WATER LOSS CONTROL PLAN

FOR THE VILLAGE OF WEST SALEM, OHIO

Contents

Executive Summary

This Water Loss Control Plan is developed for the Village of West Salem, Ohio. Technical assistance providers from Rural Community Assistance Program (RCAP), a program run by Great Lakes Community Action Partnership (GLCAP), assisted the village to complete a water audit and develop a plan to reduce water losses. The plan has been developed using the community's data and the American Water Works Association (AWWA) Free Water Audit Software (M36), version 6.1. The water audit period is for calendar year 2024 and uses year-end data from this period.

The audit identifies significant real water loss, while apparent losses are minimal. West Salem's public water system serves 1,430 customers through 660 service connections within the village. West Salem's non-revenue water (NRW) for the audit period is calculated to be 23.932 million gallons (MG) per year, which the M36 estimates costs the system $50,021 a year. The audit identifies moderate real water loss, while apparent losses are minimal. The overall validity score of the audit is 50 (out of a possible 100), which puts the system in Tier II (out of 5 tiers, with V being the highest). This tier indicates that water loss tracking policies and procedures should be improved before the system sets long-term goals for water loss. In Tier II totals for real losses are not yet reliable enough to be used for benchmarking or for comparison purposes.

The following information outlines the analysis of the community's data through the AWWA's software, actionable strategies to mitigate water loss, and information to improve the financial sustainability of the system.

Introduction

A public water system (PWS) faces many challenges in maintaining a system with minimal water loss. Rural communities in Ohio are often faced with aging infrastructure and inadequate resources to fix water loss issues. Tracking water loss is essential to reduce the amount of water and resources wasted or lost. This can lessen the financial burden on the community. With proper tracking, a PWS can use their resources effectively to promptly investigate and correct any water loss issues that occur. There are numerous ways a community can effectively track water loss.

West Salem's public water system tracked water loss using different methodologies. Currently, the system's primary way to detect water loss is by analyzing the bills for all the water customers for anomalies. The billing software automatically flags erroneous amounts for the administration to check, and the customer meters that are unable to be radio read are checked manually. Water personnel are sent to check meters for accounts that have unusually high water usage for the month. Historically, the system has tracked water loss informally to meet minimum regulatory requirements. While this approach satisfied compliance, it lacked the depth and precision needed for strategic decision-making. This water audit introduces a more detailed and comprehensive methodology, providing accurate data and actionable insights. The enhanced level of detail enables management to:

- Identify inefficiencies and prioritize corrective actions.
- Make informed decisions regarding infrastructure investments and operational improvements.
- Establish a foundation for long-term water loss control and performance benchmarking.

The AWWA M36 is the industry standard guidance for conducting annual water audits. The M36 uses data from the community to track and analyze where water is going within a system, and the water system's associated costs and revenue. The data provided to the software is graded through a series of questions, determining the validity and accuracy of each data point. The software gives each PWS a score ranging from 1 to 100. The score range is divided into five tiers. Scoring in a high tier indicates a PWS is following best practices for water auditing. Validity scoring also influences the priorities for future improvement. The M36 gives key takeaways for each system, and a generalized strategy to implement a water loss control program. Public water systems should have a goal of receiving a higher validity score each year they complete the water audit, by accurately collecting their system's water usage, revenue, and expenses. The system can also implement operational improvements, such as meter calibration to lift their validity score and minimize apparent water loss.

