied to Real Losses):	<input type="text" value="10"/>	<input type="text" value="\$642.00"/>	\$/Megalitre

Retail costs are less than (or equal to) production costs; please review and correct if necessary

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="12.5%"/>
Non-revenue water as percent by cost of operating system:	<input type="text" value="15.0%"/>
Annual cost of Apparent Losses:	<input type="text" value="\$2,399,668"/>
Annual cost of Real Losses:	<input type="text" value="\$11,353,321"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="35.57"/>	litres/connection/day
Real Losses per service connection per day*:	<input type="text" value="168.29"/>	litres/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per meter (head) pressure:	<input type="text" value="2.88"/>	litres/connection/day/m
Unavoidable Annual Real Losses (UARL):	<input type="text" value="8,960.91"/>	cubic meters/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="1.97"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 64 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: Master meter error adjustment
- 3: Billed unmetered

[For more information, click here to see the Grading Matrix worksheet](#)

**AWWA WLCC Free Water Audit Software: Acknowledgements**

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WAS v4.0

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AWWA Water Audit Software Version 4.0 Developed by the Water Loss Control Committee of the American Water Works Association April 2009

This software is intended to serve as a basic tool to compile a preliminary, or "top-down", water audit. It is recommended that users also refer to the 3rd Edition AWWA M36 Publication, Water Audits and Loss Control Programs, for detailed guidance on compiling a comprehensive, or "bottom-up", water audit using the same water audit methodology.

DEVELOPED BY: ANDREW CHASTAIN-HOWLEY, Miya Water

DAVID GOFF, P.E. Goff Water Audits & Engineering

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ALAIN LALONDE, Veritec Consulting

DAVID SAYERS, Delaware River Basin Commission

REFERENCES:

- Alegre, H., Hirner, W., Baptista, J. and Parena, R. Performance Indicators for Water Supply Services. IWA Publishing 'Manual of Best Practice' Series, 2000. ISBN 1 900222 272
- Kunkel, G. et al, 2003. Water Loss Control Committee Report: Applying Worldwide Best Management Practices in Water Loss Control. Journal AWWA, 95:8:65
- AWWA Water Audits and Loss Control Programs, M36 Publication, 3<sup>rd</sup> Edition, 2009
- Service Connection Diagrams courtesy of Ronnie McKenzie, WRP Pty Ltd.

# AWWA Water Loss Control Committee (WLCC) Free Water Audit Software v4.0

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WAS v4.0

**PURPOSE:** 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.

**USE:** The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons on the left below. Descriptions of each sheet are also given below.

**THE FOLLOWING KEY APPLIES THROUGHOUT:**

Value can be entered by user

Value calculated based on input data

These cells contain recommended default values

Please begin by providing the following information, then proceed through each sheet in the workbook:

NAME OF CITY OR UTILITY:  COUNTRY:

REPORTING YEAR:  START DATE (MM/YYYY):  END DATE (MM/YYYY):

NAME OF CONTACT PERSON:  E-MAIL:  TELEPHONE:  Ext.

PLEASE SELECT PREFERRED REPORTING UNITS FOR WATER VOLUME:

Click to advance to sheet...

Click here:  for help about units and conversions

- 
- 
- 
- 
- 
- 
- 

The current sheet

Enter the required data on this worksheet to calculate the water balance

The values entered in the Reporting Worksheet are used to populate the water balance

Depending on the confidence of audit inputs, a grading is assigned to the audit score

Diagrams depicting possible customer service connection configurations

Use this sheet to understand terms used in the audit process

Use this sheet to interpret the results of the audit validity score and performance indicators

**Comments:**

Add comments here to track additional supporting information, sources or names of participants

If you have questions or comments regarding the software please contact us at: [wlc@awwa.org](mailto:wlc@awwa.org)

[Click to access definition](#)

Water Audit Report for: **Moulton Miguel Water District**

Reporting Year: **2007** 7/2006 - 6/2007

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 (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: ACRE-FEET PER YEAR

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="0.000"/>	acre-ft/yr
Master meter error adjustment (enter positive value):	<input type="text"/>	acre-ft/yr
Water imported:	<input type="text" value="36,410.000"/>	acre-ft/yr
Water exported:	<input type="text"/>	acre-ft/yr
<b>WATER SUPPLIED:</b>	<b><input type="text" value="36,410.000"/></b>	<b>acre-ft/yr</b>

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="33,175.000"/>	acre-ft/yr
Billed unmetered:	<input type="text"/>	acre-ft/yr
Unbilled metered:	<input type="text"/>	acre-ft/yr
Unbilled unmetered:	<input type="text" value="1,400.800"/>	acre-ft/yr
<b>AUTHORIZED CONSUMPTION:</b>	<b><input type="text" value="34,575.800"/></b>	<b>acre-ft/yr</b>

Click here: [?](#) for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

acre-ft/yr

**Apparent Losses**

Unauthorized consumption:  acre-ft/yr

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

Customer metering inaccuracies:  acre-ft/yr  
 Systematic data handling errors:

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Apparent Losses:  acre-ft/yr

Pcnt:  Value:

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:  acre-ft/yr

**WATER LOSSES:**  acre-ft/yr

**NON-REVENUE WATER**

NON-REVENUE WATER:  acre-ft/yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text"/>	miles
Number of active AND inactive service connections:	<input type="text"/>	
Connection density:	<input type="text"/>	conn./mile main
Average length of customer service line:	<input type="text"/>	ft (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	<input type="text"/>	psi

**COST DATA**

Total annual cost of operating water system:	<input type="text"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text"/>	
Variable production cost (applied to Real Losses):	<input type="text"/>	\$/acre-ft/yr

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="8.9%"/>
Non-revenue water as percent by cost of operating system:	<input type="text"/>
Annual cost of Apparent Losses:	<input type="text"/>
Annual cost of Real Losses:	<input type="text"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text"/>	gallons/connection/day
Real Losses per service connection per day*:	<input type="text"/>	gallons/connection/day
Real Losses per length of main per day*:	<input type="text"/>	gallons/mile/day
Real Losses per service connection per day per psi pressure:	<input type="text"/>	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	<input type="text" value="Not Valid"/>	

\*\*\* UARL cannot be calculated as either average pressure, number of connections or length of mains is too small: SEE UARL DEFINITION \*\*\*

Infrastructure Leakage Index (ILI) [Real Losses/UARL]:

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

Add a grading value for 11 parameter(s) to enable an audit score to be calculated

**PRIORITY AREAS FOR ATTENTION:**

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

- 1: Water imported
- 2: Billed metered
- 3: Customer metering inaccuracies

For more information, click here to see the Grading Matrix worksheet

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Water Exported		Billed Water Exported		Revenue Water
Own Sources (Adjusted for known errors)	<b>0.000</b>	Billed Authorized Consumption	<b>33,175.000</b>	<b>33,175.000</b>
		Authorized Consumption	<b>34,575.800</b>	
		Billed Metered Consumption (inc. water exported)	<b>33,175.000</b>	
		Unbilled Metered Consumption	<b>0.000</b>	
		Unbilled Authorized Consumption	<b>1,400.800</b>	
		Unmetered Consumption	<b>0.000</b>	
		Unauthorized Consumption	<b>91.025</b>	
		Apparent Losses	<b>91.025</b>	
		Water Losses	<b>1,834.200</b>	
		Real Losses	<b>1,743.175</b>	
Water Imported	<b>36,410.000</b>	Unbilled Unmetered Consumption	<b>1,400.800</b>	
		Customer Metering Inaccuracies	<b>0.000</b>	
		Systematic Data Handling Errors	<b>0.000</b>	
		Leakage on Transmission and/or Distribution Mains	<b>Not broken down</b>	
		Leakage and Overflows at Utility's Storage Tanks	<b>Not broken down</b>	
		Leakage on Service Connections	<b>Not broken down</b>	
		Non-Revenue Water (NRW)		<b>3,235.000</b>



Grading

	1	2	3	4	5	6	7	8	9	10	
Improvements to obtain higher data grading for "Unlabeled Unauthorized Consumption" component:	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Evaluate the documentation of events that have been observed. Meet with user groups (ex: fire hydrants - fire departments, contractors to ascertain their need for water from fire hydrants).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>To qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unlabeled and unlabeled. Consider tracking a small sample of one such use (ex: fire hydrant flushings).</p>	<p><b>To maintain 10:</b> Continue to refine policy and procedures with intention of reducing the number of allowable uses of water in unlabeled and unlabeled facility. Any uses that can feasibly become labeled and metered should be converted eventually.</p>
Unauthorized consumption:	<p>Extent of unauthorized consumption is unknown due to unclear policies and poor recordkeeping. Total unauthorized consumption is guesstimated.</p>	<p>Unauthorized consumption is a known occurrence, but its extent requirements to document observed events, but periodic field reports capture some of these occurrences. Total unauthorized consumption is guesstimated from this limited data.</p>	<p>Unauthorized consumption is a known occurrence, but its extent requirements to document observed events, but periodic field reports capture some of these occurrences. Total unauthorized consumption is guesstimated from this limited data.</p>	<p>Procedures exist to document some unauthorized consumption such as observed unauthorized fire hydrant openings. Use formulas to quantify this consumption (time running x typical flowrate x number of events).</p>	<p>Default value of system input volume is employed</p>	<p>Coherent policies exist for some forms of unauthorized consumption but others await closer evaluation. Reasonable surveillance and recordkeeping exist for occurrences that fall under the policy. Volumes quantified by inference from these records. Unsupervised uses are guesstimated.</p>	<p>Clear policies and good recordkeeping exist for certain meters (ex: tempering with water heaters), other occurrences have limited oversight. Total consumption is a combination of volumes from formulae (time x typical flow) and subjective estimates of unconfirmed consumption.</p>	<p>Conditions between 8 and 10</p>	<p>Clear policies exist to identify all known unauthorized uses of water. Staff and procedures exist to provide enforcement of policies and detect violations. Each occurrence is quantified via formulae (time x typical flow) or similar methods.</p>	<p>Conditions between 8 and 10</p>	<p>Clear policies exist to identify all known unauthorized uses of water. Staff and procedures exist to provide enforcement of policies and detect violations. Each occurrence is quantified via formulae (time x typical flow) or similar methods.</p>
Improvements to obtain higher data grading for "Unauthorized Consumption" component:	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>To qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (ex: unauthorized fire hydrant openings)</p>	<p><b>To maintain 10:</b> Continue to refine policy and procedures to eliminate any loopholes that allow or tacitly encourage unauthorized consumption. Continue to be vigilant in documentation and enforcement efforts.</p>
Customer metering inaccuracies:	<p>Customer meters exist, but with unorganized paper records on meters; no meter accuracy testing or meter replacement program. Workflow is driven chaotically by customer complaints with no proactive management. Loss volume due to aggregate meter inaccuracy is guesstimated.</p>	<p>Poor recordkeeping and meter oversight is recognized by water utility management who has allotted staff and funding resources to organize improved recordkeeping and start meter accuracy testing. Existing paper records gathered and organized to provide cursory disposition of meter population.</p>	<p>Reliable recordkeeping exists; meter information is improving as meters are replaced. Meter accuracy testing is conducted annually for a small number of meters. Limited number of oldest meters replaced each year. Inaccuracy volume is largely an estimate, but refined based upon limited testing data.</p>	<p>A reliable electronic recordkeeping system for meters exists. Population includes a mix of new high performing meters and dated meters with suspect accuracy. Routine, but limited, meter accuracy testing and meter replacement occur. Inaccuracy volume is quantified using a mix of reliable and less certain data.</p>	<p>Conditions between 4 and 6</p>	<p>Conditions between 6 and 8</p>	<p>Conditions between 8 and 10</p>	<p>Good records of number, type and size of customer meters; ongoing meter replacement occurs. Regular meter accuracy testing gives reliable measure of composite inaccuracy volume for the system. New metering technology is embraced to keep overall accuracy improving.</p>	<p>Conditions between 8 and 10</p>	<p>Good records of number, type and size of customer meters; ongoing meter replacement occurs. Regular meter accuracy testing gives reliable measure of composite inaccuracy volume for the system. New metering technology is embraced to keep overall accuracy improving.</p>	<p>Conditions between 8 and 10</p>
Improvements to obtain higher data grading for "Customer meter inaccuracy volume" component:	<p><b>To qualify for 1:</b> Gather available meter purchase records. Conduct testing on a small number of meters believed to be the most inaccurate. Review staffing needs of metering group and budget for necessary resources to better organize meter management.</p>	<p><b>To qualify for 1:</b> Implement a reliable record keeping system for customer meter histories, preferably using electronic methods typically linked to, or part of, the Customer Billing System or Customer Information System. Expand meter accuracy testing to a larger group of meters.</p>	<p><b>To qualify for 1:</b> Standardize procedures for meter replacement. Accelerate meter accuracy information and meter replacements guided by testing results.</p>	<p><b>To qualify for 1:</b> Expand annual meter accuracy testing to evaluate a statistically significant number of meter make/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p>Conditions between 4 and 6</p>	<p>Conditions between 6 and 8</p>	<p>Conditions between 8 and 10</p>	<p>Expand meter accuracy testing to evaluate a statistically significant number of meter make/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p>Conditions between 8 and 10</p>	<p>Expand meter accuracy testing to evaluate a statistically significant number of meter make/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p><b>To maintain 10:</b> Increase the number of meters tested and replaced as justified by meter accuracy test data. Continually monitor development of new technology in Advanced Metering Infrastructure (AMI) to grasp opportunities for greater accuracy in metering and customer consumption data.</p>

