



April 15, 2025

Rosemary Chiavetta, Secretary
PA Public Utility Commission
P.O. Box 3265
Harrisburg, PA 17105-3265

RE: Water Loss Audit
Year Ending December 31, 2024
Docket No. M-2025-3052805

Dear Secretary Chiavetta:

Enclosed is the Columbia Water Company's Water Loss Audits for the year ending December 31, 2024. This audit is being filed as required by PUC Order at M-2008-2062697. Attached is a PDF copy of the audit.

Should you require any additional information, please feel free to contact me.

Sincerely,

A handwritten signature in blue ink, appearing to read "David T. Lewis".

David T. Lewis, P.E.
President and
General Manager

Copy via email: Clinton McKinley

Columbia Water Company

220 Locust Street ■ P.O. Box 350 ■ Columbia, PA 17512
Phone: 717-684-2188 ■ Fax: 717-684-4566



AWWA Free Water Audit Software v6.0

FWAS v6.0

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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. Auditors are strongly encouraged to refer to the most current edition of AWWA M36 Manual for Water Audits for detailed guidance on the water auditing process and targeting loss reduction levels. This tool contains several separate worksheets. Sheets can be accessed using the tabs at the bottom of the screen, or by clicking the TOC links below.

Table of Contents (TOC)

- Start Page** The current sheet. Enter contact information and basic audit details.
- Worksheet** Enter the required data on this worksheet to calculate the water balance and data grading.
- Interactive Data Grading** Answer questions about operational practices for each audit input, and the data validity grades will automatically populate.
- Dashboard** Review NRW components, performance indicators and graphical outputs to evaluate the results of the audit.
- Notes** Enter notes to explain how values were calculated, document data sources, and related information about data management practices.
- Blank Sheet** By popular demand! A blank sheet. The world is your canvas.
- Water Balance** The values entered in the Worksheet automatically populate the Water Balance.
- Loss Control Planning** Use this sheet to interpret the results of the audit validity score and performance indicators.
- Definitions** Use this sheet to understand the terms used in the audit process.
- Service Connection Diagram** Diagrams depicting possible customer service connection line configurations.
- Acknowledgements** Acknowledgements for development of the AWWA Free Water Audit Software v6.0.

AWWA Web Resources for Water Loss Control

<https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control>

Items referenced in the Free Water Audit Software v6.0 on the web:

- Data Grading Matrix v6.0
- Example Water Audit v6.0
- Water Audit Compiler v6.0
- AWWA Reports on Performance Indicators
- M36 Manual

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

Enter Basic Information

Name of Utility:	Columbia Water Company
Name of Contact Person:	David Lewis
Email:	dlewis@columbiawater.net
Telephone Ext.:	(717) 684-2188
City/Town/Municipality:	Columbia
State / Province:	Pennsylvania (PA)
Country:	USA
Audit Preparation Date:	Mar 27 2025
Audit Year:	2024
Audit Year Label:	Calendar (Fiscal, Calendar, etc)
Audit Period Start Date:	Jan 01 2024
Audit Period End Date:	Dec 31 2024
Volume Reporting Units:	Million gallons (US)
Water System Structure:	Retail
Water Type:	Potable Water
System ID Number:	7360123
Validator Name/ID:	n/a
Validator Email:	n/a
Estimated Total Population Served by Water Utility:	33,500

Key of Input Acronyms

In order of appearance in the Worksheet

- VOS** Volume from Own Sources
- VOSEA** VOS Error Adjustment
- WI** Water Imported
- WIEA** WI Error Adjustment
- WE** Water Exported
- WEEA** WE Error Adjustment
- BMAC** Billed Metered Authorized Consumption
- BUAC** Billed Unmetered Authorized Consumption
- UMAC** Unbilled Metered Authorized Consumption
- UUAC** Unbilled Unmetered Authorized Consumption
- SDHE** Systematic Data Handling Errors
- CMI** Customer Metering Inaccuracies
- UC** Unauthorized Consumption
- Lm** Length of mains
- Nc** Number of service connections
- Lp** Average length of (private) customer service line
- AOP** Average Operating Pressure
- CRUC** Customer Retail Unit Charge
- VPC** Variable Production Cost

Color Key

User input

Calculated

Optional default

Guidance for the Worksheet

Choosing to enter unit of **percent** or **volume** (applies to VOSEA, WIEA, WEEA, CMI)

choose entry option:

1.00%	percent	or
	volume	25.000

Choosing to enter **default** or **custom input** (applies to UUAC, SDHE, UC)

choose entry option:

0.25%	default	or
	custom	75.000

Guidance for the Interactive Data Grading

Use acronym buttons in IDG header to navigate among inputs. Acronym Key above. White = needs answers, orange = complete, clear = not required. Example below.

VOS	VOSEA	WI	WIEA	WE	WEEA	BMAC	BUAC	UMAC	UUAC
SDHE	CMI	UC	Lm	Nc	Lp	AOP	CRUC	VPC	

After clicking an acronym button, answer all visible questions in the order they're presented, choosing best-fit answer

Grade will populate when all visible questions are complete for an input

7

The limiting criteria will be labeled along the right. If only 1 limiting criterion is shown, improving on that criterion will achieve a higher data grade. If multiple limiting criteria are shown, improving on *each* limiting criterion is necessary to achieve a higher data grade. A complete inventory of data grading criteria is available in the Data Grading Matrix v6.0 (see web resources)

Limiting



AWWA Free Water Audit Software: Worksheet

FWAS v6.0
American Water Works Association.

Water Audit Report for: **Columbia Water Company**
Audit Year: **2024** | **Jan 01 2024 - Dec 31 2024** | **Calendar**

To access definitions, click the input name

Click 'n' to add notes
Click 'g' to determine data validity grade

To edit water system info: [go to start page](#)

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

Water Supplied Error Adjustments

choose entry option:

WATER SUPPLIED

VOS	Volume from Own Sources:	<input type="text" value="n"/> <input type="text" value="g"/> 5	1,109.618	MG/Yr
WI	Water Imported:	<input type="text" value="n"/> <input type="text" value="g"/> n/a	0.000	MG/Yr
WE	Water Exported:	<input type="text" value="n"/> <input type="text" value="g"/> n/a	0.000	MG/Yr

10 | 0.00% | percent

VOSEA
WIEA
WEEA

WATER SUPPLIED: 1,109.618 MG/Yr

AUTHORIZED CONSUMPTION

BMAC	Billed Metered:	<input type="text" value="n"/> <input type="text" value="g"/> 8	926.594	MG/Yr
BUAC	Billed Unmetered:	<input type="text" value="n"/> <input type="text" value="g"/> n/a	0.000	MG/Yr
UMAC	Unbilled Metered:	<input type="text" value="n"/> <input type="text" value="g"/> 10	21.986	MG/Yr
UUAC	Unbilled Unmetered:	<input type="text" value="n"/> <input type="text" value="g"/> 8	32.744	MG/Yr

choose entry option:

MG/Yr

AUTHORIZED CONSUMPTION: 981.324 MG/Yr

WATER LOSSES

128.294 MG/Yr

Apparent Losses

Default option selected for Systematic Data Handling Errors, with automatic data grading of 3

choose entry option:

SDHE	Systematic Data Handling Errors:	<input type="text" value="n"/> <input type="text" value="g"/> 3	2.316	MG/Yr
CMI	Customer Metering Inaccuracies:	<input type="text" value="n"/> <input type="text" value="g"/> 4	14.445	MG/Yr
UC	Unauthorized Consumption:	<input type="text" value="n"/> <input type="text" value="g"/> 3	2.316	MG/Yr

default
 percent
 default

[under-registration](#)

Default option selected for Unauthorized Consumption, with automatic data grading of 3

Apparent Losses: 19.078 MG/Yr

Real Losses

Real Losses: 109.215 MG/Yr

WATER LOSSES: 128.294 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 183.024 MG/Yr

SYSTEM DATA

Lm	Length of mains:	<input type="text" value="n"/> <input type="text" value="g"/> 10	170.5	miles	(including fire hydrant lead lengths)
Nc	Number of service connections:	<input type="text" value="n"/> <input type="text" value="g"/> 10	12,235		(active and inactive)
	Service connection density:		72	conn./mile main	
Lp	Average length of (private) customer service line:	<input type="text" value="n"/> <input type="text" value="g"/> 10	30.0	ft	(average distance between property line and meter)
AOP	Average Operating Pressure:	<input type="text" value="n"/> <input type="text" value="g"/> 7	79.5	psi	

COST DATA

CRUC	Customer Retail Unit Charge:	<input type="text" value="n"/> <input type="text" value="g"/> 9	\$7.45	\$/1000 gallons (US)	Total Annual Operating Cost
VPC	Variable Production Cost:	<input type="text" value="n"/> <input type="text" value="g"/> 9	\$981.65	\$/Million gallons	

WATER AUDIT DATA VALIDITY TIER:

***** The Water Audit Data Validity Score is in Tier III (51-70). See Dashboard tab for additional outputs. *****

[go to dashboard](#)

A weighted scale for the components of supply, consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION TO IMPROVE DATA VALIDITY:

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

- 1: Volume from Own Sources (VOS)
- 2: Customer Metering Inaccuracies (CMI)
- 3: Billed Metered (BMAC)

