

(All numbers used in this worksheet are for example purposes only)

The following instructions can be used in completing the Water Audit Worksheet. The instructions are labeled by line number shown on the worksheet. The Water Audit Worksheet requests that the water utility enter general information and water supply, consumption, and loss quantities. It also requests assessment scores representing the degree of validation of individual components. For those components that include an assessment line, enter a number between 0.5 and 5. (See Appendix 1.3 for more information). If a component does not apply, then select N/A (for example, if the water utility does not purchase any treated water, select N/A for Total Treated Purchased Water). You may visit the TWDB Web site for the online version of the water audit:

<http://www.twdb.texas.gov/conservation/municipal/waterloss/index.asp>.

A. Water Utility Information

1. **Water Utility Name:** Lists the formal name of the water utility for which the water audit exists.
- 1a. **Regional Water Planning Area:** Select the RWP Area (A through P) into which your utility falls (see map at http://www.twdb.texas.gov/mapping/doc/maps/RWPAs_8x11.pdf).
2. **Contact:** Displays the name of the person completing the water audit, including email address and telephone number.
3. **Reporting Period:** Enter calendar year dates for the reporting period.
4. **Source Water Utilization:** Enter percentages to represent the proportions of surface water and groundwater withdrawn for source water supply. Remember that the total of the two percentages must equal 100%.
5. **Population Served:** Lists separately the retail and wholesale populations served. The retail population data is obtained from the Water Use Survey.
6. **Utility's Length of Main Lines, miles:** List the total length of pipeline in the water distribution system in miles.
7. **Number of Retail Service Connections Served:** Lists the number of active plus inactive retail customer service connections served by the utility's water distribution system. This number is obtained from data entered in the Water Use Survey.
8. **Number of Wholesale Connections Served:** List the number of wholesale interconnections supplying water to other water utilities.
9. **Service Connection Density:** Calculates the service connection density by dividing the number of retail customer service connections by the length of miles of pipeline in the water distribution system.
10. **Average Yearly System Operating Pressure:** List the average pressure across the entire water distribution systems for the audit period. If a hydraulic model of the network exists, the average pressure can be calculated by the model; otherwise, an estimate can be used.
11. **Volume Units of Measure:** The volume unit of measure used throughout the Water Loss Audit form is gallons. Ensure that any values entered are in gallons.

B. System Input Volume: The total water supplied to the distribution system. It is the total of all production meter readings for the entire year. List the volume or percentage requested in each item,

along with the scores from Appendix 1.3 that in your judgment best represent the degree of validation of the data.

12. **Volume of Water Intake:** Includes all water taken as source water from permitted sources, such as rivers, lakes, streams, and wells. This volume is obtained from the Water Use Survey and is for reference purpose only.
13. **Produced Water:** The volume of treated water input to distribution system from own production facilities.
- 13a. **Production Meter Accuracy (enter a percentage):** Achieved by calibrating or verifying the accuracy level (expressed as a percentage) of production meters. For example purposes, if the meter over-registered by 4 percent, enter 104; if it under-registered by 4 percent, enter 96.
- 13b. **Corrected Input Volume (calculated automatically online):** The sum obtained when the production meter adjustment is either added to or subtracted from the system input volume. This value is auto-calculated.

Example: If “water volume from own sources” registered 1.8 MG/year through two production meters, which were found to be collectively under-registering flow by 4 percent, then the corrected input volume (CIV) is:

Corrected Input Volume = (1,800,000) ÷ (.96) = 1,875,000 – 1,800,000 = 75,000.
The additional 75,000 gallons was not registered by the meter.