APPARENT LOSSES

## Water Loss Control Planning Guide

Water Audit Data Validity Level / Score					
Functional Focus Area	Level I (0-25)	Level II (26-50)	Level III (51-70)	Level IV (71-90)	Level V (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		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.	Begin to assemble economic needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

*For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.*

Once data has been entered into the Reporting Worksheet, the performance indicators are automatically calculated. How does a water utility operator know how well his or her system is performing? The AWWA Water Loss Control Committee provided the following table to assist water utilities in gauging an approximate Infrastructure Leakage Index (ILI) that is appropriate for their water system and local conditions. The lower the amount of leakage and real losses that exist in the system, then the lower the ILI value will be.

**Note:** this table offers an approximate guideline for leakage reduction target-setting. The best means of setting such targets include performing an economic assessment of various loss control methods. However, this table is useful if such an assessment is not possible.

**General Guidelines for Setting a Target ILI  
(without doing a full economic analysis of leakage control options)**

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 - 5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning.
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
<b>Greater than 8.0</b>	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		

[Click to access definition](#)

Water Audit Report for: **Philadelphia Water Department**  
 Reporting Year: **2008** **7/2007 - 6/2008**

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 (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**

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	7	94,536.900	Million gallons (US)/yr (MG/Yr)
Master meter error adjustment:	10	2,779.300	over-registered MG/Yr
Water imported:	n/a		MG/Yr
Water exported:	10	7,100.400	MG/Yr
<b>WATER SUPPLIED:</b>		<b>84,657.200</b>	<b>MG/Yr</b>

**AUTHORIZED CONSUMPTION**

Billed metersd:	7	57,242.400	MG/Yr
Billed unmetered:	n/a		MG/Yr
Unbilled metered:	n/a		MG/Yr
Unbilled unmetered:	8	764.200	MG/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>58,006.600</b>	<b>MG/Yr</b>

Click here: [?](#) for help using option buttons below

Pcnt:  Value:  764.200

Use buttons to select percentage of water supplied OR value

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

26,650.600 MG/Yr

**Apparent Losses**

Unauthorized consumption:	8	2,086.300	MG/Yr
Customer metering inaccuracies:	8	190.300	MG/Yr
Systematic data handling errors:	5	4,674.400	MG/Yr
<b>Apparent Losses:</b>		<b>6,951.000</b>	<b>MG/Yr</b>

Pcnt:  Value:  2,086.300

190.300

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:		19,699.600	MG/Yr
<b>WATER LOSSES:</b>		<b>26,650.600</b>	<b>MG/Yr</b>

**NON-REVENUE WATER**

NON-REVENUE WATER: 27,414.800 MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	9	3,137.0	miles
Number of active AND inactive service connections:	7	547,932	
Connection density:		175	conn./mile main
Average length of customer service line:	7	12.0	ft
Average operating pressure:	10	55.0	psi

(pipe length between curbside and customer meter or property boundary)

**COST DATA**

Total annual cost of operating water system:	10	\$219,182,339	\$/Year
Customer retail unit cost (applied to Apparent Losses):	9	\$4.97	\$/1000 gallons (US)
Variable production cost (applied to Real Losses):	9	\$215.50	\$/Million gallons

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	32.4%
Non-revenue water as percent by cost of operating system:	17.8%
Annual cost of Apparent Losses:	\$34,546,470
Annual cost of Real Losses:	\$4,245,264

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	34.76	gallons/connection/day
Real Losses per service connection per day*:	98.50	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	1.79	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	2,178.15	million gallons/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	9.04	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 82 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: Billed metered
- 3: Systematic data handling errors

For more information, click here to see the Grading Matrix worksheet

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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WAS v4.0

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[?](#) Click to access definition

Water Audit Report for: **Regional Municipality of Peel**  
 Reporting Year: **2008** 1/2008 - 12/2008

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 (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: MEGALITRES (THOUSAND CUBIC METRES) PER YEAR

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="7"/>	<input type="text" value="213,977.000"/>	Megalitres/yr (or ML/Yr)
Master meter error adjustment:	<input type="text" value="4"/>	<input type="text" value="0.000"/>	ML/Yr
Water imported:	<input type="text" value="n/a"/>	<input type="text" value="0.000"/>	ML/Yr
Water exported:	<input type="text" value="7"/>	<input type="text" value="26,457.500"/>	ML/Yr
<b>WATER SUPPLIED:</b>		<b><input type="text" value="187,519.500"/></b>	<b>ML/Yr</b>

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="7"/>	<input type="text" value="163,665.000"/>	ML/Yr
Billed unmetered:	<input type="text" value="2"/>	<input type="text" value="433.900"/>	ML/Yr
Unbilled metered:	<input type="text" value="8"/>	<input type="text" value="1,768.400"/>	ML/Yr
Unbilled unmetered:	<input type="text" value="5"/>	<input type="text" value="230.100"/>	ML/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b><input type="text" value="166,097.400"/></b>	<b>ML/Yr</b>

Click here: [?](#) for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

ML/Yr

**Apparent Losses**

Unauthorized consumption:	<input type="text" value="5"/>	<input type="text" value="886.800"/>	ML/Yr
Customer metering inaccuracies:	<input type="text" value="7"/>	<input type="text" value="2,851.000"/>	ML/Yr
Systematic data handling errors:	<input type="text" value="7"/>	<input type="text" value="0.000"/>	ML/Yr
<b>Apparent Losses:</b>		<b><input type="text" value="3,737.800"/></b>	<b>ML/Yr</b>

Pcnt:  Value:

**Real Losses**

Real Losses = Water Losses - Apparent Losses:	<input type="text" value="7"/>	<input type="text" value="17,684.300"/>	ML/Yr
<b>WATER LOSSES:</b>		<b><input type="text" value="21,422.100"/></b>	<b>ML/Yr</b>

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**NON-REVENUE WATER**

**NON-REVENUE WATER:**   ML/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="8"/>	<input type="text" value="4,161.0"/>	kilometers
Number of active AND inactive service connections:	<input type="text" value="9"/>	<input type="text" value="287,905"/>	
Connection density:		<input type="text" value="69"/>	conn./km main
Average length of customer service line:	<input type="text" value="5"/>	<input type="text" value="16.0"/>	metres
Average operating pressure:	<input type="text" value="7"/>	<input type="text" value="58.4"/>	metres (head)

(pipe length between curbside and customer meter or property boundary)

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="7"/>	<input type="text" value="3"/>	<input type="text" value="\$100,000,000"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="7"/>	<input type="text" value="10"/>	<input type="text" value="\$0.64"/>	\$/1000 litres
Variable production cost (applied to Real Losses):	<input type="text" value="7"/>	<input type="text" value="10"/>	<input type="text" value="\$642.00"/>	\$/Megalitre

Retail costs are less than (or equal to) production costs; please review and correct if necessary

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="12.5%"/>
Non-revenue water as percent by cost of operating system:	<input type="text" value="15.0%"/>
Annual cost of Apparent Losses:	<input type="text" value="\$2,399,668"/>
Annual cost of Real Losses:	<input type="text" value="\$11,353,321"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="35.57"/>	litres/connection/day
Real Losses per service connection per day*:	<input type="text" value="168.29"/>	litres/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per meter (head) pressure:	<input type="text" value="2.88"/>	litres/connection/day/m
Unavoidable Annual Real Losses (UARL):	<input type="text" value="8,960.91"/>	cubic meters/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="1.97"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 64 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: Master meter error adjustment
- 3: Billed unmetered

[For more information, click here to see the Grading Matrix worksheet](#)

**AWWA WLCC Free Water Audit Software: [Acknowledgements](#)**

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WAS v4.0

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AWWA Water Audit Software Version 4.0 Developed by the Water Loss Control Committee of the American Water Works Association April 2009

This software is intended to serve as a basic tool to compile a preliminary, or "top-down", water audit. It is recommended that users also refer to the 3rd Edition AWWA M36 Publication, Water Audits and Loss Control Programs, for detailed guidance on compiling a comprehensive, or "bottom-up", water audit using the same water audit methodology.