KEY PERFORMANCE INDICATOR TARGETS:

OPTIONAL: If targets exist for the operational performance indicators, they can be input below:

Unit Total Losses: gal/conn/day
 Unit Apparent Losses: gal/conn/day
 Unit Real Losses^A: gal/conn/day
 Unit Real Losses^B: gal/mile/day

If entered above by user, targets will display on KPI gauges (see Dashboard)

2024

White = incomplete
Orange = complete

Use acronyms for navigation

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Limiting criteria (see Start Page for details)

go to input

Volume from Own Sources (VOS) - Data Grading Criteria

go to notes

vos	Criteria Question	Select Best-Fit Answers to All Visible Questions	
vos.0	Did the water utility supply any water from its own sources during the audit year?	Yes	
vos.1	What percent of own supply volume is metered?	>99%	
<p>For questions 2-10 below: Choose the answer that applies for those meters that measure >90% of the finished water volume.</p> <p>In-situ flow accuracy testing = a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location, using an independent reference volume.</p> <p>Electronic calibration = a process that checks for error in the metering secondary device(s) and/or the tertiary device(s).</p> <p>Secondary device can include conversion to mA, meter transmitter or similar instrumentation.</p> <p>Tertiary device can include SCADA, historian or other computerized archival system.</p>			
vos.2	What is the frequency of electronic calibration?	Less than annual but within last 5 years	Limiting
vos.3	What level of data transfer errors are checked as part of the electronic calibration process?	Data transfer errors are checked at secondary device(s), but not to tertiary device(s)	
vos.4	Is the most recent electronic calibration documentation available for review?	Yes	
vos.5	What is the frequency of in-situ flow accuracy testing?	Less than annual but within last 5 years	Limiting
vos.6	Is the most recent in-situ flow accuracy testing documentation available for review?	Yes	
vos.7	What are the total volume-weighted average results of in-situ flow accuracy testing (during or closest to audit year)?	At or within ±3%	
vos.8	Have testing and calibration procedures been closely scrutinized for compliance with procedures described in the AWWA M36 and/or M33 Manual(s)?	Yes	
vos.9	Which best describes the frequency of finished water meter readings?	Continuous	
vos.10	Which best describes the frequency of data review for anomalies/errors? These can include numbers that are outside of typical patterns, and zero or "null" values that may reflect a gap in data recording.	Daily	
FINAL DATA GRADE FOR THIS AUDIT INPUT:		5	

go to input

Volume from Own Sources Error Adjustment (VOSEA) - Data Grading Criteria

go to notes

vosea	Criteria Question	Select Best-Fit Answers to All Visible Questions
vosea.1	Are tank levels monitored automatically & recorded daily?	Yes
vosea.2	Are daily changes of stored water volumes in distribution system tanks included in the tabulation of the daily "Volume from Own Sources" quantity?	Yes
vosea.3	Is the annual net distribution storage change included in either the VOS input or the VOSEA input?	Yes
vosea.4	Are the flow accuracy test and/or electronic calibration results included in the VOSEA input in the water audit?	Yes, results are analyzed and incorporated
FINAL DATA GRADE FOR THIS AUDIT INPUT:		10

go to input

Water Imported (WI) - Data Grading Criteria

go to notes

wi	Criteria Question	Select Best-Fit Answers to All Visible Questions
wi.0	Did the water utility import any water during the audit year?	No
wi.1		
<p>For questions 2-10 below: Choose the answer that applies for those meters that measure >90% of the water imported volume.</p> <p>In-situ flow accuracy testing = a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location, using an independent reference volume.</p> <p>Electronic calibration = a process that checks for error in the metering secondary device(s) and/or the tertiary device(s).</p> <p>Secondary device can include conversion to mA, meter transmitter or similar instrumentation.</p> <p>Tertiary device can include SCADA, historian or other computerized archival system.</p>		
wi.2		
wi.3		
wi.4		
wi.5		
wi.6		
wi.7		
wi.8		
wi.9		
wi.10		
FINAL DATA GRADE FOR THIS AUDIT INPUT:		n/a

go to input

Water Imported Error Adjustment (WIEA) - Data Grading Criteria

go to notes

wiea	Criteria Question	Select Best-Fit Answers to All Visible Questions
wiea.1		
wiea.2		
wiea.3		
wiea.4		
FINAL DATA GRADE FOR THIS AUDIT INPUT:		n/a

[go to input](#) **Water Exported (WE) - Data Grading Criteria** [go to notes](#)

we	Criteria Question	Select Best-Fit Answers to All Visible Questions
we.0	Did the water utility export any water during the audit year?	No
we.1		
we.2		
we.3		
we.4		
we.5		
we.6		
we.7		
we.8		
we.9		
we.10		
FINAL DATA GRADE FOR THIS AUDIT INPUT:		n/a

For questions 2-10 below: Choose the answer that applies for those meters that measure >90% of the water exported volume.
In-situ flow accuracy testing = a test process that confirms the flow measuring accuracy of the primary device (the flowmeter), in its installed location, using an independent reference volume.
Electronic calibration = a process that checks for error in the metering secondary device(s) and/or the tertiary device(s).
Secondary device can include conversion to mA, meter transmitter or similar instrumentation.
Tertiary device can include SCADA, historian or other computerized archival system.

[go to input](#) **Water Exported Error Adjustment (WEEA) - Data Grading Criteria** [go to notes](#)

weea	Criteria Question	Select Best-Fit Answers to All Visible Questions
weea.1		
weea.2		
weea.3		
weea.4		
FINAL DATA GRADE FOR THIS AUDIT INPUT:		n/a

[go to input](#) **Billed Metered Authorized Consumption (BMAC) - Data Grading Criteria** [go to notes](#)

bmac	Criteria Question	Select Best-Fit Answers to All Visible Questions
bmac.0	Were any customers metered in the audit year?	Yes
bmac.1	For billed metered accounts, what % of bills are estimated in a typical billing cycle?	5% or less
bmac.2	How often does the utility read its customer meters? For systems with multiple read frequencies, select the reading frequency that describes the majority of your customers.	Monthly
bmac.3	Is the BMAC volume pro-rated to represent consumption occurring exactly during the audit period?	No
bmac.4	How frequently does internal review by utility staff of the BMAC volumes occur?	Every billing cycle
bmac.5	What level of detail is examined in the internal review of BMAC volumes?	Totals grouped by use type or customer class and specific accounts flagged for anomalous consumption
bmac.6	When was the most recent billing data review by someone who is independent of the utility billing process?	Within last 3 years
bmac.7	What level of detail was examined in the review by someone who is independent of the utility billing process?	Full billing database query and analysis of raw data to verify the summary consumption volumes
FINAL DATA GRADE FOR THIS AUDIT INPUT:		8

Limiting

[go to input](#) **Billed Unmetered Authorized Consumption (BUAC) - Data Grading Criteria** [go to notes](#)

buac	Criteria Question	Select Best-Fit Answers to All Visible Questions
buac.0	Was there any billed consumption on unmetered accounts in the audit year?	No
buac.1		
buac.2		
buac.3		
FINAL DATA GRADE FOR THIS AUDIT INPUT:		n/a

[go to input](#) **Unbilled Metered Authorized Consumption (UMAC) - Data Grading Criteria** [go to notes](#)

umac	Criteria Question	Select Best-Fit Answers to All Visible Questions
umac.0	Did the water utility have any unbilled-metered consumption in the audit year?	Yes
umac.1	Does the water utility policy articulate which accounts are exempt from billing?	Policy includes specific exemptions
umac.2	How many unbilled metered accounts exist?	Monitored, count available
umac.3	How often is each unbilled customer meter read? For systems with multiple read frequencies, select the reading frequency that describes the majority of your customers.	Monthly or more frequently
umac.4	How often are unbilled metered volumes reviewed for error?	Each billing cycle
FINAL DATA GRADE FOR THIS AUDIT INPUT:		10

[go to input](#) **Unbilled Unmetered Authorized Consumption (UUAC) - Data Grading Criteria** [go to notes](#)

uuac	Criteria Question	Select Best-Fit Answers to All Visible Questions
uuac.0	On the Worksheet, the status of the default option is:	A system specific volume has been entered
uuac.1	How well-understood is the extent of unbilled unmetered use?	Majority identified and tracked
uuac.2	Which best describes the records that are kept for events of unbilled unmetered use?	Each event is documented
uuac.3	How is the majority of unbilled unmetered use estimated?	Entirely from event-specific estimates
FINAL DATA GRADE FOR THIS AUDIT INPUT:		8

Limiting

[go to input](#) **Systematic Data Handling Error (SDHE) - Data Grading Criteria** [go to notes](#)

This Data Grading Criteria is hidden when the 'default' input is used on the Worksheet