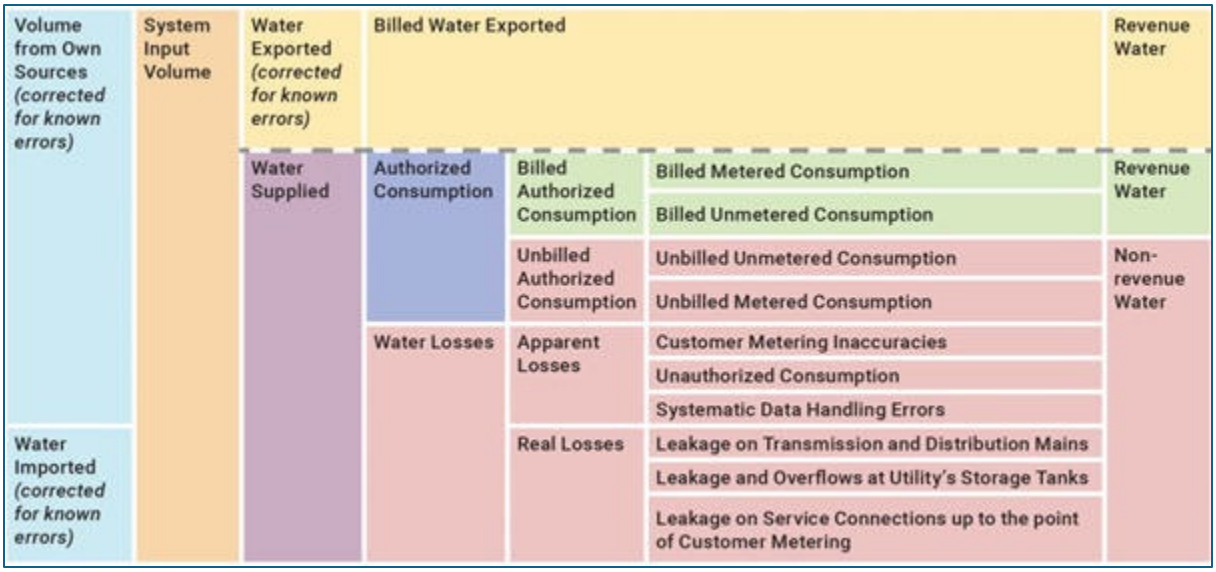

Figure 1: The water balance from AWWA detailing the distribution of water across defined categories. This details how water from the source will be supplied, and either lost or consumed.

Non-revenue water (NRW) represents water that has been produced and supplied to a distribution system but is not billed to customers. It is a critical indicator of a water utility's operational efficiency and financial health. NRW comprises both apparent losses (unauthorized consumption, customer metering inaccuracies, and systematic data handling errors) and real losses (leakage from pipes, storage tanks, and service connections). It is important to understand that while real losses represent physical loss of product (water), apparent losses equate to loss of revenue (money). Reducing NRW is essential for water conservation, optimizing operational costs, and ensuring equitable billing for all customers. Water audits assist communities by representing water usage and losses within a system, then taking this information to create a water loss control program. The program should state ways to effectively mitigate water loss and recover lost revenue.

The Rural Community Assistance Program (RCAP) assists public water systems to complete water audits, water loss control plans, and the implementation of individualized water loss programs. RCAP assisted the Village of West Salem, Ohio with the completion of a water audit through AWWA's M36 software. This was completed between May of 2025 through November of 2025, for the audit period of calendar year in 2024. RCAP's condition assessment team provided technical assistance to compile the community's data, complete the data analysis, and create a water loss control plan. The plan was presented to the village and water system representatives. This project was funded by the Ohio Environmental Protection Agency (OEPA), by a grant made available to communities to complete a water audit, a water loss control plan, and the implementation of the loss control program.

Water Audit Data Analysis

Based on the provided AWWA Free Water Audit Software, the following key figures were identified for the Village of West Salem, Ohio. The AWWA website and M36 software contain further information and definitions for each of the following key data points. The complete water audit software workbook is included in Appendix A of this report.

Water Supplied: 58.498 MG/Yr

West Salem produces its own water. No water is imported or exported. The system does not sell wholesale water to any other PWS.

Non-Revenue Water: 23.932 MG/Yr costing ≈ $50,021 Yr

Total non-revenue water is 23,932,000 gallons for the audit year. This was calculated by adding the real losses, apparent losses, and the unbilled authorized consumption. Non-revenue water includes all water that runs through the system but does not generate billable revenue. This includes water that is lost to leaks, and water that makes it to an end user, but does not get billed.

Non-Revenue Water Percentage: 40.9% in 2024

Water Loss Percentage: 29.6% in 2024

This percentage should not be the key takeaway of the audit. Instead, this figure is provided for consistency with reporting standards and to highlight the difference between non-revenue water and water loss. For West Salem in 2024, the vast majority of non-revenue water is actual water loss.