**DEVELOPED BY: ANDREW CHASTAIN-HOWLEY, Miya Water**

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ALAIN LALONDE, Veritec Consulting  
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**REFERENCES:**

- Alegre, H., Hirner, W., Baptista, J. and Parena, R. Performance Indicators for Water Supply Services. IWA Publishing 'Manual of Best Practice' Series, 2000. ISBN 1 900222 272
- Kunkel, G. et al, 2003. Water Loss Control Committee Report: Applying Worldwide Best Management Practices in Water Loss Control. Journal AWWA, 95:8:65
- AWWA Water Audits and Loss Control Programs, M36 Publication, 3<sup>rd</sup> Edition, 2009
- Service Connection Diagrams courtesy of Ronnie McKenzie, WRP Pty Ltd.

# AWWA Water Loss Control Committee (WLCC) Free Water Audit Software v4.0

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WAS v4.0

**PURPOSE:** 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.

**USE:** The spreadsheet contains several separate worksheets. Sheets can be accessed using the tabs towards the bottom of the screen, or by clicking the buttons on the left below. Descriptions of each sheet are also given below.

## THE FOLLOWING KEY APPLIES THROUGHOUT:

Value can be entered by user

Value calculated based on input data

These cells contain recommended default values

Please begin by providing the following information, then proceed through each sheet in the workbook:

NAME OF CITY OR UTILITY:  COUNTRY:

REPORTING YEAR:  START DATE (MM/YYYY):  END DATE (MM/YYYY):

NAME OF CONTACT PERSON:  E-MAIL:  TELEPHONE:  Ext.

PLEASE SELECT PREFERRED REPORTING UNITS FOR WATER VOLUME:

Click to advance to sheet...

Click here:  for help about units and conversions

- 
- 
- 
- 
- 
- 
- 

The current sheet

Enter the required data on this worksheet to calculate the water balance

The values entered in the Reporting Worksheet are used to populate the water balance

Depending on the confidence of audit inputs, a grading is assigned to the audit score

Diagrams depicting possible customer service connection configurations

Use this sheet to understand terms used in the audit process

Use this sheet to interpret the results of the audit validity score and performance indicators

## Comments:

Add comments here to track additional supporting information, sources or names of participants

If you have questions or comments regarding the software please contact us at: [wlc@awwa.org](mailto:wlc@awwa.org)

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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WAS v4.0

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[Click to access definition](#)

Water Audit Report for: **City of Tustin Water Services Division**

Reporting Year: **2007** 1/2007 - 12/2007

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 (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: ACRE-FEET PER YEAR

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="10"/>	<input type="text" value="11,292.800"/>	acre-ft/yr
Master meter error adjustment (enter positive value):	<input type="text" value="4"/>	<input type="text" value="28.000"/>	under-registered acre-ft/yr
Water imported:	<input type="text" value="10"/>	<input type="text" value="3,014.900"/>	acre-ft/yr
Water exported:	<input type="text" value="10"/>	<input type="text" value="0.000"/>	acre-ft/yr
<b>WATER SUPPLIED:</b>		<b>14,335.700</b>	acre-ft/yr

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="10"/>	<input type="text" value="13,360.000"/>	acre-ft/yr
Billed unmetered:	<input type="text" value="10"/>	<input type="text" value=""/>	acre-ft/yr
Unbilled metered:	<input type="text" value="9"/>	<input type="text" value="408.000"/>	acre-ft/yr
Unbilled unmetered:	<input type="text" value="9"/>	<input type="text" value="35.000"/>	acre-ft/yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>13,803.000</b>	acre-ft/yr

Click here:  for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

**532.700** acre-ft/yr

**Apparent Losses**

Unauthorized consumption:	<input type="text" value="2"/>	<input type="text" value="5.000"/>	acre-ft/yr
Customer metering inaccuracies:	<input type="text" value="9"/>	<input type="text" value="425.814"/>	acre-ft/yr
Systematic data handling errors:	<input type="text" value="7"/>	<input type="text" value=""/>	acre-ft/yr
<b>Apparent Losses:</b>		<b>430.814</b>	

Pcnt:  Value:

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:	<input type="text" value="9"/>	<input type="text" value="101.886"/>	acre-ft/yr
<b>WATER LOSSES:</b>		<b>532.700</b>	acre-ft/yr

**NON-REVENUE WATER**

**NON-REVENUE WATER:**  **975.700** acre-ft/yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="6"/>	<input type="text" value="172.0"/>	miles
Number of active AND inactive service connections:	<input type="text" value="10"/>	<input type="text" value="14,124"/>	
Connection density:		<input type="text" value="82"/>	conn./mile main
Average length of customer service line:	<input type="text" value="9"/>	<input type="text" value="20.0"/>	ft (pipe length between curbtop and customer meter or property boundary)
Average operating pressure:	<input type="text" value="9"/>	<input type="text" value="50.0"/>	psi

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="10"/>	<input type="text" value="\$11,649,391"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="6"/>	<input type="text" value="\$1.99"/>	\$/100 cubic feet (ccf)
Variable production cost (applied to Real Losses):	<input type="text" value="9"/>	<input type="text" value="\$379.64"/>	\$/acre-ft/yr

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="6.8%"/>
Non-revenue water as percent by cost of operating system:	<input type="text" value="5.0%"/>
Annual cost of Apparent Losses:	<input type="text" value="\$373,449"/>
Annual cost of Real Losses:	<input type="text" value="\$38,680"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="27.23"/>	gallons/connection/day
Real Losses per service connection per day*:	<input type="text" value="6.44"/>	gallons/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per psi pressure:	<input type="text" value="0.13"/>	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	<input type="text" value="62.97"/>	million gallons/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="0.53"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 83 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: Master meter error adjustment
- 2: Unauthorized consumption
- 3: Customer retail unit cost (applied to Apparent Losses)

[For more information, click here to see the Grading Matrix worksheet](#)



Water Audit Report For: <b>Division</b>		Report Yr: <b>2007</b>
	Billed Water Exported	
<b>0.000</b>	Billed Metered Consumption (inc. water exported)	<b>13,360.000</b>
<b>11,320.800</b>	Billed Unmetered Consumption	<b>0.000</b>
Own Sources (Adjusted for known errors)	Unbilled Metered Consumption	<b>408.000</b>
<b>14,335.700</b>	Unbilled Unmetered Consumption	<b>35.000</b>
Water Supplied	Unauthorized Consumption	<b>5.000</b>
<b>13,803.000</b>	Apparent Losses	<b>430.814</b>
Water Imported	Real Losses	<b>101.886</b>
<b>3,014.900</b>	Water Losses	<b>532.700</b>
<b>13,360.000</b>	Leakage on Transmission and/or Distribution Mains	<b>Not broken down</b>
Revenue Water	Leakage and Overflows at Utility's Storage Tanks	<b>Not broken down</b>
<b>13,360.000</b>	Systematic Data Handling Errors	<b>0.000</b>
Non-Revenue Water (NRW)	Customer Metering Inaccuracies	<b>425.814</b>
<b>975.700</b>	Systematic Data Handling Errors	<b>0.000</b>
Non-Revenue Water (NRW)	Leakage on Service Connections	<b>Not broken down</b>

In the Reporting Worksheet, grades were assigned to each component of the audit to describe the confidence and accuracy of the input data. The grading assigned to each audit component and the corresponding recommended improvements and actions are highlighted in yellow. Audit accuracy is likely to be improved by prioritizing those items shown in red

Grading

	1	2	3	4	5	6	7	8	9	10
Volume from own sources:	Less than 25% of water production sources are metered, remaining sources are estimated. No regular meter accuracy testing.	25% - 50% of water production sources are metered, other sources estimated. Occasional meter accuracy testing.	Conditions between 2 and 4	50% - 75% of water production sources are metered, other sources estimated. Occasional meter accuracy testing.	Conditions between 4 and 6	At least 75% of 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 conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 6 and 8	100% of water supply sources are metered, meter accuracy testing and electronic calibration conducted annually, less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of water production sources are metered, meter accuracy testing and electronic calibration conducted semi-annually, with less than 10% found outside of +/- 3% accuracy
Improvements to attain higher data grading for "Volume from own Sources" component:	<b>To qualify for 2:</b> Organize efforts to begin to collect data for determining volume from own sources	<b>To qualify for 4:</b> Locate all water production sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered water production sources and replace any obsolete/defective meters	<b>To qualify for 4:</b> No automatic datalogging of production volumes; daily readings are scribbled on paper records. Tank/storage elevation changes are not employed in calculating "Volume from own sources" component. Data is adjusted only when grossly evident data error occurs.	<b>To qualify for 6:</b> Formalize annual meter accuracy testing for all sources meters. Complete installation of meters on unmetered water production sources and complete replacement of all obsolete/defective meters.	<b>To qualify for 8:</b> Conduct annual meter accuracy testing on all meters. Complete project to install new, or replace defective existing, meters so that entire production meter population is metered. Repair or replace meters outside of +/- 6% accuracy	<b>To qualify for 10:</b> Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology; pilot one or more replacements with innovative meters in attempt to improve meter accuracy.	<b>To qualify for 10:</b> Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/adopt improving metering technology.			
Master meter error adjustment:	Select n/a only if the water utility fails to have meters on its sources of supply, either its own source, and/or imported (purchased) water sources	Inventories of meters and paper records of measured volumes in crude condition; data error cannot be determined	Conditions between 2 and 4	Production meter data is logged automatically in electronic format and reviewed at least on a monthly basis. "Volume from own sources" tabulations include estimate of daily changes. Meter tank/storage facilities. Meter data is adjusted when gross data errors occur, or occasional meter testing deems this necessary.	Conditions between 4 and 6	Hourly production meter data logged automatically & reviewed on at least a weekly basis. Data adjusted to correct gross error from equipment malfunction and accuracy testing. Tank/storage facility elevation changes are automatically used in calculating a balanced "Volume from own sources" component.	Conditions between 6 and 8	Continuous production meter data logged automatically & reviewed daily. Data adjusted to correct gross error from equipment malfunction & results of meter accuracy testing. Tank/storage facility elevation changes are automatically used in "Volume from own sources" tabulations.	Conditions between 8 and 10	Computerized system (SCADA or similar) automatically balances flows from all sources and stores; results reviewed daily. Mass balance technique compares production meter data to raw (untreated) water and treatment volumes to detect anomalies. Regular calibrations between SCADA and sources meters ensures minimal data transfer error.
Improvements to attain higher data grading for "Master meter error adjustment" component:	<b>To qualify for 2:</b> Develop plan to restructure recording system to capture all flow data, set procedures to review data daily to detect input errors	<b>To qualify for 4:</b> Install automatic datalogging equipment on production meters. Identify tank/storage facilities and include estimated daily volume of water added to, or subtracted from, "Water Supplied" volume based upon changes in storage	<b>To qualify for 6:</b> Review hourly production meter data for gross error on, at least, a weekly basis. Begin to install instrumentation on tank/storage facilities to record elevation changes. Use daily net storage change to balance flows in calculating "Water Supplied" volume	<b>To qualify for 8:</b> Complete installation of elevation instrumentation on all tank/storage facilities. Continue to use daily net storage change in calculating balanced "Volume from own sources" component. Adjust production meter data for gross error and inaccuracy confirmed by testing.	<b>To qualify for 10:</b> Link all production and tank/storage facility elevation change data to a Supervisory Control & Data Acquisition (SCADA) System, or similar computerized monitoring/control system, and establish automatic flow balancing algorithm and regularly calibrate between SCADA and source meters.	<b>To qualify for 10:</b> Link all production and tank/storage facility elevation change data to a Supervisory Control & Data Acquisition (SCADA) System, or similar computerized monitoring/control system, and establish automatic flow balancing algorithm and regularly calibrate between SCADA and source meters.				
Water imported:	Less than 25% of imported water remaining sources are metered. No regular meter accuracy testing	25% - 50% of imported water sources are metered; other meter accuracy testing.	Conditions between 2 and 4	50% - 75% of imported water sources are metered, other meter accuracy testing. Occasional meter accuracy testing.	Conditions between 4 and 6	At least 75% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Conditions between 6 and 8	100% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, with less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of imported water sources are metered, meter accuracy testing and/or electronic calibration conducted semi-annually, with less than 10% found outside of +/- 3% accuracy.
Improvements to attain higher data grading for "Water Imported Volume" component:	<b>To qualify for 2:</b> Review bulk water purchase agreements with partner suppliers; confirm requirements for use and maintenance of accurate metering. Identify needs for new or replacement meters with goal to meter all imported water sources.	<b>To qualify for 4:</b> Locate all imported water sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered imported water interconnections and replace obsolete/defective meters	<b>To qualify for 6:</b> Formalize annual meter accuracy testing for all imported water meters. Continue installation of meters on unmetered imported water interconnections and replacement of obsolete/defective meters.	<b>To qualify for 8:</b> Formalize annual meter accuracy testing for all meters. Complete installation of meters on unmetered water production sources and complete replacement of all obsolete/defective meters.	<b>To qualify for 10:</b> Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Investigate new meter technology; pilot one or more replacements with innovative meters in attempt to improve meter accuracy.	<b>To qualify for 10:</b> Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/adopt improving metering technology.				