FINAL DATA GRADE FOR THIS AUDIT INPUT: **3**

[go to input](#) **Customer Metering Inaccuracies (CMI) - Data Grading Criteria** [go to notes](#)

cmi **Criteria Question** **Select Best-Fit Answers to All Visible Questions**

cmi.0	Was there any metered customer usage during the audit period?	Yes	
cmi.1	Do you test meters reactively (when triggered by customer complaint or billing/consumption flag)?	Reactive testing conducted	
cmi.2	For small size customer meters, which best describes the frequency of proactive testing (effort beyond when triggered by customer complaint or billing/consumption flags)?	No testing conducted, but at least 10% of meter stock has been replaced within two years of the audit period	
cmi.3			
cmi.4	For mid and large size customer meters, which best describes the frequency of the proactive testing program?	Not recurring, last testing effort occurred more than 5 years prior to audit period	Limiting
cmi.5			
cmi.6	Which best describes how the input was derived?	Meter accuracy test results or manufacturer specs are referenced but not analyzed and used directly in calculation	
cmi.7	Has the input derivation been reviewed by someone with expert knowledge in the M36 methodology?	No	
cmi.8	To what extent does meter replacement occur and for which meters?	Annual proactive replacement of subset of meters (i.e. by age or throughput)	
cmi.9	Which best describes the reliability of meter installation records?	Records are kept for meter installations, and they include data on installation date, type, size, and manufacturer	
FINAL DATA GRADE FOR THIS AUDIT INPUT:		4	

[go to input](#) **Unauthorized Consumption (UC) - Data Grading Criteria** [go to notes](#)

This Data Grading Criteria is hidden when the 'default' input is used on the Worksheet

FINAL DATA GRADE FOR THIS AUDIT INPUT: **3**

[go to input](#) **Length of Mains (Lm) - Data Grading Criteria** [go to notes](#)

Lm	Criteria Question	Select Best-Fit Answers to All Visible Questions
Lm.1	How was the input derived?	Derived directly from Mains inventory (GIS, ledger, etc)
Lm.2	Are hydrant laterals included in the input derivation?	Yes
Lm.3	Which best describes how the Mains inventory (GIS, ledger, etc) is kept up to date?	Additions or subtractions are updated in the mains inventory (GIS, ledger, etc), at least annually
Lm.4	Which best describes how the Mains inventory (GIS, ledger, etc) is field validated to confirm field conditions match the inventory?	Field validation is accomplished (i.e. in daily operations or specific validation projects)
FINAL DATA GRADE FOR THIS AUDIT INPUT:		10

[go to input](#) **Number of Service Connections (Nc) - Data Grading Criteria** [go to notes](#)

Nc	Criteria Question	Select Best-Fit Answers to All Visible Questions
Nc.1	How was the input derived?	Extracted from Services inventory (GIS, billing system, etc)
Nc.2	What is the count of services based on?	Premise based, i.e. service connection count, location ID count
Nc.3	Are inactive (but still pressurized) service lines included in the input? These may be metered or unmetered.	Yes
Nc.4	Which best describes how the inventory of service connections (GIS, billing system, etc) is kept up to date?	Additions or subtractions are updated in the service line inventory (GIS, billing system, etc), at least annually
Nc.5	Which best describes how the inventory of service connections (GIS, billing system, etc) is field validated to confirm field conditions match the inventory?	Field validation is accomplished for the entire system (i.e. in daily operations or specific validation projects)
FINAL DATA GRADE FOR THIS AUDIT INPUT:		10

[go to input](#) **Average Length of (Private) Customer Service Line (Lp) - Data Grading Criteria** [go to notes](#)

Lp	Criteria Question	Select Best-Fit Answers to All Visible Questions
Lp.0	Are customer meters typically located at the curbside or property line?	No
Lp.1	How was the input derived?	Derived from full mapping and customer inventory
Lp.2	Which best describes how the Customer Service Line and Meter Locations mapping is kept up to date?	Additions or subtractions are updated in the service line and meter locations inventory, at least annually
Lp.3	Which best describes how the Customer Service Line mapping is validated to what is in the field?	Field validation is accomplished (i.e. through normal work order processes or specific validation projects)
Lp.4	Which best describes the policy to define where the utility's ownership of the service line ends, and the customer's ownership of the service line begins?	Policy is clear, and adherence in practice is consistent
FINAL DATA GRADE FOR THIS AUDIT INPUT:		10

[go to input](#) **Average Operating Pressure (AOP) - Data Grading Criteria** [go to notes](#)

aop	Criteria Question	Select Best-Fit Answers to All Visible Questions
aop.1	Which best describes checks on the boundary integrity for the system's pressure zone(s)?	Normally-closed boundary valves between zones have been confirmed within the past 3 years to be fully closed
aop.2	Which best describes how one-time pressure readings (i.e. from hydrants) are collected?	Collected annually during routine system flushing and/or hydrant testing
aop.3	Which best describes where continuous pressure data (via temporary data loggers or permanent telemetry) is collected?	At zone boundary conditions only (i.e. supply entry points, PRVs, booster stations)
aop.4	Which best describes how continuous pressure data is collected?	Temporary data logger(s) deployed, adequately capturing seasonal variation during the year
aop.5	How was the input derived?	Calculated from field data as a simple average
FINAL DATA GRADE FOR THIS AUDIT INPUT:		7

Limiting

[go to input](#) **Customer Retail Unit Charge (CRUC) - Data Grading Criteria** [go to notes](#)

cruc	Criteria Question	Select Best-Fit Answers to All Visible Questions
cruc.0	Was any metered consumption billed on a volumetric basis in the audit period?	Yes
cruc.1	Which best describes the use and reliability of the current rate structure?	Customer bill calculations have been checked to confirm the rate structure is correctly implemented
cruc.2	Choose the option that best describes how the input was derived	A volume-weighted average of all rates was calculated
cruc.3	Is there any additional volumetric revenue the utility receives that depends on water meter readings, such as sewer?	No
cruc.4	Has the input derivation been reviewed by someone with expert knowledge in the M36 methodology?	No
FINAL DATA GRADE FOR THIS AUDIT INPUT:		9

Limiting

[go to input](#) **Variable Production Cost (VPC) - Data Grading Criteria** [go to notes](#)

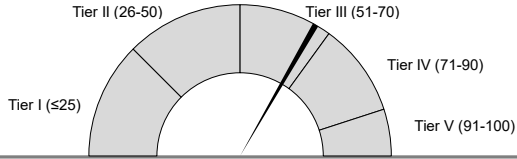
vpc	Criteria Question	Select Best-Fit Answers to All Visible Questions
vpc.1	Choose the option that best describes how the input was derived	Only one source of water exists, which was the basis for the input derivation
vpc.2	Choose the option that best describes which short-run marginal costs have been included in the input, using the definitions below for reference. Short-run marginal costs can include the following: - chemicals + power for treatment, typically applicable if the utility is producing/treating water - power for distribution, typically applicable if pumps exist in the distribution network - water acquisition costs, typically applicable if the utility is purchasing water or incurs any extraction costs for withdrawing from a source Some short-run marginal costs may not be applicable. The auditor should analyze the system characteristics to determine which costs are applicable for inclusion in the VPC input derivation. See also the latest AWWA M36 Manual for further guidance.	All applicable short-run marginal costs are included
vpc.3	Choose the option that best describes which long-run marginal costs have been included in the input, using the definitions below for reference. Long-run marginal costs can include the following: - water treatment residuals management, typically applicable if solids are produced from water treatment process - accelerated wear & tear on dynamic equipment, typically applicable if pumps exist for treatment and/or distribution, or any other equipment exists that wears out as a function of use instead of time (i.e. filter media, chemical dosing pumps, uv disinfection bulbs, etc) - payouts for damage claims from main and service line breaks, typically applicable if damage claims are paid by the utility - accelerated expansion of supply capacity, typically applicable if the utility is at or nearing supply capacity, or scarcity costs in water scarce areas - full cost pricing that includes all lifecycle costs and externalities (internalized or not) Some long-run marginal costs may not be applicable. The auditor should analyze the system characteristics to determine which costs are applicable for inclusion in the VPC input derivation. See also the latest AWWA M36 Manual for further guidance.	Long-run marginal costs have been evaluated for applicability, and all applicable costs are included
vpc.4	Has the input derivation been reviewed by someone with expert knowledge in the M36 methodology?	No
FINAL DATA GRADE FOR THIS AUDIT INPUT:		9

Limiting

Data Validity

Data Validity Score: **66** Data Validity Tier: **Tier III (51-70)**

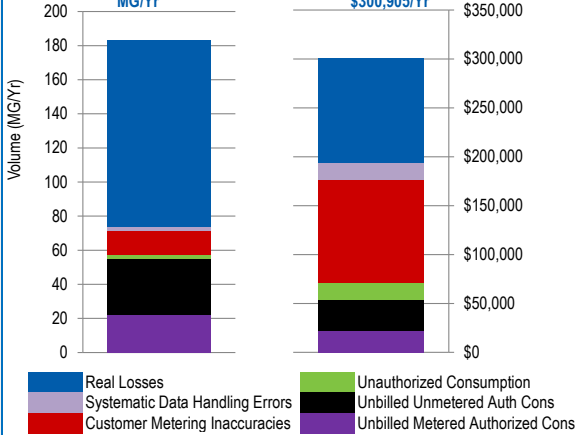
See **Loss Control Planning** for Tier Details