14. **Total Treated Water Purchased:** Amount of purchased wholesale water transferred into the utility’s water distribution system from other water suppliers. This is obtained from the Water Use Survey.
- 14a. **Treated Purchased Water Meter Accuracy (enter a percentage):** Achieved by calibrating or verifying the accuracy level (expressed as a percentage) of purchase meters. For example purposes, if the meter over-registered by 4 percent, enter 104; if it under-registered by 4 percent, enter 96.
- 14b. **Corrected Treated Purchased Water Volume (calculated automatically online):** The sum obtained when the production meter adjustment is either added to or subtracted from the purchased water volume. This value is auto-calculated.
15. **Total Treated Wholesale Water Sales from Produced Water:** Amount of wholesale water transferred out of the utility’s distribution system. It may be put into the system initially but is only in the system for a brief time for conveyance reasons. This is obtained from the Water Use Survey.
- 15a. **Treated Wholesale Water Meter Accuracy (enter a percentage):** Achieved by calibrating or verifying the accuracy level (expressed as a percentage) of wholesale meters. For example purposes, if the meter over-registered by 4 percent, enter 104; if it under-registered by 4 percent, enter 96.
- 15b. **Corrected Treated Wholesale Sales Volume (calculated automatically online):** The sum obtained when the production meter adjustment is either added to or subtracted from the wholesale water volume. This value is auto-calculated.
16. **Total System Input Volume:** Calculated as the corrected input volume plus treated water purchased minus treated wholesale water sales. (Line 13b, plus Line 14b, minus Line 15b). The volume unit of measure should be gallons. This value is auto-calculated.

C. Authorized Consumption: All water that has been authorized for use or consumption by the utility or its customers. Remember to enter these volumes in gallons.

17. **Billed Metered:** All retail water sold and metered. This is obtained from the Water Use Survey.
18. **Billed Unmetered:** All water sold but not metered.
19. **Unbilled Metered:** All water metered but not billed, such as back flushing water, parks, golf courses, and municipal government offices.
20. **Unbilled Unmetered:** All water not billed or metered, such as flushing fire hydrants.
21. **Total Authorized Consumption:** The total of the above four components, automatically calculated in the online worksheet.

D. Water Losses: Water delivered to the distribution system that does not appear as authorized consumption.

22. Calculated as the difference of the system input volume and total authorized consumption (Line 16 minus Line 21).

E. Apparent Losses: Water that has been consumed but not properly measured or billed. These losses represent under-registered or under-billed water that occurs via customer meter inaccuracy, systematic data handling error in the customer billing system, and unauthorized consumption:

23. **Average Customer Meter Accuracy:** List the composite accuracy percentage for your customer's meters. This percentage is typically derived from meter testing results. A representative assessment of customer meter accuracy can be obtained by testing as few as 50 meters.
24. **Customer Meter Accuracy Loss:** Obtained by dividing the billed metered water volume by the degree of average customer meter inaccuracy (Line 17 ÷ Line 23). This is auto-calculated.

Example: If billed metered (line 17) consumption registered 1.5 MG/year and random meter testing found customer meters to be collectively under-registering flow by 8 percent, then the customer meter inaccuracy loss is:

Customer Meter Accuracy Loss = $[(1,500,000) \div (.92) - 1,500,000] = 130,434.782$ gallons.

The 130,434 represents water that was not registered by the meter.

25. **Systematic Data Handling Errors:** List the estimated volume of water recorded by customer meters but distorted by meter reading or billing system error. The utility may choose to set up an account within their software called unbilled consumption, it is for water not billed but that was recorded by the meter. If unbilled consumption is not tracked, this volume becomes part of your water loss.
26. **Unauthorized Consumption (theft):** Estimate amount of water loss due to theft. Include an estimate of water taken illegally from fire hydrants, as well as water loss at the customer service connection. Theft at the customer connection can include tampering with meters or meter reading equipment, in addition to illegal taps and other similar occurrences. The online form has a box you may check that will automatically take 0.25% of the corrected input volume if you have low levels of confidence in the estimated amount.

27. **Total Apparent Losses:** This value is calculated automatically online as the sum of customer meter inaccuracy loss, systematic data handling error, and unauthorized consumption.

F. Real Losses: These are physical losses from the pressurized water distribution system, including water mains and all appurtenances (for example, valves and hydrants) and customer service connection piping. Real losses represent water that is lost from the distribution system prior to reaching the customer destination.

28. **Reported Breaks and Leaks:** Reported breaks and leaks are brought to the attention of the water utility by customers, public safety officials, other utilities, or other members of the general public. Usually these visible water main breaks are very disruptive and water utilities respond quickly to these events, so the run duration of the break or leak is relatively short. Estimate the total volume of water loss during the water audit period from reported breaks and leaks that were repaired during the year. Leakage flow rates must be estimated for various types of breaks and leaks, as well as the approximate duration of the breaks or leaks prior to repair.