Grading

	1	2	3	4	5	6	7	8	9	10
Water Exported:	Select n/a if the water utility sells no bulk water to neighboring water utilities (no exported water sales)	25% - 50% of exported water sources are metered; other sources estimated. No regular meter accuracy testing.	Conditions between 2 and 4	50% - 75% of exported water sources are metered, other sources estimated. Occasional meter accuracy testing	Conditions between 4 and 6	At least 75% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually. Less than 25% of meters are found outside of +/- 6% accuracy	Conditions between 6 and 8	100% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted annually, with less than 10% of meters are found outside of +/- 6% accuracy	Conditions between 8 and 10	100% of exported water sources are metered, meter accuracy testing and/or electronic calibration conducted semi-annually, with less than 10% found outside of +/- 3% accuracy
Improvements to obtain higher data grading for "Water Exported Volume" component:	To qualify for 2: Review bulk water sales agreements with partner suppliers; confirm requirements for use & upkeep of accurate metering. Identify needs to install new, or replace defective meters as needed.	To qualify for 3: Locate all exported water sources on maps and in field, launch meter accuracy testing for existing meters, begin to install meters on unmetered exported water interconnections and replace obsolete/defective meters	To qualify for 4: Formalize annual meter accuracy testing for all exported water meters. Continue installation of interconnections and replacement of obsolete/defective meters.	To qualify for 5: Complete annual meter accuracy testing for all defective meters on all exported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	To qualify for 6: Complete annual meter accuracy testing for all defective meters on all exported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	To qualify for 7: Complete annual meter accuracy testing for all defective meters on all exported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	To qualify for 8: Complete annual meter accuracy testing for all defective meters on all exported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	To qualify for 9: Complete annual meter accuracy testing for all defective meters on all exported water interconnections. Maintain annual meter accuracy testing for all imported water meters. Repair or replace meters outside of +/- 6% accuracy.	To qualify for 10: Maintain annual meter accuracy testing for all meters. Repair or replace meters outside of +/- 6% accuracy. Upgrade new meter technology, pilot one or more replacements with innovative meters in attempt to improve meter accuracy.	To maintain 10: Standardize meter accuracy test frequency to semi-annual, or more frequent, for all meters. Repair or replace meters outside of +/- 3% accuracy. Continually investigate/pilot improving metering technology.
<b>AUTHORIZED CONSTRUCTION</b>										
Billed metered:	Select n/a only if the customer population is not metered, and is serviced on a flat or fixed rate basis	At least 50% of customers with volume-based billing from meter reads; flat or fixed rate billed for remainder. Manual meter reading used, less than 30% read success rate, failed reads are estimated. Limited customer meter records, no regular meter testing or replacement. Billing data maintained on paper records, with no auditing.	Conditions between 2 and 4	At least 75% of customers with volume-based billing from meter reads; flat or fixed rate billed for remainder. Manual meter reading used, at least 50% meter read success rate, failed reads are estimated. Purchase records verify age of customer meters; only very limited meter accuracy testing is conducted. Customer meters replaced only upon complete failure. Computerized billing records, but only periodic internal auditing conducted.	Conditions between 4 and 6	At least 90% of customers with volume-based billing from meter reads; remaining accounts are estimated. Manual customer meter reading gives at least 80% success rate, failed reads are estimated. Good customer meter records, regular meter accuracy testing, limited meter accuracy records, regular replacement of oldest meters. Computerized billing records with routine auditing of global statistics.	Conditions between 6 and 8	At least 97% of customers with volume-based billing from meter reads. At least 90% customer meter read success rate, or minimum 80% read success rate with planning and budgeting for trials of Automatic Metering Reading (AMR) in one or more pilot areas. Good customer meter records. Regular meter accuracy testing, significant number of statistically significant number of records for global and detailed statistics; verified periodically by third party.	Conditions between 8 and 10	At least 99% of customers with volume-based billing from meter reads. At least 95% customer meter read success rate, or minimum 80% meter reading success rate, with Automatic Meter Reading (AMR) trials underway. Statistically significant customer meter testing and replacement program in place. Computerized billing with routine detailed auditing, including field investigation of representative sample of accounts. Annual audit verification by third party.
Improvements to obtain higher data grading for "Billed Metered Consumer" component:	If n/a is selected because the customer meter population is unmetered, consider establishing a new policy to meter the customer population and employ water rates based upon metered volumes.	To qualify for 2: Conduct investigations or trials of customer meters to select appropriate meter models. Budget funding for meter testing. Investigate volume based water rates structures.	To qualify for 3: Purchase and install meters on unmetered accounts. Implement policies to improve meter reading success. Update metering data to identify aged/metered meters. Test a number of meters for accuracy. Install computerized billing system.	To qualify for 4: Purchase and install meters on unmetered accounts. Eliminate flat fee billing and upon metered consumption. Continue to achieve meter accuracy in removing manual metering for billing. Expand meter accuracy program. Launch routine audit of global statistics.	To qualify for 5: Purchase and install meters on unmetered accounts. Eliminate flat fee billing and upon metered consumption. Continue to achieve meter accuracy in removing manual metering for billing. Expand meter accuracy program. Launch routine audit of global statistics.	To qualify for 6: Purchase and install meters on unmetered accounts. Assess cost-effectiveness of Automatic Meter Reading (AMR) system for portion or entire system, or achieve ongoing improvements in manual meter reading success rate. Refine meter accuracy testing upon accuracy test results. Refine routine auditing procedures based upon third party guidance.	To qualify for 7: Purchase and install meters on unmetered accounts. Launch Automatic Meter Reading (AMR) system if manual meter reading success rate of at least 95% is not achieved within a five-year program. Consider meter accuracy testing program. Consider planning and budgeting for large scale meter replacement over multiple years. Continue routine auditing and require annual third party review.	To qualify for 8: Purchase and install meters on unmetered accounts. Launch Automatic Meter Reading (AMR) system if manual meter reading success rate of at least 95% is not achieved within a five-year program. Consider meter accuracy testing program. Consider planning and budgeting for large scale meter replacement over multiple years. Continue routine auditing and require annual third party review.	To qualify for 9: Purchase and install meters on unmetered accounts. Launch Automatic Meter Reading (AMR) system if manual meter reading success rate of at least 95% is not achieved within a five-year program. Consider meter accuracy testing program. Consider planning and budgeting for large scale meter replacement over multiple years. Continue routine auditing and require annual third party review.	To maintain 10: Regular internal and third party auditing, and meter accuracy testing ensures that accurate customer meter readings are obtained and entered as the basis for volume based billing. Stay abreast of improvements in metering technology. Advance Metering Infrastructure (AMI) and information management. Plan and budget for justified upgrades in metering, meter reading and billing data management.
Billed unmetered:	Select n/a if it is the policy of the water utility to meter all customers and it has been confirmed by detailed auditing that all customers do indeed have a water meter, i.e. no unmetered accounts exist	Water utility policy does not require customer metering; flat or fixed fee billed. Some metered accounts exist in parts of the system (e.g. District Metered Area) with no records on portable dataloggers. Data from these sample meters are used to infer consumption for the total customer population. Site specific estimation methods are used for unusual buildings/water uses.	Water utility policy does require metering and volume based billing but lacks written procedures and employs casual oversight, resulting in up to 20% of billed accounts believed to be unmetered. A rough estimate of the annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Water utility policy does require metering and volume based billing but lacks written procedures and employs casual oversight, resulting in up to 20% of billed accounts believed to be unmetered. A rough estimate of the annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Water utility policy does require metering and volume based billing but lacks written procedures and employs casual oversight, resulting in up to 20% of billed accounts believed to be unmetered. A rough estimate of the annual consumption for all unmetered accounts is included in the annual water audit, with no inspection of individual unmetered accounts.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 5% of billed accounts unmetered and less than 10% of billed accounts installation bracketed by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained for unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 5% of billed accounts unmetered and less than 10% of billed accounts installation bracketed by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained for unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 5% of billed accounts unmetered and less than 10% of billed accounts installation bracketed by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained for unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 5% of billed accounts unmetered and less than 10% of billed accounts installation bracketed by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained for unmetered accounts via site specific estimation methods.	Water utility policy requires metering and volume based billing for all customer accounts. Metering is prevalent in the service area with less than 5% of billed accounts unmetered and less than 10% of billed accounts installation bracketed by unusual circumstances. The goal is to minimize the number of unmetered accounts. Reliable estimates of consumption are obtained for unmetered accounts via site specific estimation methods.