NRW Components Summary

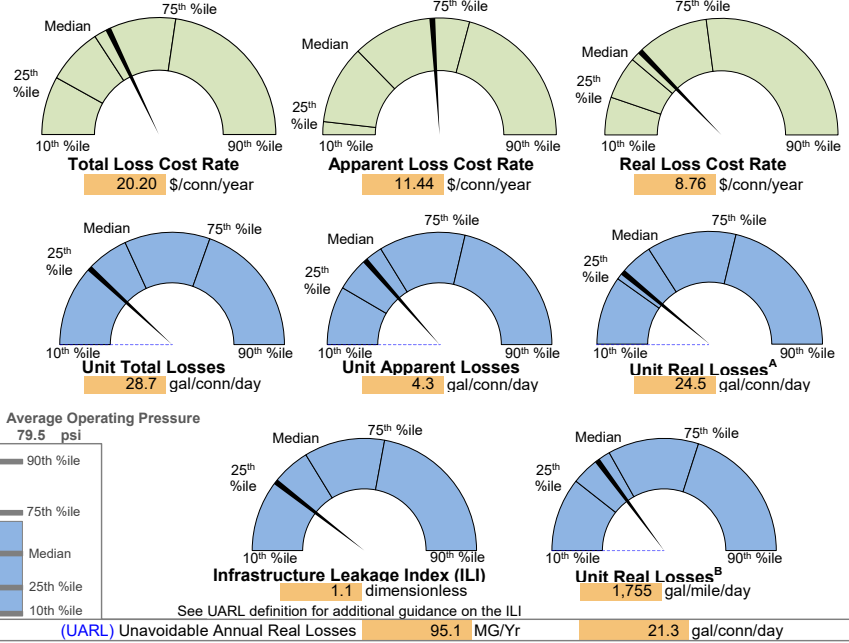
Total Volume of NRW = **183** MG/Yr

Total Cost of NRW = **\$300,905**/Yr



Actual KPI result Key Performance Indicators Target (see Worksheet)

gauge %iles per validated industry ranges²



Average Operating Pressure: 79.5 psi

(UARL) Unavoidable Annual Real Losses: **95.1** MG/Yr **21.3** gal/conn/day

Guidance Information for Key Performance

- The eight indicators shown are the recommended suite per the AWWA Water Loss Control Committee 2020 Position on KPIs¹.
- A suite of KPIs is necessary, as no single KPI can holistically communicate water loss performance for a given water system.
- See Table 1 below for Uses and Limitations for each KPI, excerpted from the AWWA Water Loss Control Committee Report (2020)³, with naming conventions updated.
- Percentiles (%iles) shown on KPI gauges come from Level 1 validated data in the AWWA WLCC Reference Water Audit Dataset (2020)².
- KPI %iles shown above are not segregated by cohorts. Limited

KPI data by cohorts may be found in WRF 4695 Guidance Manual, Appendix B (2019)³.

- Actual KPI results that fall below 10th %ile or above 90th %ile do not necessarily imply error, but should be viewed with scrutiny.
- Percentiles not intended to imply targets. Targets may be input by user for operational KPIs, if desired, on Worksheet.
- See UARL and ILI in Definitions tab for discussion of size and pressure limitations.
- Systems that fall on the extreme ends of size or connection density should use caution when interpreting Unit Losses KPIs.

Table 1

Source: AWWA Water Loss Control Committee Report (2020)³, with naming conventions updated

2020 AWWA Water Audit Method – Water Audit Outputs and Key Performance Indicators: Uses and Limitations

Type	Indicator	Description	Suitable Purposes					Uses and Limitations	Principal Users
			Assessment	Bench-Marking	Target-Setting	Planning	Tracking		
Attribute	Apparent Loss Volume	Calculated by Free Water Audit Software	✓				✓	Assess loss level	Utility, Regulators
	Apparent Loss Cost	Calculated by Free Water Audit Software	✓				✓	Assess cost loss level	Utility, Regulators
	Real Loss Volume	Calculated by Free Water Audit Software	✓				✓	Assess loss level	Utility, Regulators
	Real Loss Cost	Calculated by Free Water Audit Software	✓				✓	Assess loss cost level	Utility, Regulators
	Unavoidable Annual Real Loss (UARL)	Calculated by Free Water Audit Software	✓				✓	Reveal theoretical technical low level of leakage	Utility, Regulators
Volume	Unit Apparent Losses (vol/conn/day)	Strong and understandable indicator for multiple users.	✓	✓	✓	✓	✓	Used for performance tracking and target-setting	Utility, Regulators
	Unit Real Losses ^A (vol/conn/day)	Strong and understandable indicator for multiple users.	✓	✓	✓	✓	✓	Used for performance tracking and target-setting	Utility, Regulators, Policy Makers
	Unit Real Losses ^B (vol/pipeline length/day)	Strong and understandable indicator for use by utilities with low connection density.	✓	✓	✓	✓	✓	Data collection and assessment of systems with "low" connection density	Utility, Regulators, Policy Makers
	Unit Total Losses (vol/conn/day) New KPI	Strong and understandable indicator, suitable for high-level performance measurement.	✓				✓	High level indicator for trending analysis. Not appropriate for target-setting or benchmarking	Utilities, Customers
	Infrastructure Leakage Index (ILI)	Robust, specialized ratio KPI; can be influenced by pressure and connection density.	✓		✓		✓	Benchmarking after pressure management is implemented	Utilities
Value	Apparent Loss Cost Rate (value/conn/year) New KPI	Indicators with sufficient technical rigor. Provide the unit financial value of each type of loss, which is useful for planning and assessment of cost efficiency of water loss reduction and control interventions and programs.	✓				✓	Data collection and assessment on AWWA indicators or contextual parameters to use in conjunction with Loss Cost Rates	Utilities, Regulators, Customers
	Real Loss Cost Rate (value/conn/year) New KPI		✓				✓		Utilities, Regulators, Customers
Validity	Data Validity Tier (DVT)	Strong indicator of water loss audit data quality, if data has been validated. Tier provides guidance on priority areas of activity.	✓	✓			✓	Assess caliber of data inputs of the water audit	Regulators, Utilities



AWWA Free Water Audit Software: User Notes

FWAS v6.0

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Water Audit Report for: Columbia Water Company
Audit Year: 2024

Calendar
Jan 01 2024 - Dec 31 2024

General Notes:		
Audit Item	Notes on Input Derivation	Notes on Data Validity Grading
Volume from Own Sources (VOS)		
Volume from Own Sources Error Adjustment (VOSEA)		
Water Imported (WI)		
Water Imported Error Adjustment (WIEA)		
Water Exported (WE)		

[go to worksheet](#) [go to grading](#)

[go to worksheet](#) [go to grading](#)

[go to worksheet](#) [go to grading](#)

[go to worksheet](#) [go to grading](#)

[go to worksheet](#) [go to grading](#)

		Audit Item	Notes on Input Derivation	Notes on Data Validity Grading
go to worksheet	go to grading	Water Exported Error Adjustment (WEIA)		
go to worksheet	go to grading	Billed Metered Authorized Consumption (BMAC)		
go to worksheet	go to grading	Billed Unmetered Authorized Consumption (BUAC)		
go to worksheet	go to grading	Unbilled Metered Authorized Consumption (UMAC)		
go to worksheet	go to grading	Unbilled Unmetered Authorized Consumption (UUAC)		
go to worksheet	go to grading	Systematic Data Handling Errors (SDHE)		
go to worksheet	go to grading	Customer Metering Inaccuracies (CMI)		

		Audit Item	Notes on Input Derivation	Notes on Data Validity Grading
go to worksheet	go to grading	Unauthorized Consumption (UC)		
go to worksheet	go to grading	Length of Mains (Lm)		
go to worksheet	go to grading	Number of Service Connections (Nc)		
go to worksheet	go to grading	Average Length of (private) Customer Service Line (Lp)		
go to worksheet	go to grading	Average Operating Pressure (AOP)		
go to worksheet	go to grading	Customer Retail Unit Charge (CRUC)		
go to worksheet	go to grading	Variable Production Cost (VPC)		

Hello, I am a blank sheet, at your service.

**AWWA Free Water Audit Software
Water Balance**



Water Audit Report for: **Columbia Water Company**

Audit Year: **2024**

Jan 01 2024 - Dec 31 2024

Data Validity Tier: **Tier III (51-70)**

FWAS v6.0

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Volume from Own Sources (VOS) (corrected for known errors)	System Input Volume	Water Exported (WE) (corrected for known errors)	Billed Water Exported				Revenue Water (Exported)
		0.000	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption (BMAC) (water exported is removed)	Billed Unmetered Consumption (BUAC)	Revenue Water
1,109.618	1,109.618	Water Supplied 1,109.618	981.324	926.594	926.594	926.594	
				Unbilled Authorized Consumption	Billed Unmetered Consumption (BUAC)	Non-Revenue Water (NRW)	
				54.730	0.000	183.024	
			Apparent Losses 19.078	Unbilled Metered Consumption (UMAC)	21.986		
		Water Losses 128.294		Real Losses 109.215	Unbilled Unmetered Consumption (UUAC)		32.744
							Systematic Data Handling Errors (SDHE)
				Customer Metering Inaccuracies (CMI)	14.445		
				Unauthorized Consumption (UC)	2.316		
Water Imported (WI) (corrected for known errors)				Leakage on Transmission and/or Distribution Mains	Not broken down		
0.000				Leakage and Overflows at Utility's Storage Tanks	Not broken down		
				Leakage on Service Connections	Not broken down		