29. **Unreported Loss:** This is a “catch-all” volume, meaning that this volume of real losses is the quantity that remains after authorized consumption, apparent losses, and reported leakage have been subtracted from the system input volume. In every water distribution system, even those employing effective active leakage control programs, experience some amount of undetected leakage. Some of this loss is comprised of unreported leakage that has not yet been detected in leak surveys. It also includes a subcomponent known as background leakage, which is the collective weeps and seeps at pipe joints and on customer service connections that cannot be detected with acoustic sounding devices. Any degree of error in quantifying metered and estimated volumes in the water audit results in error in this component. As the validation of the water audit improves over time, so will the level of validation of the unreported leaks volume.

30. **Total Real Losses:** This value is calculated automatically online as the sum of reported breaks and leaks and unreported loss.

31. **Water Losses:** Calculated as the sum of apparent losses and real losses. This value should equal the value of Line 22. This line is included as a balancing check.

32. **Non-revenue Water:** Calculated as the sum of apparent losses, plus real losses, plus unbilled metered consumption and unbilled unmetered consumption. This is the water that does not contribute to the water utility billings.

G. Technical Performance Indicator for Apparent Loss: Performance indicators are quantitative measures of key aspects within the utility. Using these indicators, the utility will have a history to track its performance from year to year. One performance indicator exists for apparent loss.

33. **Apparent Losses Normalized:** Calculated as the volume of apparent loss, divided by the number of retail customer service connections, divided by 365 days. This performance indicator allows for reliable performance tracking in the water utility’s efforts to reduce apparent losses.

H. Technical Performance Indicator for Real Loss: Several performance indicators exist for real loss.

34. **Real Loss Volume:** This is the quantity from Line 30.

35. **Unavoidable Annual Real Losses:** Calculated reference value using the equation shown in Table 3-2 of the Texas Water Loss Manual, which is found at the bottom of the page using the following link, www.twdb.texas.gov/conservation/Municipal/waterloss/index.asp. This is a theoretical value of the technical low level of leakage that might be attained in a water utility, based upon several specific parameters.

$$((Lm)(5.41)(365) + (Nc)(0.15)(365)) (P) = UARL$$

Lm = Length of main lines

Nc = Number of retail connections

P = Average operating pressure

The UARL is not valid for utilities having less than 3000 total connections.

36. **Infrastructure Leakage Index:** This performance indicator is calculated as the ratio of real losses over the unavoidable annual real losses. The index measures the water utility's leakage management effectiveness and is an excellent performance indicator for comparing performance among water utilities. The lower the value of the infrastructure leakage index, the closer the utility is operating to the theoretical low level of the unavoidable annual real loss. Appendix 1.3 gives general guidance on setting preliminary leakage reduction targets using the infrastructure leakage index without changing water pressure. The ILI is not valid for utilities having less than 3000 total connections.

$$ILI = \text{Total Real Loss}/UARL$$

37. **Real Losses Normalized:** Calculated as the real loss volume, divided by the number of retail service connections, divided by 365. This calculation is used if the service connection density is greater than, or equal to, 32 per mile. This indicator allows for reliable performance tracking in the water utility's efforts to reduce real losses.
38. **Real Losses Normalized:** Calculated as the real loss volume, divided by the number of miles of pipeline, divided by 365. This calculation is used if the service connection density is less than 32 per mile. This indicator allows for reliable performance tracking in the water utility's efforts to reduce real losses.

I. Financial Performance Indicators:

39. **Total Apparent Losses:** Lists the volume from line 27.
40. **Retail Price of Water:** Water utility rate structures usually feature multiple tiers of pricing based upon volume consumed. For the water audit, it is best to use a single composite price rate to represent the retail cost of water, which is used to place a value on the apparent losses. Where appropriate, use the tier with the majority of the consumption. Enter the price as \$/gallon.
41. **Cost of Apparent Losses:** Calculated by multiplying the apparent loss volume by the retail price of water. This represents the potential amount of missed revenue due to apparent losses.
42. **Total Real Losses:** List the volume from line 30.
43. **Variable Production Cost of Water:** Marginal production cost is defined by only costs that are vary based on amount produced. Variable cost, typically include the cost of raw water, energy, and chemicals. If applicable, the cost of raw water should include the price of take or pay contracts. For example, if you have ground water then you most likely only have the cost of chemicals and electricity

to get the water into distribution. Add the chemicals and electricity for the year and divide by Line 16, the Total System Input Volume. The answer is your cost of water per gallon. These costs are applied to determine the cost impact of real losses. In cases of water shortage, real losses might be valued at the retail price of water instead of the variable production cost.