Grading										
	1	2	3	4	5	6	7	8	9	10
Improvements to attain higher data grading for "Billed Unmetered Consumption" component:	<p><b>to qualify for 2:</b> Investigate a new water utility policy to require metering of the customer population, and a reduction of unmetered accounts. Conduct pilot metering project by installing water meters in small sample of customer accounts and databasing the water consumption.</p>	<p><b>to qualify for 4:</b> Implement a new water utility policy requiring customer metering. Expand pilot metering study to include several different meter types, which will provide data for economic assessment of full scale metering options. Assess sites with access difficulties to devise means to obtain water consumption volumes.</p>	<p><b>to qualify for 6:</b> Budget for staff resources to review billing records to identify unmetered properties. Specify metering needs and funding requirements to install sufficient meters to significant reduce the number of unmetered accounts.</p>	<p><b>to qualify for 8:</b> Install customer meters on a full scale basis. Refine metering policy and procedures to ensure that all accounts, including municipal properties, are designated for meters. Implement procedures to obtain reliable consumption estimates for unmetered accounts awaiting meter installation.</p>	<p><b>to qualify for 10:</b> Continue customer meter installation throughout the service area, with a goal to minimize unmetered accounts. Sustain the effort to investigate accounts with access difficulties to devise means to install water meters or otherwise measure water consumption.</p>	<p><b>to maintain 10:</b> Continue to refine estimation methods for unmetered consumption and explore means to establish metering, for as many billed unmetered accounts as is economically feasible.</p>				
Unbilled metered:	<p>Billing practices exempt certain accounts, such as municipal buildings, but written policies do not exist; and a reliable count of unbilled metered accounts is unavailable. Meter reading occurs on an as-needed basis. The total annual water consumption for all unbilled metered accounts is estimated based upon approximating the number of accounts and assigning consumption from actively billed accounts of same meter size.</p>	<p>Billing practices exempt certain accounts, such as municipal buildings, but only scattered, dated written directives exist to justify this practice. A reliable count of unbilled metered accounts is unavailable. Sporadic meter replacement and meter reading occurs on an as-needed basis. The total annual water consumption for all unbilled metered accounts is estimated based upon approximating the number of accounts and assigning consumption from meter size.</p>	<p>Dated written procedures permit billing exemption for specific accounts, such as municipal properties, but are unclear regarding certain other types of accounts. Meter reading is given low priority and is sporadic. Consumption is quantified from meter readings where available. The total number of unbilled, unmetered accounts must be estimated along with consumption volumes.</p>	<p>Written policies regarding billing exemptions exist but adherence in practice is questionable. Metering and meter reading for municipal buildings is reliable but sporadic for other metered accounts. Periodic auditing of water consumption is conducted directly from meter readings where available, but the majority of the consumption is estimated.</p>	<p>Written policy identifies the types of accounts granted a billing exemption. Customer meter management and meter reading are considered secondary priorities, but meter reading is conducted at least annually to obtain consumption volumes for the annual audit. High level auditing records are maintained that a reliable census of such accounts exists.</p>	<p>Clearly written policy identifies the types of accounts given a billing exemption, with emphasis on keeping such accounts to a minimum. Customer meter management and meter reading for these accounts is given proper priority and is reliably conducted. Regular auditing confirms this. Total water consumption for these accounts is taken from reliable readings from accurate meters.</p>				
Improvements to attain higher data grading for "Unbilled metered Consumption" component:	<p><b>to qualify for 2:</b> Reassess the water utility's policy allowing certain accounts to be granted a billing exemption. Draft an outline of a new written policy for billing exemptions, with clear justification as to why any accounts should be exempt from billing, and with the intention to keep the number of such accounts to a minimum.</p>	<p><b>to qualify for 4:</b> Review historic written directives and policy documents allowing certain accounts to be billing-exempt. Draft an outline of a written policy for billing exemptions, identify criteria that grants an exemption, with a goal of keeping this number of accounts to a minimum.</p>	<p><b>to qualify for 6:</b> Draft a new written policy regarding billing exemptions based upon consensus criteria allowing this occurrence. Assign resources to audit meter records and billing records to obtain census of unbilled metered accounts.</p>	<p><b>to qualify for 8:</b> Communicate billing exemption policy throughout the organization and implement procedures that ensure proper account management. Conduct inspections of accounts confirmed in unbilled metered status and verify that accurate meters exist and are scheduled for routine meter readings.</p>	<p><b>to qualify for 10:</b> Ensure that meter management (meter accuracy testing, meter replacement) and meter reading activities are accorded the same priority as billed accounts. Establish ongoing annual auditing process to ensure that water consumption is reliably collected and provided to the annual water audit process.</p>	<p><b>to maintain 10:</b> Reassess philosophy in allowing any water users to go "unbilled". It is possible to meter and bill all accounts, even if the fee charged for water consumption is discounted or waived. Metering and billing all accounts ensures that water consumption is tracked and water users from plumbing leaks is detected and minimized.</p>				
Unbilled unmetered:	<p>Extent of unbilled, unmetered consumption is unknown due to unclear policies and poor recordkeeping. Total consumption is quantified based upon a purely subjective estimate.</p>	<p>Clear extent of unbilled, unmetered consumption is known due to year, confirming existence of such consumption, but without sufficient documentation to quantify an accurate estimate of the annual volume consumed.</p>	<p>Extent of unbilled, unmetered consumption is partially known, and procedures exist to document certain events such as miscellaneous fire hydrant uses. Formulae is used to quantify the consumption from such events (time running x typical flowrate x number of events).</p>	<p>Coherent policies exist for some forms of unbilled, unmetered consumption but others await clearer evaluation. Reasonable recordkeeping for the managed uses exists and allows for annual volume to be quantified by inference, but unsupervised uses are guesstimated.</p>	<p>Clear policies and good recordkeeping exist for some uses (e.g. unmetered fire connections regarding consumption), but other uses of fire hydrants have limited oversight. Total consumption is a mix of well quantified use such as from formulae (time x typical flow) or temporary meters, and relatively subjective estimates of less regulated use.</p>	<p>Clear policies exist to identify permitted use of water in unbilled, unmetered fashion, with the intention of minimizing this type of consumption. Good records document each occurrence and consumption is quantified via formulae (time x typical flow) or use of temporary meters.</p>				

Grading

	1	2	3	4	5	6	7	8	9	10
Improvements to obtain higher data grading for "Unmetered Consumption" component:	<p><b>to qualify for 1:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>to qualify for 2:</b> Establish a policy regarding what water uses should be allowed as unmetered and unmetered. Consider tracking a small sample of one such use (e.g. fire hydrant flushings).</p>	<p><b>to qualify for 3:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of this use.</p> <p><b>to qualify for 4:</b> Evaluate the documentation of events that have been observed. Meet with user groups (e.g. for fire hydrants - fire departments, contractors to ascertain their need for water from fire hydrants).</p>	<p><b>to qualify for 5:</b> Utilize accepted default value of 1.25% of system input volume as an expedient means to gain a reasonable quantification of all such use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.</p>	<p><b>to qualify for 6 or another:</b> Finalize policy and do field checks. Proceed if top-down input is sufficient and/or a great volume of such use is suspected.</p>	<p><b>to qualify for 7:</b> Assess water utility policy and procedures to ensure that fire hydrant permits are issued for use by persons outside of the utility. Create written procedures for use and documentation of fire hydrants by water utility personnel.</p>	<p><b>to qualify for 8:</b> Refine written procedures to ensure that all uses of unmetered, unmetered water are covered by a structured permitting process managed by water utility personnel. Proceed if policy determines if some of these uses have not been converted to billed and/or metered status.</p>	<p><b>to maintain 10:</b> Continue to refine policy and procedures with intention of reducing the number of unmetered uses of water in unbillable and unmetered status. Any uses that can feasibly become billed and metered should be converted eventually.</p>			
<b>APPARENT LOSSES</b>										
Unauthorized consumption:	<p>Extent of unauthorized consumption is unknown due to unclear policies and poor recordkeeping. Total unauthorized consumption is guesstimated.</p>	<p>Unauthorized consumption is a known occurrence, but its extent is a mystery. There are no requirements to document observed events, but periodic field reports capture some of these occurrences. Total unauthorized consumption is approximated from this limited data.</p>	<p>Conditions between 2 and 4</p>	<p>Procedures exist to document some unauthorized consumption such as observed unauthorized fire hydrant openings. Use formulae to quantify this consumption (time running x typical flowrate x number of events).</p>	<p>Default value of 0.25% of system input volume is employed</p>	<p>Coherent policies exist for some forms of unauthorized consumption but others await closer evaluation. Reasonable surveillance and recordkeeping exist for occurrences that fall under the policy. Volumes quantified by inference from these records. Unsupervised uses are guesstimated.</p>	<p>Conditions between 6 and 8</p>	<p>Clear policies and good recordkeeping exist for certain events (e.g. tampering with water meters); other occurrences have limited oversight. Total consumption is a combination of typical flow and subjective estimates of unconfirmed consumption.</p>	<p>Conditions between 8 and 10</p>	<p>Clear policies exist to identify all known unauthorized uses of water. Staff and procedures exist to provide enforcement of policies and detect violations. Each occurrence is quantified via formulae (time x typical flow) or similar methods.</p>
Improvements to obtain higher data grading for "Unauthorized Consumption" component:	<p><b>to qualify for 1:</b> Use accepted default of 0.25% of system input volume.</p> <p><b>to qualify for 2:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (e.g. unauthorized fire hydrant openings)</p>	<p><b>to qualify for 3:</b> Use accepted default of 0.25% of system input volume</p> <p><b>to qualify for 4:</b> Review utility policy regarding what water uses are considered unauthorized, and consider tracking a small sample of one such occurrence (e.g. unauthorized fire hydrant openings)</p>	<p>Conditions between 2 and 4</p>	<p>Utilize accepted default value of 0.25% of system input volume as an expedient means to gain a reasonable quantification of all such use. This is particularly appropriate for water utilities who are in the early stages of the water auditing process.</p>	<p><b>to qualify for 5:</b> Finalize policy and do field checks. Proceed if top-down input is sufficient and/or a great volume of such use is suspected.</p>	<p>Assess water utility policies to ensure that all known occurrences of unauthorized consumption are outlined, and that appropriate penalties are prescribed. Create written procedures for use and documentation of various occurrences of unauthorized consumption as they are uncovered.</p>	<p><b>to qualify for 6:</b> Refine written procedures and design staff to seek out likely occurrences of unauthorized consumption. Explore new logging devices, monitors and other technologies designed to detect and thwart unauthorized consumption.</p>	<p><b>to qualify for 7:</b> Refine written procedures and design staff to seek out likely occurrences of unauthorized consumption. Explore new logging devices, monitors and other technologies designed to detect and thwart unauthorized consumption.</p>	<p><b>to qualify for 8:</b> Refine written procedures and design staff to seek out likely occurrences of unauthorized consumption. Explore new logging devices, monitors and other technologies designed to detect and thwart unauthorized consumption.</p>	<p><b>to maintain 10:</b> Continue to refine policy and procedures with intention of reducing the number of unmetered uses of water in unbillable and unmetered status. Any uses that can feasibly become billed and metered should be converted eventually.</p>
Customer metering inaccuracies:	<p>Customer meters exist, but records on meters, no meter accuracy testing or meter replacement program. Workflow is driven directly by customer complaints with no proactive management. Loss related to aggregate meter accuracy is guesstimated.</p>	<p>Poor recordkeeping and meter oversight is recognized by water utility management who has allotted staff and funding resources to organize improved recordkeeping and start meter accuracy testing. Existing paper records gathered and organized to provide cursory disposition of meter population.</p>	<p>Conditions between 2 and 4</p>	<p>Reliable recordkeeping exists; meter information is improving as meters are replaced. Meter accuracy testing is conducted annually for a small number of meters. Limited number of oldest meters replaced each year. Inaccuracy volume is largely an estimate, but refined based upon limited testing data.</p>	<p>Conditions between 4 and 6</p>	<p>A reliable electronic recordkeeping system for meters exists. Population includes a mix of new high performing meters and dated meters with suspect accuracy. Routine, but limited, meter accuracy testing and meter replacement occur. Inaccuracy volume is quantified using a mix of reliable and less certain data.</p>	<p>Conditions between 6 and 8</p>	<p>Conditions between 8 and 10</p>	<p>Good records of number, type and size of customer meters; ongoing meter replacement occurs. Regular meter accuracy testing gives reliable measure of composite inaccuracy volume for the system. New metering technology is embraced to keep overall accuracy improving.</p>	<p>to maintain 10: Increase the number of meters tested and replaced as justified by meter accuracy test data. Continually monitor development of new technology in Advanced Metering Infrastructure (AMI) to gain group infrastructure for greater accuracy in metering and customer consumption data.</p>
Improvements to obtain higher data grading for "Customer meter inaccuracy volume" component:	<p><b>to qualify for 1:</b> Gather available meter purchase records. Conduct testing on a small number of meters believed to be the most inaccurate. Review staffing needs of metering group and budget for necessary resources to better organize meter management.</p>	<p><b>to qualify for 2:</b> Implement a reliable record keeping system for customer meter histories, preferably using electronic methods typically linked to, or part of, the Customer Billing System or Customer Information System. Expand meter accuracy testing to a larger group of meters.</p>	<p><b>to qualify for 3:</b> Standardize procedures for meter recordkeeping with the electronic information system. Accelerate meter accuracy testing and meter replacements guided by testing results.</p>	<p>Expand annual meter accuracy testing to evaluate a statistically significant number of meter make/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p><b>to qualify for 4:</b> Expand annual meter accuracy testing to evaluate a statistically significant number of meter make/models. Expand meter replacement program to replace statistically significant number of poor performing meters each year.</p>	<p><b>to qualify for 5:</b> Continue efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Evaluate new meter types and install one or more types in 5-10 customer accounts each year in order to pilot improving metering technology.</p>	<p><b>to qualify for 6:</b> Continue efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Evaluate new meter types and install one or more types in 5-10 customer accounts each year in order to pilot improving metering technology.</p>	<p><b>to qualify for 7:</b> Continue efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Evaluate new meter types and install one or more types in 5-10 customer accounts each year in order to pilot improving metering technology.</p>	<p><b>to qualify for 8:</b> Continue efforts to manage meter population with reliable recordkeeping, meter testing and replacement. Evaluate new meter types and install one or more types in 5-10 customer accounts each year in order to pilot improving metering technology.</p>	<p><b>to maintain 10:</b> Increase the number of meters tested and replaced as justified by meter accuracy test data. Continually monitor development of new technology in Advanced Metering Infrastructure (AMI) to gain group infrastructure for greater accuracy in metering and customer consumption data.</p>