Item Name	Description
<p>Apparent Losses</p> <p>Find</p>	<p>= systematic data handling errors + customer metering inaccuracies + unauthorized consumption</p> <p>Apparent Losses include all types of inaccuracies associated with customer metering (worn meters as well as improperly sized meters or wrong type of meter for the water usage profile) as well as systematic data handling errors (meter reading, billing, archiving and reporting), plus unauthorized consumption (theft or illegal use).</p> <p>NOTE: Over-estimation of Apparent Losses results in under-estimation of Real Losses. Under-estimation of Apparent Losses results in over-estimation of Real Losses.</p>
<p>AUTHORIZED CONSUMPTION</p> <p>Find</p>	<p>= billed metered + billed unmetered + unbilled metered + unbilled unmetered consumption</p> <p>The volume of metered and/or unmetered water taken by registered customers, the water utility's own uses, and uses of others who are implicitly or explicitly authorized to do so by the water utility; for residential, commercial, industrial and public-minded purposes.</p> <p>Typical retail customers' consumption is tabulated usually from established customer accounts as billed metered consumption, or - for unmetered customers - billed unmetered consumption. These types of consumption, along with billed water exported, provide revenue potential for the water utility. Typically a lag will exist between timing for reading of supply meters and reading of customer meters. A lag-time correction should typically be calculated to account for this. Be certain to tabulate the water exported volume as a separate component and do not "double-count" it by including in the billed metered consumption component as well as the water exported component.</p> <p>Unbilled authorized consumption occurs typically in non-account uses, including water for fire fighting and training, flushing of water mains and sewers, street cleaning, watering of municipal gardens, public fountains, or similar public-minded uses. Occasionally these uses may be metered and billed (or charged a flat fee), but usually they are unmetered and unbilled. In the latter case, the water auditor may use a default value to estimate this quantity, or implement procedures for the reliable quantification of these uses. This starts with documenting usage events as they occur and estimating the amount of water used in each event. (See Unbilled Unmetered Authorized Consumption)</p>
<p>View Service Connection Diagram</p> <p>Average Length of (private) Customer Service Line (Lp)</p> <p>Find</p>	<p>This is the average length of underground customer service line, Lp, that is owned and maintained by the customer; from the point of ownership transfer to the customer water meter, or building line (if unmetered). The quantity is one of the data inputs for the calculation of Unavoidable Annual Real Losses (UARL), which serves as the denominator of the performance indicator: Infrastructure Leakage Index (ILI). The value of Lp is multiplied by the number of customer service connections to obtain a total length of customer owned piping in the system. The purpose of this parameter is to account for the unmetered service line infrastructure that is the responsibility of the customer for arranging repairs of leaks that occur on their lines. In many cases leak repairs arranged by customers take longer to be executed than leak repairs arranged by the water utility on utility-maintained piping. Leaks run longer - and lose more water - on customer-owned service piping, than utility owned piping.</p> <p>If the customer water meter exists near the ownership transfer point (usually the curb stop located between the water main and the customer premises) this distance is zero because the meter and transfer point are the same. This is the often encountered configuration of customer water meters located in an underground meter box or "pit" outside of the customer's building. The Free Water Audit Software asks a "Yes/No" question about the meter at this location. If the auditor selects "Yes" then this distance is set to zero and the data grading score for this component is set to 10.</p> <p>If water meters are typically located inside the customer premise/building, or properties are unmetered, it is up to the water auditor to estimate a system-wide average Lp length based upon the various customer land parcel sizes and building locations in the service area. Lp will be a shorter length in areas of high density housing, and a longer length in areas of low density housing and varied commercial and industrial buildings. General parcel demographics should be employed to obtain a total Lp length (Lc) and subsequently a weighted average Lp length for the entire system.</p> <p>Refer to the "Service Connection Diagram" worksheet for a depiction of the service line/metering configurations that typically exist in water utilities. This worksheet gives guidance on the determination of the Average Length, Lp, for each configuration.</p>
<p>Average Operating Pressure (AOP)</p> <p>Find</p>	<p>This is the average pressure in the distribution system that is the subject of the water audit. If the water utility is compiling the water audit for the first time, the average pressure can be approximated, but with a low data grading. In subsequent years of auditing, effort should be made to improve the accuracy of the average pressure quantity. This will then qualify the value for a higher data grading.</p> <p>In the absence of a hydraulic model, the average pressure may be approximated by obtaining readings of static water pressure from a representative sample of fire hydrants or other system access points evenly located across the system. A weighted average of the pressure can be assembled; but be sure to take into account the elevation of the fire hydrants, which typically exist several feet higher than the level of buried water pipelines.</p> <p>If your water utility has an up-to-date and calibrated hydraulic model of the water distribution system, it can be utilized to obtain a very accurate quantity of average pressure. However using the average pressure of all "nodes" in the system model is not necessarily the most accurate way to calculate the average operating pressure. This is especially true if there are significant pressure differences throughout the system, and the "nodes" are not evenly distributed throughout the distribution system. The most accurate calculation is to obtain the average pressure that each pipe segment experiences. The way to do this is to calculate the pressure at each end of the pipe. Then calculate the average of those two values and multiply this average value by the length of that pipe. This must be calculated for all pipe segments in the model. Finally calculate the sum of all of these values and divide by the total pipe length. This effectively calculates a weighted average of pressure over the total pipe length. For low density systems (<32 connections/mile), average mains pressures at the service connection or curb stop may have greater influence and should be considered.</p>
<p>Billed Authorized Consumption</p>	<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>

Item Name	Description
Billed Metered Authorized Consumption (BMAC) <input type="button" value="Find"/>	<p>All metered consumption which is billed to retail customers, including all groups of customers such as domestic, commercial, industrial or institutional. It does NOT include water supplied to neighboring utilities (water exported) which is metered and billed. Be sure to subtract any consumption for exported water sales that may be included in these billing roles. Water supplied as exports to neighboring water utilities should be included only in the Water Exported component. 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 lag time since not all customer meters are read on the same day of the meter reading period. However additional analysis is necessary to determine the lag time adjustment value, which may or may not be significant.</p>
Billed Unmetered Authorized Consumption (BUAC) <input type="button" value="Find"/>	<p>All billed consumption which is calculated based on estimates or norms from water usage sites that have been determined <u>by utility policy</u> to be left unmetered. This is typically a very small component in systems that maintain a policy to meter their customer population. However, this quantity can be the key consumption component in utilities that have not adopted a universal metering policy. This component should NOT include any water that is supplied to neighboring utilities (water exported) which is unmetered but billed. Water supplied as exports to neighboring water utilities should be included only in the Water Exported component.</p>
Customer Metering Inaccuracies (CMI) <input type="button" value="Find"/>	<p>Apparent water losses caused by the collective under-registration of customer water meters. Many customer water meters gradually wear as large cumulative volumes of water are passed through them over time. This causes the meters to under-register the flow of water. This occurrence is common with smaller residential meters of sizes 5/8-inch and 3/4 inch after they have registered very large cumulative volumes of water, which generally occurs only after periods of years. For meters sized 1-inch and larger - typical of multi-unit residential, commercial, institutional and industrial accounts - meter under-registration can occur from wear or from the improper application of the meter; i.e. installing the wrong type of meter or the wrong size of meter, for the flow pattern (profile) of the consumer. For instance, many larger meters have reduced accuracy at low flows. If an oversized meter is installed, most of the time the routine flow will occur in the low flow range of the meter, and a significant portion of it may not be registered. It is important to properly select and install all meters, but particularly large customer meters, size 1-inch and larger.</p> <p>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. Note that this percentage is a composite average inaccuracy for all customer meters in the entire meter population. The percentage will be multiplied by the sum of the volumes in the Billed Metered and Unbilled Metered components. Alternatively, if the auditor has substantial data from meter testing activities, he or she can calculate their own loss volumes, and this volume may be entered directly.</p> <p>Note that a value of zero will be accepted but is not recommended, as all metered systems tend to have some degree of inaccuracy. A positive value should be entered. A value of zero in this component is generally valid only if the water utility does not meter its customer population.</p> <p>The formula for calculating a volume of CMI from a percentage input is as follows: $CMI\ volume = (BMAC+UMAC)/(1-CMI\%)-(BMAC+UMAC)$</p>
Customer Retail Unit Charge (CRUC) <input type="button" value="Find"/>	<p>The Customer Retail Unit Charge represents the volumetric portion of the total charges that customers pay for water service. The CRUC does not include fixed charges. This unit charge cost is applied routinely to the components of Apparent Loss, since these losses represent water reaching customers but not (fully) paid for. Since most water utilities have a rate structure that includes a variety of different charges costs based upon class of customer, a volume-weighted average of water sold at each unique rate should be calculated to determine a single composite charge that should be entered into this cell. Finally, the weighted average charge should also include additional charges for sewer, storm water or biosolids processing, but only if these charges are based upon the volume of potable water consumed.</p> <p>For water utilities in regions with limited water resources and a questionable ability to meet the drinking water demands in the future, the Customer Retail Unit Charge Cost might also be applied to value the Real Losses; instead of applying the Variable Production Cost to Real Losses. In this way, it is assumed that every unit volume of leakage reduced by leakage management activities will be sold to a customer.</p> <p>Note: the Free Water Audit 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 for purpose of calculating Apparent Loss valuations. The monetary units are United States dollars, \$.</p>
Infrastructure Leakage Index (ILI) <input type="button" value="Find"/>	<p>The ratio of the Current Annual Real Losses (Real Losses) to the Unavoidable Annual Real Losses (UARL). This performance indicator is dimensionless.</p> <p>NOTES ON THE UARL AND ILI:</p> <ol style="list-style-type: none"> 1. This Free Water Audit Software version 6 presents the calculated UARL and ILI for systems of all sizes and all pressures. Some published research is now available on predicting how UARL is likely to be modified when modeling low leakage limits in systems that are very small (< 3000 conn), or have very low average pressures, or have very high pressures (aka boundary cases). Inherent over- or under- estimation of UARL volume may exist in these boundary cases, as they operate at or near the limits of the UARL model assumptions. More widespread application and understanding of system specific corrections to the UARL model in these boundary cases is now likely to occur, but are not included in the FWAS at the time of this publication. Caution is advised when using the standard UARL modeled value (and subsequently the ILI) for boundary cases. In boundary cases, the ILI may still be considered a general Performance Indicator, but not used as an absolute performance measurement or for benchmark comparisons. 2. The UARL term is based on average operating pressure in a given audit year, and a utility's current pressure conditions may not be optimized. Thus, ILI should always be interpreted with some measure of pressure, and only used for tracking progress if all justifiable pressure management has already been completed.