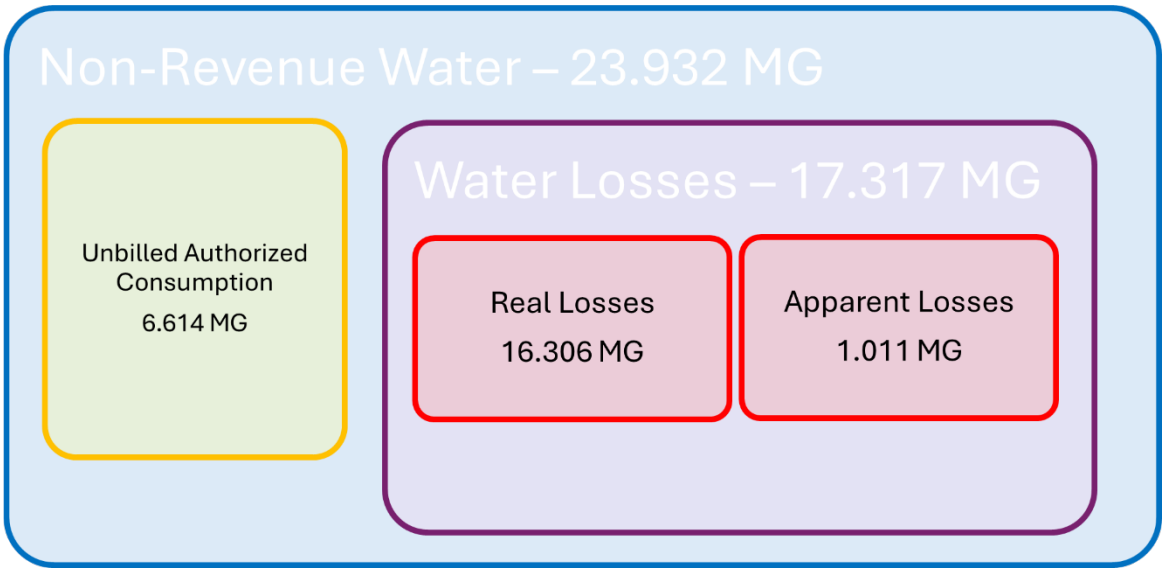

Figure 2: Graphic representation of the relationship between water losses and non-revenue water.

Apparent Losses: 1.011 MG/Yr

Apparent loss includes billing loss, potential theft, and meter inaccuracies in the system. West Salem's apparent loss is estimated to be 1.011 gallons in 2024. This is considerably less than their calculated real loss.

Variable Production Cost: $1,985 /Million gallons

The variable production cost (VPC) is estimated at $1,985 per million gallons. This includes the short-run marginal costs and some but not all the applicable long-run marginal costs within the system. For example, the VPC includes the cost for chemicals for treating water, power, and damage claims from main and service line breaks if the utility pays the claim. It should be noted that the VPC does not include employee salaries, debt repayments, and other fixed costs for the utility. For this audit $4.85 was used as the estimate for the customer retail unit charge (CRUC). In the future the CRUC can be improved by analyzing sales data and implementing a weighted average.

Real Losses: 16.306 MG/Yr

The real loss is calculated to be 16,306,000 gallons within 2024. This is more than the calculated apparent loss. The real loss occurring within the system should be one of the main focus areas for future improvement.

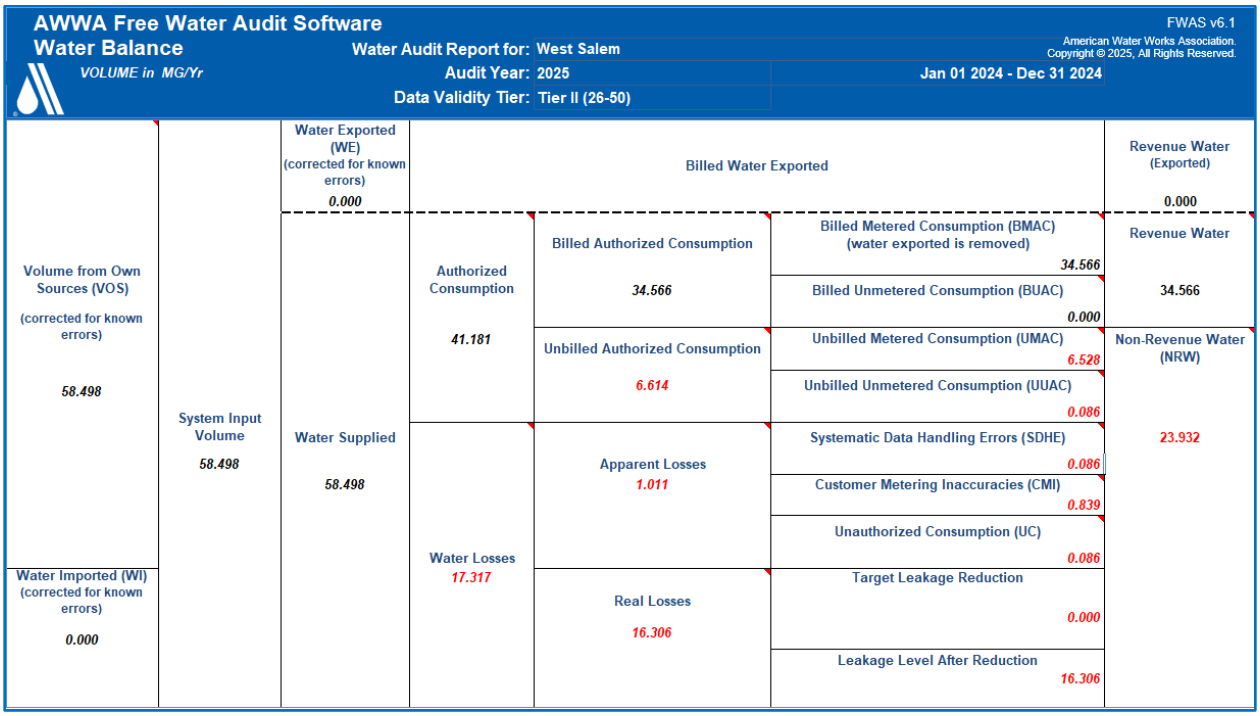

Figure 3: Taken directly from the AWWA M36 software, this chart shows the breakdown of water usage in West Salem, Ohio. The key takeaways of this chart are that out of 58.498 million gallons of water in 2024, 41.181 MG/Y is estimated to be authorized consumption, while 17.317 MG/Y is estimated to be water loss. This is broken down into further, more detailed categories, as shown above.