Grading										
	1	2	3	4	5	6	7	8	9	10
Systematic Data Handling Error:	select rate only if the customer population is billed at flat or fixed rate charge that is not based upon measured volumes of water consumption (unmetered population)	Vague policy for permitting (creating new customer accounts) and billing. Billing records which are in disarray. No audits conducted to confirm billing data handling efficiency. Unknown number of customers escape routine billing due to lack of billing process oversight.	Policy for permitting and billing exists but needs refinement. Billing data maintained on paper records or insufficiently capable electronic database. Only periodic unstructured auditing work conducted to confirm billing data handling efficiency. Volume of unbilled water due to billing lapses is a guess.	Conditions between 2 and 4	Policy and procedures for permitting and billing exist but needs refinement. Computerized billing system in use with basic reporting adjustments on measured consumption volumes is well understood. Internal checks of billing data error conducted annually. Reasonably accurate quantification of consumption volume test to billing lapses is obtained.	Conditions between 4 and 6	Conditions between 8 and 10	Permitting and billing policy reviewed at least biannually. Computerized billing system includes an array of records to confirm billing data and system functionality. Annual internal checks conducted with periodic third party audit. Accountability checks flag billing lapses. Consumption lost to billing lapses is well quantified and reducing year-by-year.	Conditions between 8 and 10	Sound policy exists for permitting of all customer billing accounts. Robust tools for identifying system gaps, high functionality and reporting capabilities. Assessment of policy and data handling errors conducted internally and audited by third party annually, ensuring consumption lost to billing lapses is minimized and detected as it occurs.
Improvements to attain higher data grading for "Systematic Data Handling Error volume" component:	In quality for 2: Draft written policy for permitting and billing. Investigate and budget for computerized customer billing system. Conduct initial audit of billing records by flow-charting the basic business processes of the customer account/billing function.	In quality for 4: Finalize written policy for permitting and billing. Implement a computerized customer billing system. Conduct initial audit of billing records as part of this process.	In quality for 6: Refine permitting and billing procedures and ensure consistency with the utility policy for recording billing. Upgrade or replace customer billing system for record functionality. Ensure that billing adjustments don't corrupt the volume of consumption volumes. Procedures internal annual audit process.	In quality for 8: Formalize regular review of permitting and billing practices. Enhance reporting capability of computerized billing system. Formalize regular auditing process to reveal scope of data handling error.	In quality for 10: Stay abreast of customer information management developments and innovations. Monitor developments of Advanced Metering Infrastructure (AMI) and integrate technology to ensure that customer endpoint information is well-monitored and error/lapses are at an economic minimum.					
<b>SYSTEM DATA</b>										
Length of mains:	Poorly assembled and maintained paper as-built records of existing water main installations makes accurate determination of system pipe length impossible. Length of mains is guesstimated.	Paper records in poor condition (no annual tracking of installations & abandonments). Poor procedures to ensure that new water mains installed by developers are accurately documented.	Conditions between 2 and 4	Sound policy and procedures for permitting and documenting new water main installations, but gaps in management result in a uncertain degree of error in tabulation of mains length.	Conditions between 4 and 6	Sound policy and procedures exist for permitting and commissioning new water mains. Highly accurate paper records with regular field validation; or electronic records and asset management system in good condition. Includes system backup.	Conditions between 8 and 10	Sound policy exists for managing water mains extensions and replacements. Geographic Information System (GIS) data and asset management database agree and random field validation proves truth of databases.	Conditions between 8 and 10	In quality for 10: Continue with standardization and random field validation to improve knowledge of system.
Improvements to attain higher data grading for "Length of Water Mains" component:	In quality for 2: Assign personnel to inventory current as-built records and compare with customer billing system records and highway plans. Assemble policy documents regarding permitting and documentation of water main installations by the utility and building developers. Identify gaps in procedure that result in poor documentation.	In quality for 4: Complete inventory of paper records of water main installations & abandonments for a number of years prior to audit year. Review policy and procedures for commissioning and documenting new water main installation and abandonments.	In quality for 6: Finalize updates/improvements to policy and procedures for permitting/commissioning new main installations. Confirm inventory of records for five years prior to audit year, correct any errors or omissions.	In quality for 8: Launch random field checks of limited number of locations. Convert to electronic databases with backup as justified.	In quality for 10: Link Geographic Information System (GIS) and asset management databases, conduct field verification of data.					
Number of active AND inactive service connections:	Vague permitting (of new service connections) policy and poor paper recordkeeping of customer connections/billings result in suspect determination of the number of service connections, which may be 10-15% in error from actual count.	General permitting policy exists but paper records, procedural gaps, and weak oversight result in questionable total for number of connections, which may vary 5-10% of actual count.	Conditions between 2 and 4	Permitting policy and procedures exist, but with some gaps in performance and oversight. Computerized information management system is being brought online to replace dated paper recordkeeping system. Reasonably accurate tracking of service connection installations & abandonments; but count can be up to 5% in error from actual total.	Conditions between 4 and 6	Permitting policy and procedures are adequate and reviewed periodically. Computerized information management system is in use with annual installations & abandonments totaled. Very limited field verifications and audits. Error in count of number of service connections is believed to be no more than 3%.	Conditions between 6 and 8	Permitting policy and procedures reviewed at least biannually. Well managed computerized information management system and routine, periodic field checks and internal system audits allows counts of connections that is no more than 2% in error.	Conditions between 8 and 10	Sound permitting policy and well managed and audited procedures ensure reliable management of service connection population. Computerized information management system and Geographic Information System (GIS) information agree; field validation proves truth of databases. Count of connections believed to be in error by less than 1%.
Improvements to attain higher data grading for "Number of Active and Inactive customer service connections" component:	In quality for 2: Draft new policy and procedures for permitting and billing. Research and collect paper records of installations & abandonments for several years prior to audit year.	In quality for 4: Refine policy and procedures for permitting and billing. Research computerized recordkeeping system (Customer Information System or Customer Billing System) to improve documentation timing for service connections.	In quality for 6: Refine procedures to ensure consistency with permitting policy to establish new service connections or decommission existing connections. Improve process to include all totals for at least five years prior to audit year.	In quality for 8: Formalize regular review of permitting policy and procedures. Launch random field checks of limited number of locations. Develop reports and auditing mechanisms for computerized information management system.	In quality for 10: Close any procedural loopholes that allow installations to go undocumented. Link computerized information management system with Geographic Information System (GIS) and formalize field inspection and information system auditing processes. Documentation of new or decommissioned service connections encounters several levels of checks and balances.					