Item Name	Description
Length of Mains (Lm) <input type="button" value="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>
NON-REVENUE WATER <input type="button" value="Find"/>	<p>= Apparent Losses + Real Losses + Unbilled Metered Consumption + Unbilled Unmetered Consumption. This is water which does not provide revenue potential to the utility.</p>
Number of Service Connections (Nc) <input type="button" value="Find"/>	<p>Number of customer service connections, extending from the water main to supply water to a customer. This includes the actual number of pressurized piping connections, including fire connections, whether active or inactive. This may differ substantially from the number of customers (or number of accounts). Note: this number does not include the pipeline leads to fire hydrants. The total length of piping supplying fire hydrants should be included in the "Length of mains" input, and excluded from the Number of service connections input.</p>
Real Losses <input type="button" value="Find"/>	<p>Physical water losses from the pressurized system (water mains and customer service connections) 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. 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	<p>Those components of System Input Volume that are billed and have the potential to produce revenue.</p>
Service Connection Density <input type="button" value="Find"/>	<p>=number of customer service connections / length of mains</p>
Systematic Data Handling Errors (SDHE) <input type="button" value="Find"/>	<p>Apparent losses caused by accounting omissions, errant computer programming, gaps in policy, procedure, and permitting/activation of new accounts; and any type of data lapse that results in under-stated customer water consumption in summary billing reports. Systematic Data Handling Errors occur as a customer consumption volume and can result in a direct loss of revenue potential. Water utilities can find "lost" revenue by keying on this component.</p> <p>Utilities typically measure water consumption volumes registered by water meters at customer premises. The meter should be read routinely (ex: monthly) and the data transferred to the Customer Billing System, which generates and sends a bill to the customer. Data Transfer Errors result in the registered consumption volume value being less than the actual consumption volume, creating an apparent loss. Such error might occur from illegible and mis-recorded hand-written readings compiled by meter readers, inputting an incorrect meter register unit conversion factor in the automatic meter reading equipment, or a variety of similar errors.</p> <p>Apparent losses also occur from Data Analysis Errors in the archival and data reporting processes of the Customer Billing System. Inaccurate estimates used for accounts that fail to produce a meter reading are a common source of error. Billing adjustments may award customers a rightful monetary credit, but do so by creating a negative value of consumption volume, thus under-stating the actual consumption. Account activation lapses may allow new buildings to begin using water for months without meter readings and billing. Poor permitting and construction inspection practices can result in a new building water service commencing without a billing account, a water meter and meter reading; i.e., the customer is unknown to the utility's billing system. Close auditing of the permitting, metering, meter reading, billing and reporting processes of the water consumption data trail can uncover data management gaps that create volumes of systematic data handling error. Utilities should routinely analyze customer billing records to detect data anomalies and quantify these losses. For example, a billing account that registers zero consumption for two or more billing cycles should be checked to explain why usage has seemingly halted. Given the revenue loss impacts of these losses, water utilities are well-justified in providing continuous oversight and timely correction of data transfer errors & data handling errors.</p> <p>If the water auditor has not yet gathered detailed data or assessment of systematic data handling error, it is recommended that the auditor apply the default value of 0.25% of the Billed Authorized Consumption volume. However, if the auditor has investigated the billing system and its controls, and has well validated data that indicates the volume from systematic data handling error is substantially higher or lower than that generated by the default value, then the auditor should enter a quantity that was derived from the utility investigations and select an appropriate grading. Negative or zero values are not allowed for this audit component.</p> <p>Note: occasionally billed consumption volumes for a customer account may be over-stated due to issues of double-counting an account or applying an over-stated meter multiplier. The possibility of such occurrences should be explored in the data validation process, particularly if billed authorized consumption volumes for the year, or for any sub-group of customers (by classification or meter size), appears to be inordinately high. It is recommended to correct any</p>
Total annual operating cost (optional input) <input type="button" value="Find"/>	<p>*This input has been made optional, as it is no longer used in calculating a Performance Indicator. Auditors are welcome to continue to track this input as desired.* These costs include those for operations, maintenance and any annually incurred costs for long-term upkeep of the drinking water supply and distribution system. It should include the costs of day-to-day upkeep and long-term financing 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. Depending upon water utility accounting procedures or regulatory agency requirements, it may be appropriate to include depreciation in the total of this cost. This cost should not include any costs to operate wastewater, biosolids or other systems outside of drinking water.</p>

Item Name	Description								
<p>Unauthorized Consumption (UC)</p> <p>Find</p>	<p>Includes water illegally withdrawn from fire hydrants, illegal connections, bypasses to customer consumption meters, or tampering with metering or meter reading equipment; as well as any other ways to receive water while thwarting the water utility's ability to collect revenue for the water. Unauthorized consumption results in uncaptured revenue and creates an error that understates customer consumption. In most water utilities this volume is low and, if the water auditor has not yet gathered detailed data for these loss occurrences, it is recommended to use the default value of 0.25% of the Billed Authorized Consumption volume. However, if the auditor has investigated unauthorized occurrences, and has well validated data that indicates the volume from unauthorized consumption is substantially higher or lower than that generated by the default value, then the auditor should enter a quantity that was derived from the utility investigations. Note that a value of zero will not be accepted since all water utilities tend to have some volume of unauthorized consumption occurring in their system.</p>								
<p>Unavoidable Annual Real Losses (UARL)</p> <p>Find</p>	<p>The UARL is a theoretical reference value representing the technical low limit of leakage for well managed systems in good condition, with aggressive active leakage control. It is a key variable in the calculation of the Infrastructure Leakage Index (ILI).</p> <p>UARL (gallons) = $(5.41L_m + 0.15N_c + 7.5L_c) \times P \times 365$ d/year, or UARL (litres) = $(18.0L_m + 0.8N_c + 25.0L_c) \times P \times 365$ d/year</p> <p>where: L_m = length of mains (miles or kilometres) N_c = number of customer service connections L_p = the average length of customer service connection piping (feet or metres) (see the Worksheet "Service Connection Diagram" for guidance on deterring the value of L_p) L_c = total length of customer service connection piping (miles or km) L_c = N_c X L_p (miles or kilometres) P = Average operating pressure (psi or metres) (see Average Operating Pressure definition)</p> <p>NOTES ON THE UARL AND ILI:</p> <p>1. This Free Water Audit Software version 6 presents the calculated UARL and ILI for systems of all sizes and all pressures. Some published research is now available on predicting how UARL is likely to be modified when modeling low leakage limits in systems that are very small (< 3000 conn), or have very low average pressures, or have very high pressures (aka boundary cases). Inherent over- or under- estimation of UARL volume may exist in these boundary cases, as they operate at or near the limits of the UARL model assumptions. More widespread application and understanding of system specific corrections to the UARL model in these boundary cases is now likely to occur, but are not included in the FWAS at the time of this publication. Caution is advised when using the standard UARL modeled value (and subsequently the ILI) for boundary cases. In boundary cases, the ILI may still be considered a general Performance Indicator, but not used as an absolute performance measurement or for benchmark comparisons.</p> <p>2. The UARL term is based on average operating pressure in a given audit year, and a utility's current pressure conditions may not be optimized. Thus, ILI should always be interpreted with some measure of pressure, and only used for tracking progress if all justifiable pressure management has already been completed.</p>								
<p>Unbilled Authorized Consumption</p>	<p>All consumption that is unbilled, but still authorized by the utility. This includes Unbilled Metered Authorized Consumption (UMAC) + Unbilled Unmetered Authorized Consumption (UUAC). See "Authorized Consumption" for more information.</p>								
<p>Unbilled Metered Authorized Consumption (UMAC)</p> <p>Find</p>	<p>Metered consumption which is authorized by the water utility, but, for any reason, is <u>deemed by utility policy</u> to be unbilled. This might for example include metered water consumed by the utility itself in treatment or distribution operations, or metered water provided to civic institutions free of charge. It does not include water supplied to neighboring utilities (water exported) which may be metered but not billed.</p>								
<p>Unbilled Unmetered Authorized Consumption (UUAC)</p> <p>Find</p>	<p>Any kind of Authorized Consumption which is neither billed nor metered. This component typically includes water used in activities such as fire fighting, flushing of water mains and sewers, street cleaning, fire flow tests conducted by the water utility, etc. In most water utilities it is a small component.</p> <p>This component does NOT include water supplied to neighboring utilities (water exported) which is unmetered and unbilled – an unlikely case. Also, if any potable water used at a water treatment plant is tapped from a location <u>upstream</u> of the meter(s) used to determine the Volume from Own Sources in the audit, this is outside of the boundary of the audit and should therefore not be included as part of Unbilled, Unmetered Authorized Consumption.</p> <p>This component has many sub-components of water use which may not yet be quantified. The default is 0.25% of the Billed Authorized Consumption volume (BMAC + BUAC), and is recommended for temporary use if customized estimates are not yet available, with recommendation to begin tracking and estimating these volumes for the next audit.</p> <p>Note that a value of zero is not permitted, since all water utilities likely have some volume of water in this component occurring in their system.</p>								
<p>Units and Conversions</p>	<p>The user may develop an audit based on one of three unit selections:</p> <ol style="list-style-type: none"> 1) Million Gallons (US) 2) Megalitres (Thousand Cubic Metres) 3) Acre-feet <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):</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;">Enter Units:</td> <td style="text-align: center;">Convert From...</td> <td style="text-align: center;">=</td> <td style="text-align: center;">Converts to.....</td> </tr> <tr> <td style="text-align: center;">100</td> <td style="text-align: center;">Million Gallons (US)</td> <td style="text-align: center;">=</td> <td style="text-align: center;">306.888329 Acre-feet</td> </tr> </table>	Enter Units:	Convert From...	=	Converts to.....	100	Million Gallons (US)	=	306.888329 Acre-feet
Enter Units:	Convert From...	=	Converts to.....						
100	Million Gallons (US)	=	306.888329 Acre-feet						