The analysis highlighted the highest sources of water loss:

1. Leakage Level After Reduction: 16.306 MG/Yr contributing to real losses.
2. Customer Metering Inaccuracies: 0.839 MG/Yr contributing to apparent losses.
3. Systematic data handling errors: 0.086 MG/Yr contributing to apparent losses.

It's important to understand how a system's water loss is divided between apparent loss and real loss before taking remedial action. The M36 software has used the data provided by West Salem's staff, created the chart above, and shows how water falls within the balance sheet. Most of the water loss appears to be coming from real loss, such as from leaks within the system. Apparent loss is still seen, with the unauthorized consumption and systematic data handling errors having a combined estimated 172,000 gallons a year lost.

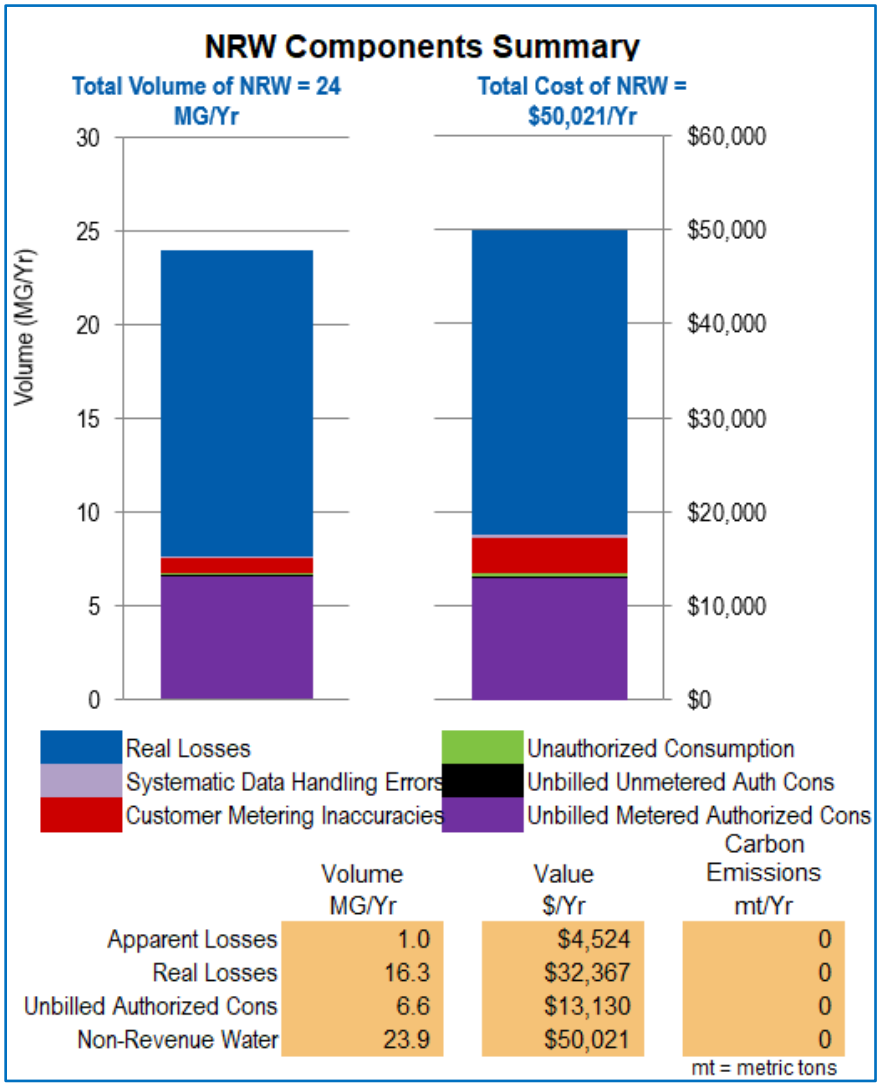

Figure 4: AWWA M36 created this non-revenue water figure. These charts represent a part of West Salem's dashboard. The left bar shows the total volume of non-revenue water, (NRW), at 23.9 MG/Yr, while the right bar shows the cost per year of the NRW, at $50,021. This is broken down further, into the authorized and unauthorized consumption quantities.

As the NRW Components Summary above represents, there is a yearly cost of more than $50,021 due to non-revenue water. Although less gallons per year are lost by apparent losses, it still costs a significant amount, estimated at $4,524 per year. Real loss is shown to cost an estimated $32,367 each year. Improvement in data validity and future data handling should improve this figure.