**Grading**

	1	2	3	4	5	6	7	8	9	10
	n/a									
Average length of customer service line	<p>If customer water meters are located outside of the customer building and adjacent to the curbside or boundary separating utility/customer responsibility for the service connection piping (typically in a meter box or meter pit), the location of the meter is the responsibility of the utility/customer. The Reporting Worksheet with a grading of 10.</p>	<p>Policy requires that the curbside point serves as the delineation point between water utility ownership and customer ownership of the service connection piping. The curbside is the property of the water utility, and the piping from the curbside to the customer building is owned by the customer. Most curbsides are well-documented. Their location varies widely from site-to-site, and estimating this distance is arbitrary due to the unknown location of many curbsides.</p>	<p>Conditions between 2 and 4</p>	<p>Good policy requires that the curbside point serves as the delineation between water utility ownership and customer ownership of the service connection piping. Curbsides are generally installed as needed and are reasonably documented. Their location varies widely from site-to-site, and an estimate of this distance is hindered by the availability of paper records.</p>	<p>Conditions between 4 and 6</p>	<p>Clear policy exists to define utility/customer responsibility for service connection piping. Accurate, well-maintained paper or basic electronic recordkeeping system exists. Periodic field checks confirm piping lengths for a sample of customer properties.</p>	<p>Conditions between 6 and 8</p>	<p>Clearly worded policy standardizes the location of curbsides and meters, which are inspected upon installation. Accurate and well maintained electronic records exist with periodic field checks to confirm locations of service lines, curbsides and customer meter pits. An accurate number of customer properties from the customer billing system allows for reliable averaging of this length.</p>	<p>Conditions between 8 and 10</p>	<p>Either of two conditions can be met to obtain a grading of 10:                      a) The customer water meter is located outside of the customer building adjacent to the curbside or boundary separating utility/customer responsibility for the service connection piping. In this case enter a value of zero in the Reporting Worksheet with a grading of 10.                      b) Customer water meters are located inside customer buildings, or the properties are unmetered. In either case the distance to highly reliable site data is drawn from a Geographic Information System (GIS) and confirmed by routine field checks.</p>
Improvements to attain higher data grading for "Average Length of Customer Service Line" component:	<p>Research and collect paper records of service line installations. Inspect several sites in the field using pipe locators to locate curbsides. Obtain the length of this small sample of connections in this manner.</p>	<p><b>To qualify for 4:</b>                      Formalize and communicate policy delineating utility/customer responsibilities for service connection piping. Assess accuracy of paper records by field inspection of a small sample of service connections using pipe locators as needed. Research the potential migration to a computerized information management system to store service connection data.</p>	<p>Conditions between 2 and 4</p>	<p><b>To qualify for 6:</b>                      Establish coherent procedure to ensure that policy for curbside, meter installation and documentation is followed. Gain consensus within the water utility for the establishment of a computerized information management system.</p>	<p><b>To qualify for 8:</b>                      Implement an electronic means of recordkeeping, typically via a customer information system or customer billing system. Standardize the process to conduct field checks of limited number of locations.</p>	<p><b>To qualify for 10:</b>                      Link customer information management system and Geographic Information System (GIS). Standardize process for field verification of data.</p>	<p>Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA System exists to monitor the water distribution system and collect readings at representative sites across the system. The average system pressure is determined by averaging the mix of reliable data.</p>	<p>Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA System exists to monitor the water distribution system and collect readings at representative sites across the system. The average system pressure is determined by averaging the mix of reliable SCADA System data.</p>	<p>Well-managed pressure distribution zones exist to give very precise pressure data across the water distribution system. Average system pressure is reliably calculated from extensive, reliable, and cross-checked data.</p>	<p>Well-managed pressure distribution zones exist to give very precise pressure data across the water distribution system. Average system pressure is reliably calculated from extensive, reliable, and cross-checked data.</p>
Average operating pressure:	<p>Available records are poorly assembled and maintained. Paper records of supply pump characteristics and water distribution system operating conditions. Average pressure is estimated based upon this information and ground elevations from crude topographical maps. Widely varying distribution system pressures due to undulating terrain, high system head loss and weak/erratic pressure controls further compromise the validity of the average pressure calculation.</p>	<p>Limited telemetry monitoring of scattered sites provides some static pressure data, which is recorded in handwritten logbooks. Pressure data is gathered at individual sites only when low pressure complaints arise. Average pressure is determined by averaging telemetry crude data, and is affected by significant variation in ground elevations, system needs and gaps in the pressure data points in the distribution system.</p>	<p>Conditions between 2 and 4</p>	<p>Effective pressure controls separate different pressure zones, moderate pressure variation across the system, occasional open boundary valves are discovered that breach pressure zones. Basic telemetry monitoring of the distribution system logs pressure data electronically. Pressure data gathered by gauges or dataloggers at fire hydrants or buildings when low pressure complaints arise, and flow tests and flushing. Reliable topographical data exists. Average pressure is calculated using this mix of data.</p>	<p>Reliable pressure controls separate district pressure zones; only very occasional open boundary valves are encountered that breach pressure zones. Well-covered telemetry monitoring of the distribution system logs pressure data electronically. Pressure gathered by gauges/dataloggers at fire hydrants and buildings when low pressure complaints arise, and flow tests and flushing. Average pressure is determined by averaging the mix of reliable data.</p>	<p>Conditions between 6 and 8</p>	<p>Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA System exists to monitor the water distribution system and collect readings at representative sites across the system. The average system pressure is determined by averaging the mix of reliable SCADA System data.</p>	<p>Well-managed, discrete pressure zones exist with generally predictable pressure fluctuations. A current full-scale SCADA System exists to monitor the water distribution system and collect readings at representative sites across the system. The average system pressure is determined by averaging the mix of reliable SCADA System data.</p>	<p>Well-managed pressure distribution zones exist to give very precise pressure data across the water distribution system. Average system pressure is reliably calculated from extensive, reliable, and cross-checked data.</p>	<p>Well-managed pressure distribution zones exist to give very precise pressure data across the water distribution system. Average system pressure is reliably calculated from extensive, reliable, and cross-checked data.</p>
Improvements to attain higher data grading for "Average Operating Pressure" component:	<p>Employ pressure gauging and/or datalogging equipment to obtain pressure measurements from fire hydrants. Locate accurate topographical maps of service area in order to confirm ground elevations. Research pump data needs to find pump pressure/flow characteristics</p>	<p><b>To qualify for 4:</b>                      Formalize a procedure to use pressure gauging/datalogging equipment to gather pressure data during various system events such as low pressure complaints, or operational different flow regimes. Identify faulty pressure controls (pressure reducing valves, altitude valves, partially open boundary valves) and plan to properly configure pressure zones. Make pressure data from these efforts available to generate system-wide average pressure.</p>	<p>Conditions between 4 and 6</p>	<p>Expand the use of pressure gauging/datalogging equipment to gather pressure data at a representative set of sites, based upon pressure zones or areas. Utilize pump pressure and flow data to determine supply head entering each pressure zone or district. Connect any faulty pressure controls (pressure reducing valves, altitude valves, partially open boundary valves) to ensure properly configured pressure zones. Use expanded pressure dataset from these activities to generate system-wide average pressure.</p>	<p><b>To qualify for 6:</b>                      Install a Supervisory Control and Data Acquisition (SCADA) System to monitor system parameters and control operations. Set regular calibration schedule for instrumentation to insure data accuracy. Obtain accurate topographical data and utilize pressure data gathered from flow surveys to provide comparative, reliable data for pressure averaging.</p>	<p><b>To qualify for 8:</b>                      Acquire a Supervisory Control and Data Acquisition (SCADA) System to monitor system parameters and control operations. Set regular calibration schedule for instrumentation to insure data accuracy. Obtain accurate topographical data and utilize pressure data gathered from flow surveys to provide comparative, reliable data for pressure averaging.</p>	<p><b>To qualify for 10:</b>                      Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.</p>	<p><b>To qualify for 10:</b>                      Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.</p>	<p><b>To qualify for 10:</b>                      Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.</p>	<p><b>To qualify for 10:</b>                      Obtain average pressure data from hydraulic model of the distribution system that has been calibrated via field measurements in the water distribution system and confirmed in comparisons with SCADA System data.</p>

Grading											
n/a	1	2	3	4	5	6	7	8	9	10	
COST DATA											
Total annual cost of operating water system:	Incomplete paper records and lack of documentation on many operating functions making calculation of water system operating costs a pure guessimate	Reasonably maintained, but incomplete, paper or electronic accounting provides data to estimate the major portion of water system operating costs.	Conditions between 2 and 4	Electronic, industry-standard cost accounting system in place. Gaps in data known to exist, periodic internal reviews conducted but not a structured audit.	Conditions between 4 and 6	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited periodically by utility personnel, not a Certified Public Accountant (CPA).	Conditions between 8 and 10	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited at least annually by utility personnel, and periodically by third-party CPA.	Conditions between 8 and 10	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Data audited annually by utility personnel and by third-party CPA.	
Improvements to attain Higher data grading for "Total Annual Cost of Operating the Water System" component:	<b>To qualify for 2:</b> Gather available records, institute new procedures to regularly collect and audit basic cost data of most important operations functions.	<b>To qualify for 4:</b> Implement an electronic cost accounting system, structured according to accounting standards for water utilities	<b>To qualify for 3:</b> Establish process for periodic internal audit of water system operating costs; identify cost data gaps and institute procedures for tracking these outstanding costs.	<b>To qualify for 6:</b> Standardize the process to conduct routine financial audit on an annual basis.	<b>To qualify for 8:</b> Standardize the process to conduct a third-party financial audit by a CPA on an annual basis.	<b>To maintain 10:</b> Maintain program, stay abreast of expenses subject to erratic cost changes and budget/track costs proactively					
Customer retail unit cost (applied to Apparent Losses):	Antiquated, cumbersome water rate structure is used, with periodic historic amendments that were poorly documented and implemented, resulting in classes of customers being billed inconsistent charges. The actual composite billing rate likely differs significantly from the published water rate structure, but a lack of auditing leaves the degree of error indeterminate.	Dated, cumbersome water rate structure, not always employed consistently in actual billing operations. The actual composite billing rate is known to differ from the published water rate structure, and a reasonably accurate estimate of the degree of error is determined, allowing a composite billing rate to be quantified	Conditions between 2 and 4	Straight-forward water rate structure in place, but not updated in several years. Billing operations reliably employ the rate structure. The composite billing rate is derived from a single number customer class such as residential customer accounts, neglecting the effect of different rates from varying customer classes.	Customer population unmetered. Fixed fee charged; single composite number derived from multiple customer classes.	Clearly written, up-to-date water rate structure in place and is applied reliably in billing operations. Composite billing rate is determined using a weighted average composite consumption rate (includes residential, commercial, industrial, etc.)	Conditions between 8 and 10	Effective water rate structure is in force and is applied reliably in billing operations. Composite customer rate is determined using a weighted average composite consumption rate, including residential, commercial, industrial and any other customer classes within the water rate structure.	Conditions between 8 and 10	Third party reviewed weighted average composite consumption rate (includes residential, commercial, industrial, etc.)	
Improvements to attain Higher data grading for "Customer Retail Unit Cost" component:	<b>To qualify for 2:</b> Formalize the process to implement water rates, including a secure documentation procedure. Create a current, formal water rate document and gain approval from all stakeholders.	<b>To qualify for 4:</b> Review the water rate structure and update/formalize as needed. Assess billing operations to ensure that actual billing operators incorporate the established water rate structure.	<b>To qualify for 3:</b> Evaluate volume of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	<b>To qualify for 6:</b> Evaluate volume of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	<b>Meter.</b> Customers and charging rate based upon water volumes	<b>To qualify for 8:</b> Conduct a periodic third-party audit of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	<b>To maintain 10:</b> Keep water rate structure current in addressing the water utility's revenue needs. Update the calculation of the customer unit rate as new rate components, customer classes, or other components are modified.	<b>To qualify for 10:</b> Conduct a periodic third-party audit of water used in each usage block by all classifications of users. Multiply volumes by full rate structure.	<b>To maintain 10:</b> Keep water rate structure current in addressing the water utility's revenue needs. Update the calculation of the customer unit rate as new rate components, customer classes, or other components are modified.		
Variable production cost (applied to Real Losses):	If the water utility purchases/import its entire water supply, then enter the unit purchase cost of the water supply in the Worksheet with a grading of 10	Reasonably maintained, but incomplete, paper or electronic accounting provides data to roughly estimate the basic operations costs (pumping power costs, treatment chemicals) and calculate a unit variable production cost.	Conditions between 2 and 4	Electronic, industry-standard cost accounting system in place. Electric power and treatment costs are reliably tracked and allow accurate calculation of unit variable production costs based on these two inputs only. All costs are audited internally on a periodic basis.	Conditions between 4 and 8	Reliable electronic, industry-standard cost accounting system in place, with all pertinent water system operating costs tracked. Pertinent additional costs beyond power and treatment (for liability, residuals management, etc.) are included in the unit variable production cost. Data audited at least annually by utility personnel.	Conditions between 8 and 10	Reliable electronic, industry-standard cost accounting system in place, with all pertinent variable production costs tracked. Data audited at least annually by utility personnel, and periodically by third-party.	Conditions between 8 and 10	Either of two conditions can be met to obtain a grading of 10: 1) Third party CPA audit of all primary and secondary cost components on an annual basis. OR 2) Water supply is entirely purchased as bulk imported water, and unit purchase cost serves as the variable production cost.	
Improvements to attain Higher data grading for "Variable Production Cost" component:	<b>To qualify for 2:</b> Gather available records, institute new procedures to regularly collect and audit basic cost data and most important operations functions.	<b>To qualify for 4:</b> Implement an electronic cost accounting system, structured according to accounting standards for water utilities	<b>To qualify for 3:</b> Formalize process for regular internal audits of production costs. Assess whether additional costs (liability, residuals management, etc.) should be included to calculate a more accurate variable production cost.	<b>To qualify for 6:</b> Formalize the accounting process to include primary cost components (power, treatment) as well as secondary components (liability, residuals management, etc.) Conduct periodic third-party audits.	<b>To qualify for 8:</b> Standardize the accounting process to conduct a third-party financial audit by a CPA on an annual basis.	<b>To maintain 10:</b> Maintain program, stay abreast of expenses subject to erratic cost changes and budget/track costs proactively					