Item Name	Description
	(conversion factor = 3.0689)
<p>Variable Production Cost (VPC) (applied to Real Losses)</p> <p>Find</p>	<p>The cost to produce and supply the next unit of water (e.g., \$/million gallons). This cost can include both short-run and long-run marginal costs. See the VPC data grading questions on IDG tab for examples of short-run and long-run marginal costs that may be included.</p> <p>It is common to apply the VPC unit cost to the volume of Real Losses. However, if water resources are strained and the ability to meet future drinking water demands is in question, then the water auditor may be justified in applying the Customer Retail Unit Charge to the Real Loss volume, rather than applying the Variable Production Cost.</p>
<p>Volume from Own Sources (VOS)</p> <p>Find</p>	<p>The volume of water withdrawn (abstracted) from water resources (rivers, lakes, streams, wells, etc) controlled by the water utility, and then treated for potable water distribution. Most water audits are compiled for utility retail water distribution systems, so this volume should reflect the amount of treated drinking water that entered the distribution system. Often the volume of water measured as treated effluent of the treatment works is slightly less than the volume measured at the raw water source, since some of the water is used in the treatment process. Thus, it is useful if flows are metered at the effluent of the treatment works. Water treatment plants are also often supplied potable drinking water and therefore are a "customer" of the water utility. If the service connection line serving the water treatment plant is downstream of treated water effluent flowmeters, this water should be metered and billed as billed authorized consumption. In this case, this volume of water does not enter into any calculations for Volume from Own Sources. If the service connection line supplying potable water to the treatment plant is upstream of treated water effluent flowmeters, then this water is considered "process" water and included with calculations accounting for process water use.</p> <p>If metering exists only at the raw water source, an adjustment for water used in the treatment process should be included to account for water consumed in treatment operations such as filter backwashing, basin flushing and cleaning, plant potable water consumption (if the supply is drawn upstream of effluent flowmetering,) and similar uses. If the audit is conducted for a wholesale water agency that sells untreated water, then this quantity reflects the measure of the raw water, typically metered at the source.</p>
<p>Volume from own sources: error adjustment</p> <p>Find</p>	<p>An estimate or measure of the degree of inaccuracy that exists in the master (production) meters measuring the annual Volume from own Sources, and any error in the data trail that exists to collect, store and report the summary production data. This adjustment is a weighted average number that represents the collective error for all master meters for all days of the audit year and any errors identified in the data trail. Meter error can occur in different ways. A meter or meters may be inaccurate by under-registering flow (did not capture all the flow), or by over-registering flow (overstated the actual flow). Data error can occur due to data gaps caused by temporary outages of the meter or related instrumentation. All water utilities encounter some degree of inaccuracy in master meters and data errors in archival systems are common. Enter a <u>positive</u> percentage or volume, then select 'under-registration' or 'over-registration' from the drop-down immediately adjacent. See Water Supplied Error Adjustments definition for guidance on how to calculate this input.</p>
<p>Water Exported (WE)</p> <p>Find</p>	<p>The Water Exported volume is the bulk water conveyed or sold by the water utility to neighboring water systems that exists outside of their service area. Typically this water is metered at the custody transfer point of interconnection between the two water utilities. Usually the meter(s) are owned by the water utility that is selling or transferring the water: i.e. the exporter. If the water utility who is compiling the annual water audit sells or transfers bulk water in this manner, they are an exporter of water.</p> <p>Note: The Water Exported volume is typically sold to wholesale customers who are charged a wholesale rate that is different than retail rates charged to the retail customers existing within the service area. Many state regulatory agencies require that the Water Exported volume be reported to them as a quantity separate and distinct from the retail customer billed consumption. For these reasons - and others - the Water Exported volume is always quantified separately from Billed Authorized Consumption in the standard water audit. Be certain not to "double-count" this quantity by including it in both the Water Exported box and the Billed Metered Consumption box of the water audit Worksheet. This volume should be included only in the Water Exported box.</p>
<p>Water Exported: Error Adjustment (WEEA)</p> <p>Find</p>	<p>An estimate or measure of the volume by which the Water Exported volume is incorrect. This adjustment is a weighted average that represents the collective error for all of the metered and archived exported flow for all days of the audit year. Meter error can occur in different ways. A meter may be inaccurate by under-registering flow (did not capture all the flow), or by over-registering flow (overstated the actual flow). Error in the metered, archived data can also occur due to data gaps caused by temporary outages of the meter or related instrumentation. All water utilities encounter some degree of error in their metered data, particularly if meters are aged and infrequently tested. Occasional errors also occur in the archived data. Enter a positive percentage or volume, then select 'under-registration' or 'over-registration' from the drop-down immediately adjacent. If regular meter accuracy testing is conducted on the meter(s) - which is usually conducted by the water utility selling the water - then the results of this testing can be used to help quantify the meter error adjustment. Corrections to data gaps or other errors found in the archived data should also be included as a portion of this meter error adjustment. See Water Supplied Error Adjustments definition for guidance on how to calculate this input.</p>
<p>Water Imported (WI)</p> <p>Find</p>	<p>The Water Imported volume is the bulk water purchased to become part of the Water Supplied volume. Typically this is water purchased from a neighboring water utility or regional water wholesale supplier, and is metered at the custody transfer point of interconnection between the two water utilities. Usually the meter(s) are owned by the water supplier selling the water to the utility conducting the water audit. The water supplier selling the bulk water usually charges the receiving utility based upon a wholesale water rate.</p>
<p>Water Imported: Error Adjustment (WIEA)</p> <p>Find</p>	<p>An estimate or measure of the volume by which the Water Imported volume is incorrect. This adjustment is a weighted average that represents the collective error for all of the metered and archived imported flow for all days of the audit year. Meter error can occur in different ways. A meter may be inaccurate by under-registering flow (did not capture all the flow), or by over-registering flow (overstated the actual flow). Error in the metered, archived data can also occur due to data gaps caused by temporary outages of the meter or related instrumentation. All water utilities encounter some level of meter inaccuracy, particularly if meters are aged and infrequently tested. Occasional errors also occur in the archived metered data. Enter a positive percentage or volume, then select 'under-registration' or 'over-registration' from the drop-down immediately adjacent. If regular meter accuracy testing is conducted on the meter(s) - which is usually conducted by the water utility selling the water - then the results of this testing can be used to help quantify the meter error adjustment. See Water Supplied Error Adjustments definition for guidance on how to calculate this input.</p>