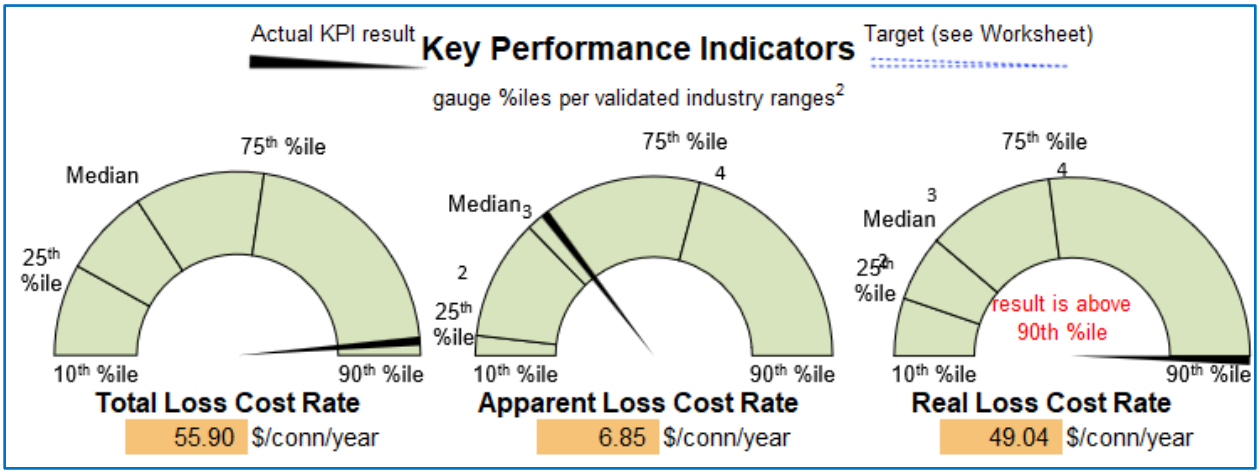

Figure 5: The following figure is from the AWWA M36. It represents the "Key Performance Indicators' for West Salem. These gauges show where West Salem stands in percentiles compared to other validated industry ranges.

As shown above, the total loss cost rate is $55.90 per connection, per year. Real loss is costing more than apparent loss in the system, at $49.04 rate per connection per year of the total loss cost. The cost of real loss is significantly higher than most other validated water audit, this likely due to authorized unbilled consumption (no meter at sewer plant, fire department and village offices).

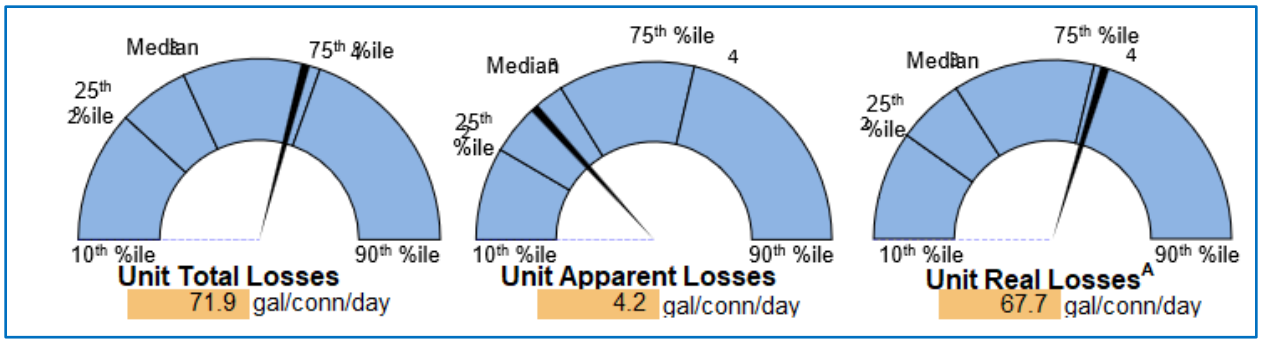

Figure 6: The following figure is from the AWWA M36. It represents the "Key Performance Indicators' for West Salem. These gauges show where West Salem stands in percentiles compared to other validated industry ranges. These gauges specifically represent the total losses broken down into apparent and real losses.

The figure above notes how the total loss for 2024 is around 71.9 gallons per connection per day. The system has 660 service connections, and at 71.9 gallons per connection, equals an estimated 47,454 gallons per day of total loss.