## Water Loss Control Planning Guide

Water Audit Data Validity Level / Score					
Functional Focus Area	Level I (0-25)	Level II (26-50)	Level III (51-70)	Level IV (71-90)	Level V (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		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.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

*For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.*

Once data has been entered into the Reporting Worksheet, the performance indicators are automatically calculated. How does a water utility operator know how well his or her system is performing? The AWWA Water Loss Control Committee provided the following table to assist water utilities in gauging an approximate Infrastructure Leakage Index (ILI) that is appropriate for their water system and local conditions. The lower the amount of leakage and real losses that exist in the system, then the lower the ILI value will be.

**Note:** this table offers an approximate guideline for leakage reduction target-setting. The best means of setting such targets include performing an economic assessment of various loss control methods. However, this table is useful if such an assessment is not possible.

**General Guidelines for Setting a Target ILI  
(without doing a full economic analysis of leakage control options)**

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 - 5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning.
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		

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Water Audit Report for: **Philadelphia Water Department**  
 Reporting Year: **2008** 7/2007 - 6/2008

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 (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**

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	7	94,536.900	Million gallons (US)/yr (MG/Yr)
Master meter error adjustment:	10	2,779.300	over-registered MG/Yr
Water imported:	n/a		MG/Yr
Water exported:	10	7,100.400	MG/Yr
<b>WATER SUPPLIED:</b>		<b>84,657.200</b>	<b>MG/Yr</b>

**AUTHORIZED CONSUMPTION**

Billed metered:	7	57,242.400	MG/Yr
Billed unmetered:	n/a		MG/Yr
Unbilled metered:	n/a		MG/Yr
Unbilled unmetered:	8	764.200	MG/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b>58,006.600</b>	<b>MG/Yr</b>

Click here: [?](#) for help using option buttons below

Pcnt:  Value:  764.200

Use buttons to select percentage of water supplied OR value

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

26,650.600 MG/Yr

**Apparent Losses**

Unauthorized consumption:	8	2,086.300	MG/Yr
Customer metering inaccuracies:	8	190.300	MG/Yr
Systematic data handling errors:	5	4,674.400	MG/Yr
<b>Apparent Losses:</b>		<b>6,951.000</b>	<b>MG/Yr</b>

Pcnt:  Value:  2,086.300

190.300

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:		19,699.600	MG/Yr
<b>WATER LOSSES:</b>		<b>26,650.600</b>	<b>MG/Yr</b>

**NON-REVENUE WATER**

NON-REVENUE WATER: 27,414.800 MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	9	3,137.0	miles
Number of active AND inactive service connections:	7	547,932	
Connection density:		175	conn./mile main
Average length of customer service line:	7	12.0	ft (pipe length between curbside and customer meter or property boundary)
Average operating pressure:	10	55.0	psi

**COST DATA**

Total annual cost of operating water system:	10	\$219,182,339	\$/Year
Customer retail unit cost (applied to Apparent Losses):	9	\$4.97	\$/1000 gallons (US)
Variable production cost (applied to Real Losses):	9	\$215.50	\$/Million gallons

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	32.4%
Non-revenue water as percent by cost of operating system:	17.8%
Annual cost of Apparent Losses:	\$34,546,470
Annual cost of Real Losses:	\$4,245,264

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	34.76	gallons/connection/day
Real Losses per service connection per day*:	98.50	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	1.79	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	2,178.15	million gallons/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	9.04	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

**\*\*\* YOUR SCORE IS: 82 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: Billed metered
- 3: Systematic data handling errors

[For more information, click here to see the Grading Matrix worksheet](#)

AWWA WLCC Free Water Audit Software: Reporting Worksheet

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WAS v4.0

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Water Audit Report for: **Regional Municipality of Peel**  
 Reporting Year: **2008** 1/2008 - 12/2008

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 (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: MEGALITRES (THOUSAND CUBIC METRES) PER YEAR

**WATER SUPPLIED**

<< Enter grading in column 'E'

Volume from own sources:	<input type="text" value="7"/>	<input type="text" value="213,977.000"/>	Megalitres/yr (or ML/Yr)
Master meter error adjustment:	<input type="text" value="4"/>	<input type="text" value="0.000"/>	ML/Yr
Water imported:	<input type="text" value="n/a"/>	<input type="text" value="0.000"/>	ML/Yr
Water exported:	<input type="text" value="7"/>	<input type="text" value="26,457.500"/>	ML/Yr
<b>WATER SUPPLIED:</b>		<b><input type="text" value="187,519.500"/></b>	<b>ML/Yr</b>

**AUTHORIZED CONSUMPTION**

Billed metered:	<input type="text" value="7"/>	<input type="text" value="163,665.000"/>	ML/Yr
Billed unmetered:	<input type="text" value="2"/>	<input type="text" value="433.900"/>	ML/Yr
Unbilled metered:	<input type="text" value="8"/>	<input type="text" value="1,768.400"/>	ML/Yr
Unbilled unmetered:	<input type="text" value="5"/>	<input type="text" value="230.100"/>	ML/Yr
<b>AUTHORIZED CONSUMPTION:</b>		<b><input type="text" value="166,097.400"/></b>	<b>ML/Yr</b>

Click here:  for help using option buttons below

Pcnt:  Value:

Use buttons to select percentage of water supplied OR value

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

ML/Yr

**Apparent Losses**

Unauthorized consumption:	<input type="text" value="5"/>	<input type="text" value="886.800"/>	ML/Yr
Customer metering inaccuracies:	<input type="text" value="7"/>	<input type="text" value="2,851.000"/>	ML/Yr
Systematic data handling errors:	<input type="text" value="7"/>	<input type="text" value="0.000"/>	ML/Yr

Pcnt:  Value:

Systematic data handling errors are likely, please enter a non-zero value; otherwise grade = 5

Apparent Losses:  ML/Yr

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

**Real Losses**

Real Losses = Water Losses - Apparent Losses:  ML/Yr

**WATER LOSSES:**  ML/Yr

**NON-REVENUE WATER**

NON-REVENUE WATER:  ML/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

**SYSTEM DATA**

Length of mains:	<input type="text" value="8"/>	<input type="text" value="4,161.0"/>	kilometers
Number of active AND inactive service connections:	<input type="text" value="9"/>	<input type="text" value="287,905"/>	
Connection density:		<input type="text" value="69"/>	conn./km main
Average length of customer service line:	<input type="text" value="5"/>	<input type="text" value="16.0"/>	metres
Average operating pressure:	<input type="text" value="6"/>	<input type="text" value="58.4"/>	metres (head)

(pipe length between curbstop and customer meter or property boundary)

**COST DATA**

Total annual cost of operating water system:	<input type="text" value="3"/>	<input type="text" value="\$100,000,000"/>	\$/Year
Customer retail unit cost (applied to Apparent Losses):	<input type="text" value="10"/>	<input type="text" value="\$0.64"/>	\$/1000 litres
Variable production cost (applied to Real Losses):	<input type="text" value="10"/>	<input type="text" value="\$642.00"/>	\$/Megalitre

Retail costs are less than (or equal to) production costs; please review and correct if necessary

**PERFORMANCE INDICATORS**

**Financial Indicators**

Non-revenue water as percent by volume of Water Supplied:	<input type="text" value="12.5%"/>
Non-revenue water as percent by cost of operating system:	<input type="text" value="15.0%"/>
Annual cost of Apparent Losses:	<input type="text" value="\$2,399,668"/>
Annual cost of Real Losses:	<input type="text" value="\$11,353,321"/>

**Operational Efficiency Indicators**

Apparent Losses per service connection per day:	<input type="text" value="35.57"/>	litres/connection/day
Real Losses per service connection per day*:	<input type="text" value="168.29"/>	litres/connection/day
Real Losses per length of main per day*:	<input type="text" value="N/A"/>	
Real Losses per service connection per day per meter (head) pressure:	<input type="text" value="2.88"/>	litres/connection/day/m
Unavoidable Annual Real Losses (UARL):	<input type="text" value="8,960.91"/>	cubic meters/year
Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	<input type="text" value="1.97"/>	

\* only the most applicable of these two indicators will be calculated

**WATER AUDIT DATA VALIDITY SCORE:**

\*\*\* YOUR SCORE IS: 64 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: Master meter error adjustment
- 3: Billed unmetered

For more information, click here to see the Grading Matrix worksheet

## AWWA WLCC Free Water Audit Software: Acknowledgements

WAS v4.0

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This software is intended to serve as a basic tool to compile a preliminary, or "top-down", water audit. It is recommended that users also refer to the 3rd Edition AWWA M36 Publication, Water Audits and Loss Control Programs, for detailed guidance on compiling a comprehensive, or "bottom-up", water audit using the same water audit methodology.

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- Service Connection Diagrams courtesy of Ronnie McKenzie, WRP Pty Ltd.