44. **Cost of Real Losses:** Calculated by multiplying the real loss volume by the variable production cost of water. These costs represent the additional operating costs incurred by the water utility due to the real losses (in other words, leakage).
45. **Total Cost Impact of Apparent and Real Losses:** Calculated by adding lines 41 and 44. This amount indicates the cost inefficiency encountered by the water utility for losses. This cost value can be objectively weighed against potential loss control programs to determine the cost effectiveness of such programs.
46. **Total Assessment Score:** Adds the individual assessment scores and inserts the total.

J. System Losses:

47. **Total Loss Percent:** This value is calculated as the sum of the real loss volume (Line 30) plus the apparent loss volume (Line 28), divided by the Total System Input Volume (Line 16).
48. **Total GPCD Input:** This is the volume of water produced Per Capita Daily in gallons and is calculated as the Total System Input Volume (Line 16) divided by the Retail Population Served (line 5a)
49. **GPCD Loss:** This is the volume of water lost Per Capita Daily in gallons and is calculated as total water losses (Line 31), divided by the retail population served (Line 5a), divided by 365.

K. Wholesale Factor Adjustments

Texas Water Development Board recognizes that some utilities provide large volumes of wholesale water to other providers that travel through the general distribution system, so a calculation has been established to adjust for that volume of wholesale water

50. **Percent of Treated Wholesale Water Traveling Through the General Distribution System:** This is the percentage of wholesale water traveling through the general distribution system, as opposed to traveling through dedicated pipelines.
51. **Volume of Treated Wholesale Water Traveling Through the General Distribution System:** This is the volume of wholesale water traveling through the general distribution system, as opposed to traveling through dedicated pipelines. It is calculated by multiplying the Corrected Treated Wholesale Water Sales Volume (Line 15b) by the Percent of Wholesale Water traveling through the General Distribution System (Line 50).
52. **Wholesale Factor:** The ratio of wholesale water volume (Line 15b) to Corrected Input Volume (Line 13b + Line 14b).
53. **Adjusted Real Loss Volume:** This is the Real Loss Volume after applying the Wholesale Factor (if applicable). It is calculated based on the percentage of wholesale water traveling through the general distribution system.
54. **Adjusted Cost of Real Losses:** This is the Cost of Real Losses after applying the Wholesale Factor (if applicable). It is calculated based on the percentage of wholesale water traveling through the general distribution system.
55. **Adjusted Total Water Loss Volume:** This is the Total Water Loss Volume after applying the Wholesale Factor (if applicable). It is calculated based on the percentage of wholesale water traveling through the general distribution system.

56. **Adjusted Total Cost Impact or Apparent and Real Losses:** This is the Total Cost Impact of Apparent and Real Losses applying the Wholesale Factor (if applicable). It is based on the percentage of wholesale water traveling through the general distribution system.
57. **Adjusted Real Loss Per Connection:** This is the Real Loss Per Connection after applying the Wholesale Factor (if applicable). It is calculated based on the percentage of wholesale water traveling through the general distribution system.
58. **Adjusted Real Loss Per Mile:** This is the Real Loss Per Mile after applying the Wholesale Factor (if applicable). It is calculated based on the percentage of wholesale water traveling through the general distribution system.
59. **Adjusted Infrastructure Leakage Index:** This is the Infrastructure Leakage Index after applying the Wholesale Factor (if applicable). It is calculated based on the percentage of wholesale water traveling through the general distribution system.
60. **Adjusted Total Water Loss Percent:** This is the Total Water Loss Percent after applying the Wholesale Factor (if applicable). It is calculated based on the percentage of wholesale water traveling through the general distribution system.
61. **Adjusted GPCD Loss:** This is the GPCD Lost after applying the Wholesale Factor (if applicable). It is calculated based on the percentage of wholesale water traveling through the general distribution system.

Comments: Any information pertinent to the system and/or the data in the audit may be entered here.

If you or the utility need(s) water loss assistance, please call Daniel Rice at 512-463-0987 or email: daniel.rice@twdb.texas.gov.