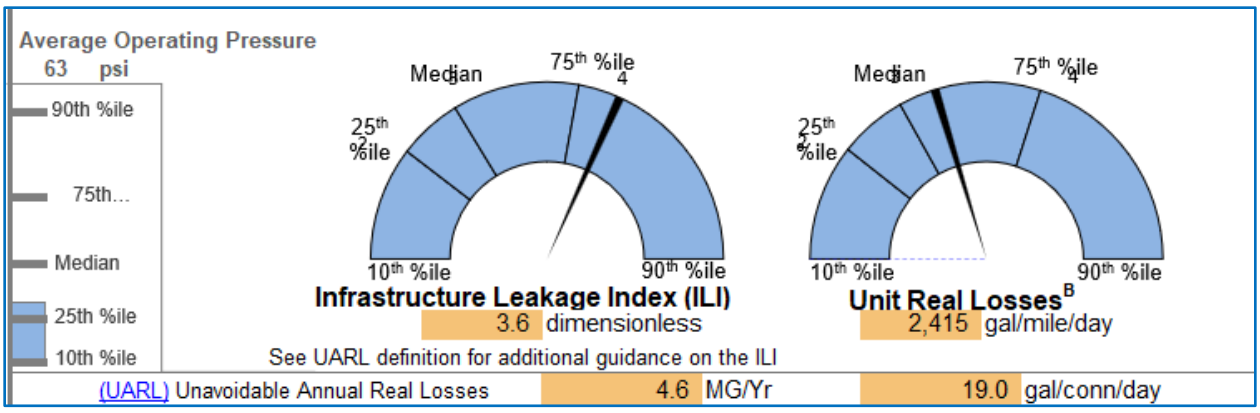

Figure 7: The following figure is from the AWWA M36. It represents the "Key Performance Indicators' for West Salem. These gauges show where West Salem stands in percentiles compared to other validated industry ranges.

The infrastructure leakage index (ILI) is of note here. West Salem within 2024 is above the 75th percentile, which pairs with the above-median percentile for the unit real losses, at 2,415 gallons per mile per day. West Salem contains 18.6 miles of mains and hydrant laterals, which means the system could be losing 44,677 gallons per day spread out across the system in real losses. The ILI measures the ratio of current annual real losses (CARL) to unavoidable annual real losses (UARL). The UARL is shown at the bottom of the figure, at 4.6 MG/Yr, or 19.0 gallons per connection per day. The 'avoidable' real loss is 12,540 gallons per day.

Strategies to Improve Validity Score

The data validity score within the free water audit software is based on AWWA's M36 methodology, and the information the system provides. The "Interactive Data Grading" tab within the workbook creates the scoring for the data validity score. The score is the sum of the data grading results, and then the score falls into a range of tiers from one to five, with five being the highest. The data grading asks a range of questions to understand how the system acquired or created a specific data entry, and whether the source of the data, such as the master meter, has been checked or calibrated recently.

The data validity is an important measure of how a water system retrieves, handles, and proactively corrects their data and its sources. West Salem had a score of 50 of 100 and landed in Tier II. This tier indicates that water loss tracking policies and procedures should be improved before the system sets long-term goals for water loss. In Tier II, totals for real losses are not yet reliable enough to be used for benchmarking or for comparison purposes.

The overall goal of each water audit should be for the system to improve their score each year or audit period. Systems should do this by implementing strategies to improve data accuracy.

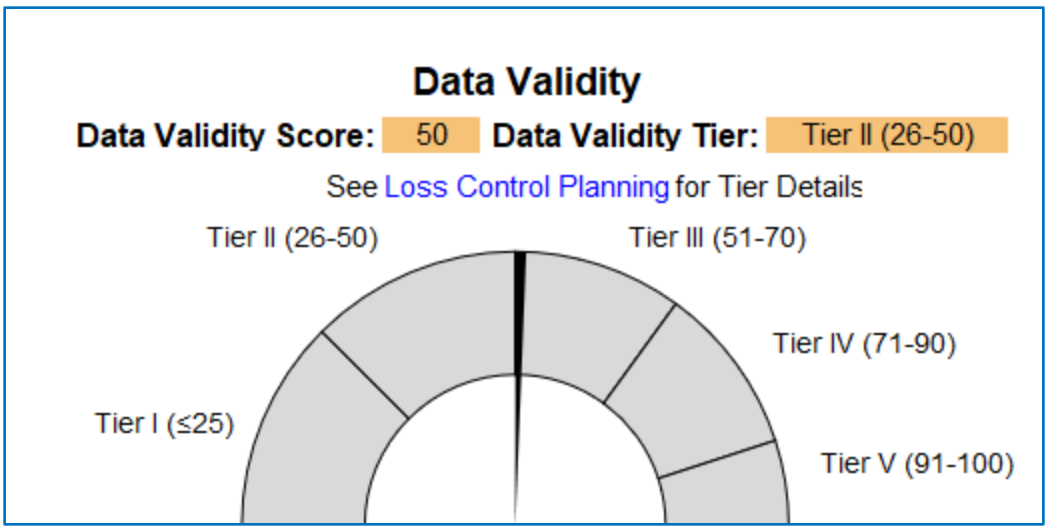

Figure 8: This figure is from AWWA's M36 for West Salem. West Salem scored 50 out of 100, landing in data validity Tier II.

The following are recommended categories for the Village of West Salem to prioritize for improvement. Recommended strategies should be implemented to improve the data validity score in future audit years. Within each category, recommendations have been included along with the current score of that category, ranging from one to ten. The possible improvements will be expanded upon further. Categories with a score of three or less should be prioritized for future improvement.