Item Name	Description
<p>Water Supplied Error Adjustments</p> <p>Find</p>	<p>Disclaimer: The guidance provided below should be considered general, representing a typical approach to determining Error Adjustment. Supply metering setups, metering technologies, instrumentation, data recording/archival, and data management systems can vary significantly from one water utility to the next. Inherent margins of error will also vary among different testing and calibration methods and the measurement systems being tested. Other factors that may be important include, but are not limited to, frequency of testing and calibration practices, data communication outages in the audit period, tested flowrates versus typical operating flowrates, and test durations. All of these factors must be considered when assessing Error Adjustment for the Water Supplied inputs. Each specific situation should be carefully analyzed to determine the most appropriate approach for determining the Error Adjustment to input, if any.</p> <p>General: For the Water Supplied inputs, there are three typical sources of error that may warrant an Error Adjustment on the Worksheet.</p> <ol style="list-style-type: none"> 1. Meter error: measurement inaccuracy in the meter(s) used to derive the input volume, typically identified through in-situ flow accuracy testing. Applicable for VOS, WI and WE. If no such testing has been performed, adjustment for meter error is not typically recommended. 2. Data transfer error: inaccuracy in archived volumes, typically due to gaps in data, programming errors impacting unit conversions, and/or programming errors impacting totalization of measured volumes over the audit period. Applicable for VOS, WI and WE. These errors are typically identified through electronic calibration to verify data transfer at the secondary device (i.e. conversion to mA, meter transmitter or similar instrumentation) and/or the tertiary device (i.e. SCADA, historian or other computerized archival system). 3. Net distribution storage change: The difference between end of audit period and beginning of audit period for total finished water stored, downstream of the system input meter(s). Typically applicable for VOS or WI. This volume is typically derived by comparing distribution storage tank water levels at end and beginning of the water audit period and using approximate tank geometry to convert levels to volumes. <p>Derivation Guidance:</p> <p>If an Error Adjustment input is being calculated as a <u>volume</u>, each source of error (described above) may be separately calculated, with careful consideration of under- vs over-registration, then added together to determine the composite <u>volume</u> to input. The composite input should be entered on the Worksheet as a positive number, then under- or over-registration selected on the adjacent dropdown.</p> <p>If an Error Adjustment input is being calculated as a <u>percent</u>, some very general guidance for calculating each error source (described above) is provided below. The auditor is again cautioned that each specific water supply setup needs to be evaluated closely as noted in the <u>Disclaimer</u>. Refer to the latest AWWA M36 Manual for additional discussion and guidance on this matter.</p> <ol style="list-style-type: none"> 1. Meter error: If in-situ flow accuracy testing has been performed, and inherent testing method error is understood, first the <i>meter accuracy %</i> may be determined as follows: $\text{meter accuracy \%} = \text{System input meter(s) volume} / \text{Reference volume}$ Then, the <i>meter error %</i> may be determined as follows: <input type="checkbox"/> $\text{meter error \%} = \text{meter accuracy \%} - 100\%$ 2. Data transfer error: If electronic calibration at the secondary (i.e. conversion to mA, meter transmitter or similar instrumentation) and/or tertiary (i.e. SCADA, historian or other computerized archival system) devices has been performed, first the <i>data transfer accuracy %</i> may be determined as follows: $\text{data transfer accuracy \%} = \text{Tertiary device volume} / \text{Reference volume (typically at Secondary device)}$ Then, the <i>data transfer error %</i> may be determined as follows: <input type="checkbox"/> $\text{data transfer error \%} = \text{data transfer accuracy \%} - 100\%$ <p>If no error is identified, or if electronic calibration has not been performed, or if no secondary or tertiary devices exist, a <i>data transfer error %</i> adjustment is not typically recommended.</p> <ol style="list-style-type: none"> 3. Net distribution storage change. If meter error and/or data transfer error are being calculated as a %, it is recommended to make the adjustment for net distribution storage change as a volume adjustment, directly in the VOS or WI input, as applicable. <p>The final step is to add <i>meter error %</i> and <i>data transfer error %</i>: $\text{Error Adjustment \%} = \text{meter accuracy \%} + \text{data transfer error \%}$ </p> <p>If the total Error Adjustment % calculates out as a negative number, it represents an under-registration. Vice versa, if positive. The composite input should be entered on the Worksheet as a positive number, then under- or over-registration selected on the adjacent dropdown. <input type="checkbox"/></p>
<p>WATER LOSSES</p> <p>Find</p>	<p>= apparent losses + real losses = water supplied - authorized consumption</p> <p>Water Losses are the difference between Water Supplied and Authorized Consumption. Water losses can be considered as a total volume for the whole system, or for partial systems such as transmission systems, pressure zones or district metered areas (DMA), if one of these configurations are the basis of the water audit.</p>



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.

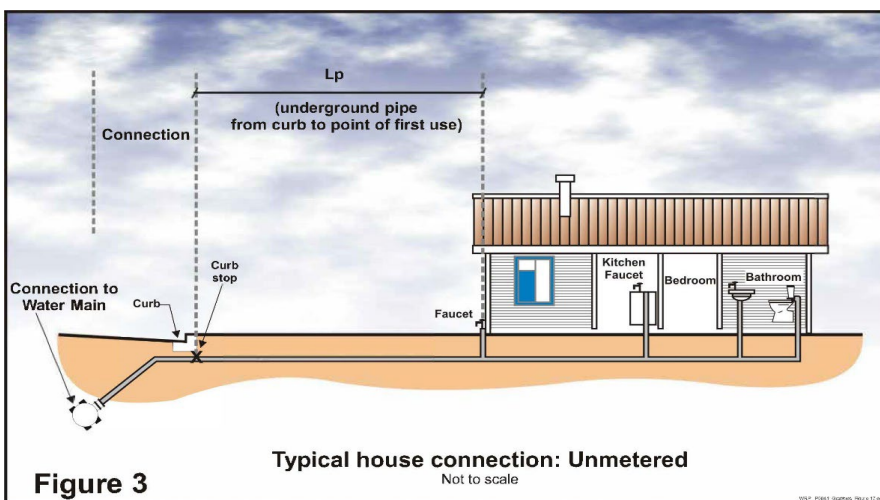
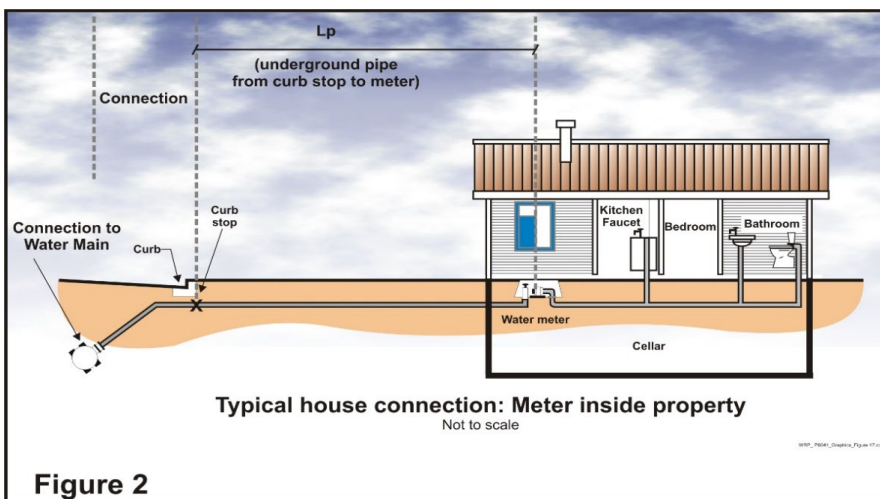
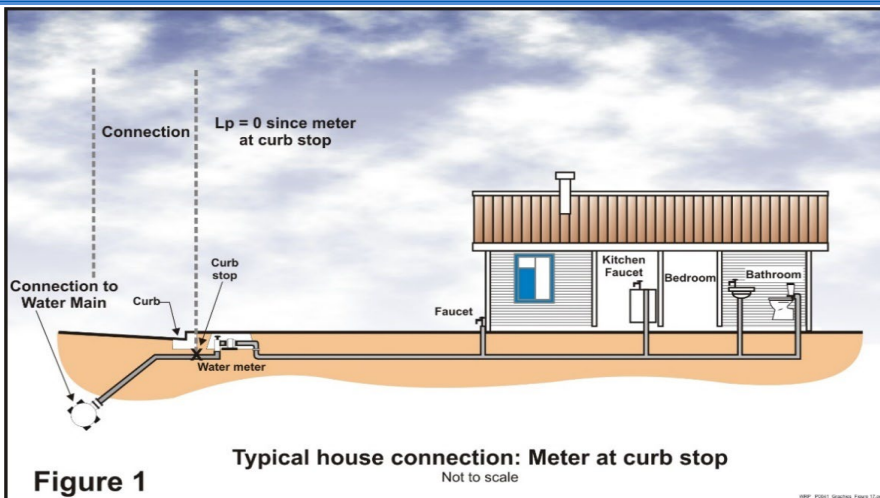
Figure 1 shows the configuration of the water meter outside of the customer building next to the curb stop valve. In this configuration $L_p = 0$ since the distance between the curb stop and the customer metering point is essentially zero.

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

Figure 3 shows the configuration of an unmetred customer building, where L_p is the distance from the curb stop 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](#)





AWWA Free Water Audit Software: Determining Water Loss Standing

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Water Audit Report for: **Columbia Water Company**
 Audit Year: **2024** **Jan 01 2024 - Dec 31 2024**
 Data Validity Tier: **Tier III (51-70)**

Water Loss Control Planning Guide

Water Audit Data Validity Tier (Score Range)					
Functional Focus Area	Tier I (1-25)	Tier II (26-50)	Tier III (51-70)	Tier IV (71-90)	Tier V (91-100)
Audit Data Collection	Launch auditing and loss control team; address supply metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations; Identify data gaps; improve supply metering	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 AMR/AMI 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 with PIs for performance comparisons for real losses	Performance Benchmarking with PIs is meaningful in comparing real loss standing	Identify Best Practices/ Best in class; PIs are very reliable as real loss performance indicators 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.