Priority in Validity Categories and Methods for Improvement

This section provides insights into how future water audits can build upon the work done for the 2024 audit year by improving data validity. The areas below are highlighted because they are shown as the most influential on the validity score, and as such are limiting factors preventing overall higher scoring. The data in these categories is not necessarily indicative of a problem, but the data can be made more reliable by improving how it is measured, tracked, or handled.

Volume from Own Sources (VOS): 3 out of 10

The score for the volume of own sources section could be improved. To improve the accuracy and data of the VOS section, we recommend that the master meter is checked and calibrated first. The master meter is the first point of tracking the amount of water being produced and used within the system. Validating that the master meter is the correct type, installed properly, and is reading flow accurately will verify the data collected for the VOS input, and could instantly decrease the amount of apparent water loss occurring in the system. The system should electronically calibrate the master meter. After this, the system could improve upon the accuracy of their data collection and the meter by completing in-situ flow testing.

In-situ flow testing ensures the flowmeter performance, and checks for the accuracy of the meters in the system. Understanding the flow through a pipe is also a vital contributing parameter in the

calculation of the cost of water in the system. Starting with the master meter validation is ideal, with in-situ flow testing being a recommendation in the future for the system.

Customer Retail Unit Charge (CRUC): 5 out of 10

The customer retail unit charge for West Salem was last changed in January of 2015. The current rate ordinance no. 14-03 lists the water rates as follows: "0-500 gallons per month at $41.00," "501-1,000GPM at $47.00," and "1,001 GPM – 20K GPM at $4.75 per thousand," etc. It is important to ensure that the rates are correctly implemented within the billing software. A check of a sample of accounts should be completed to ensure the water usage is charged at the current water rate.

The system should also consider ensuring that the language of the rate structure is clearly defined and interpreted. A possible recommendation is to change the rate structure within future water rate ordinances to rephrase the wording, adding a "minimum," and further defining how the charge per thousand gallons is implemented. For example, with the current rate structure listed above, would a customer who uses 1,100 gallons of water in a month be charged the $47 and the entire amount of the $4.75 for the usage after 1,000 gallons? Or would the customer be charged $47 and a percentage of $4.75 because the customer used 100 gallons compared to a full 1,000 gallons? Changing the language of the rate ordinance in future editions could elaborate how the rate structure is implemented within the billing software to calculate each customer's bill.

Customer Metering Inaccuracies (CMI): 2 out of 10

The data grading criteria for the customer metering inaccuracies includes the reactive and proactive testing for all meters. West Salem conducts reactive testing, but has not completed proactive testing of small, mid, and large size customer meters. Proactive testing includes any effort to test or look to fix meters, beyond when triggered by customer complaint or the billing software raising a flag for an account.

The system is actively replacing customer meters, as most meters were at the end of useful life. It is recommended to complete proactive testing as the meters get older, to test for accuracy. Usually, if a meter is reading inaccurately, it will track less than is being used, which is lost revenue for the system. Proactive testing can start with a small, random sample of the customer meters in the system. Proactive testing can allow the system to test for the accuracy of meter reads, but also to determine how well the meters are upkeeping in the system. This allows the system to have more time to prepare for meter replacements.

Unbilled Unmetered Authorized Consumption (UUAC): 3 out of 10

The score for the UUAC, or the unbilled unmetered authorized consumption from unbilled but authorized water customers in the system, could be improved. This should be a priority, as tracking water usage, whether billed or unbilled should always occur. This section did not have any data grading questions, as the M36 calculated an estimate for this consumption based on the volume of own sources value.

The first strategy to improve the water audit score, and the data the system is collecting, is to place meters at these unbilled unmetered accounts. It is recommended to record and track the unbilled account usage to gain a more accurate water usage volume. West Salem knows some of the unbilled, metered accounts, such as the village offices, sewer plant and fire department. Tracking or more accurately estimating the unbilled unmetered water usage will also help to see if water loss is occurring at these points of use. Tracking or gaining a better estimate for water usage during flushing would be recommended for West Salem as well, as it occurs annually. The water in the category can significantly change the NRW and water loss values.

Strategies for Water Loss Control

West Salem is experiencing loss in the form of apparent and real water losses. The M36 software shows the system to have much more real loss than apparent loss, as the data grading also shows the system having an overall good handling of their records and meter reads, with some of the system having brand new meters.

Apparent Loss Strategies

The M36 creates a calculated estimate for apparent loss, based off the system's volume of own sources and reported, tracked consumption. The unauthorized consumption, or water theft, customer metering inaccuracies and the systematic data handling errors are contributing to the moderate water loss percentage in the system, at 5.84% of the total water loss.

Systematic data handling errors could be improved upon by having an internal and external review of the billing software. This includes a review of the customer accounts, and comparing the list to addresses known in the system, the lead service line inventory, and county records. This rules out if the software is missing any water usage that should be receiving bills. All systems should try to minimize manual entries and prioritize using automated meter reads and processes when possible. The system could implement a new SOP, regarding systematic data handling, allowing for more consistent work and data records between staff. West Salem should keep up with monthly manual checks of their billing software. Lastly, the system should investigate the customer metering inaccuracies and determine any points where unauthorized consumption could occur.

Meter errors could be occurring in the system. Typically, meter errors lead to low reads, taking directly from the revenue for the system. Some of West Salem's customer meters were replaced recently, which makes it less likely that the meters are reading flow incorrectly. Testing a small random sample of the customer meters annually can improve the data validity for meter readings. The system should inventory and test large-sized meters. In addition to replacing old meters, they could inspect business meters to make sure it is the correct meter type for the flow rate, and take a small, random sample of the larger meters to proactively test each year for accuracy.

Unauthorized consumption, or water theft, can be found through normal daily operations. The billing and consumption data can be used to find extraneously low water usage in an account, which may indicate unauthorized use. Water system personnel should continue checking such accounts for misconduct or issues with the meter read. The village could also implement a

proactive program of field inspections to identify and address illegal connections, bypassed meters, and unmetered connections. Lastly, the system could educate the community about the importance of legal water connections, the expenses of the water system, and the consequences of water theft.

Real Loss Strategies

The water audit findings indicate that while apparent losses are present, a substantial portion of the non-revenue water in the Village of West Salem is due to real losses. Real losses are an important aspect of NRW because they include leakage from distribution mains, leakage and overflows from storage tanks, and leakage from service connections up to and including the meter. Real water losses are significant because they contribute costs to the water system due to the additional energy and chemical usage required to treat the lost water.

The first step to real loss reduction is leak detection. West Salem should implement leak detection in its operations at a larger scale, to lower the amount of real loss occurring within the system. This can be completed during normal operations and maintenance, such as during water line, meter, or hydrant repairs. An amplified listening device could be used during the annual hydrant flushing project, and during valve exercising. Conduct leak detection surveys, to discover unreported water leaks and minimize real losses.

Conclusion and Recommendations

There are various opportunities for improvement in data validity and water loss for the community. The “strategies for water loss control” and “priority in validity categories…” sections above have detailed multiple methods in which the system can increase its data validity score and lower the total water loss amount each year. The strategies listed throughout the water loss control plan are not comprehensive of all water loss or data validity concerns within the system, but rather recommended to implement as a starting point for improvement.

The village can achieve substantial improvements in their data validity score by implementing the recommended strategies. The system should use the water loss control plan as an actionable plan to implement a combination of the listed strategies. The system should create target timelines for implementation, and complete regular monitoring and evaluation to track progress and make necessary adjustments.

1. **Master Meter Validation:** The first step should involve the validation of the master meter, as the master meter is the first basis of all the water audit data. Electronic calibration of this meter was conducted last year and should continue to be completed yearly, in correlation with this. Ultimately, this will lead to an improved source of data and accurate water usage amount being tracked.

2. **Unbilled Unmetered Accounts:** The system should install water meters on all accounts or locations that currently do not have one. This includes the sewer plant, fire department, village office, parks and other unmetered places. Although some of these places are not billed, they should still be metered to ensure proper tracking of water usage, which would reduce the water losses total.
    - Place residential meters on fire department and village offices.
    - Install the water meter at the wastewater treatment plant. The meter is purchased; it has not yet been installed.
3. **Billing Software Address Review:** West Salem should verify that the billing software matches the lead service line inventory, for the addresses and amount of service connections within the system. The number of service connections should match the lead service line inventory. If this number does not match, the spreadsheet and software should be compared and corrected. There may be a missing account within the billing software, contributing to unbilled water consumption volumes.
4. **Leak Detection:** The system should consider a leak detection plan after installing meters for the unbilled unmetered accounts. Detection can be completed during normal operations, such as during flushing and valve exercising.

Overall, the village of West Salem is in a good baseline position, with new meters throughout the system, an implemented billing structure with software that flags anomalous amounts, and master meter calibration occurring last year. The system should improve their data validity score and water loss volumes in future water audits by implementing the various recommended strategies listed throughout the water loss control plan. Other strategies may be found by the system and implemented as well. Water audits should be completed annually by the system, with a new copy of the M36 downloaded from the AWWA's website each time. An external review of the water system should be completed every 3 years.

Continuous improvement is at the heart of a successful water loss control plan. At the current validity tier II, the system is not yet ready to set long-term goals based on the performance indicators provided. Improvement of the validity score enough to move the system into Tier III should be prioritized rather goal setting. Additional annual water audits will be required to track improvement in the validity scoring.

Appendix A – AWWA M36 Water Audit Data Sheets

Attached is a printed copy of the source data from the AWWA M36 software. A digital copy of this workbook is also provided with the water loss control plan printout.

1. Start page
2. Primary worksheet
3. Dashboard
4. Water balance
5. Loss control planning

Appendix B – Project Source Data

Additional documentation can be included in this section that was provided by the system to assist in the completion of the water audit.

1. Water Ordinance 14-03
2. Appropriation Status for 2024