

Water Use Auditing Pilot Project 2006
New Mexico Rural Water Association
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This report details the process and findings of the Water Use Audit pilot projects conducted in three New Mexico communities by New Mexico Rural Water Association in 2006.

Introduction:

In 2006, New Mexico Rural Water Association (NMRWA) was one of three Technical Assistance Providers that worked with the State of New Mexico to develop methods and manuals to assist rural drinking water systems with water use auditing, financial management, and infrastructure assets. Part of this project involved choosing three New Mexico water systems to test the methods via pilot projects. The Village of Bosque Farms in Valencia County, Ilfeld Mutual Domestic Water Consumers Association (MDWCA) in San Miguel County, and Arenas Valley MDWCA in Grant County were selected and agreed to participate in the project.

The first part of this document contains an explanation of water use auditing, details of the project implementation, key findings from the project and lessons learned by NMRWA. The second section of this document includes the water use audit reports for each of the three pilot communities.

What is Water Use Auditing?

Drinking water systems lose some amount of water for a variety of reasons. Water use auditing is a method that water system managers use to determine how to track and better manage water loss. Water loss simply refers to the difference between water produced (e.g. pumped from a well, purchased from another water system, etc.) and authorized water use (e.g. water sold for revenue or used for an authorized purpose). There are two key types of water loss that will be referred to in this report. The first is *apparent loss* and the second is *real loss*:

Apparent loss refers to water loss that occurs as inaccuracies in water flow measurement, errors in water accounting and unauthorized use. Simply put, *apparent loss* refers to water that has been used but is not accounted for properly.

Real loss includes all water that physically escapes the distribution system via leaks and overflows.

(Please note that a glossary of key water audit terms is included in the back of this document.)

There is no set standard for acceptable water system loss in the United States, but an average of 13% is common. Many systems in New Mexico have water loss ranging from 10% - 40%. For the purpose of this project, 13% is used as the benchmark for acceptable percentage of water loss. Water use auditing is an ongoing management technique that water system managers may utilize to maximize tracking and revenue of the water produced or purchased.

Water Audit Pilot Projects

During the 2006 calendar year, NMRWA worked with system managers, board members and operators to collect water use audit data in the three project areas. Each report details the key characteristics of the water system and the results of the water audit with recommendations. The Water Audit Worksheet, from the Water Use Auditing Manual, is the main tool used to analyze each system's water use. A completed Water Audit Worksheet with specific data for each community is included in each report.

NMRWA staff found that with good water system records and two days of fieldwork, the worksheet was frequently completed in less than a week. Some examples of data collection include water system well records, financial records, engineering reports and water system maps. NMRWA staff worked with water operators and board members in the field to assess meter accuracy. Analysis of the data typically took another two weeks, as the process involved an understanding of the Water Use Auditing Manual principles and some technical assistance to advise on record keeping or leak problems. NMRWA staff experience indicates that with proper records and staff support a water audit may be completed in a month.

The water use audit process was developed to utilize all quantifiable water use and loss data in order to provide a comprehensive water use audit. However, it is important to note that complete data is not necessary for a useful water audit. For instance, Arenas Valley hired an outside group to conduct a leak detection assessment of their distribution system. This information proved extremely valuable in determining which portion of their 20% water loss came from *apparent* versus *real loss*. Ilfeld and the Village of Bosque Farms did not have leak assessment data, yet the systems' data was sufficient to identify the likely causes of water loss.

Each water audit report represents a snapshot of each water system's current water use. The water use data will change over time as supply and demand vary and infrastructure ages. For this reason the NMRWA recommends conducting a new water audit annually or bi-annually to minimize water loss and maximize operations.

Pilot Projects Findings

The communities chosen for the project vary significantly in location, size and system type, yet there were some similarities in water audit results. For instance, all three systems had a good idea of their water loss amount before conducting the water audit. All three systems assumed that water loss was either due to physical leak or customer metering inaccuracies. All water systems' boards were well informed and supportive of water use auditing efforts.

In all pilot studies, water system staff found that the Water Auditing Manual process was relatively easy to understand and to implement. In all cases, the water use audit results were a clear catalyst for action. All three systems took immediate action on the water audit results ranging from master meter calibration to tracking un-billed, un-metered water use.

Arenas Valley was the only system that was actively measuring and tracking their un-billed and un-metered consumption such as fire department training use, system flushing and fire hydrant maintenance. Of the three water systems, only the Village of Bosque Farms was actively tracking their loss from storage.

Summary of Pilot Project Findings:

- Water systems were tracking their system input and water use and therefore had a good idea of water loss amount before the water audit was conducted.
- Water systems initially looked to physical leaks and customer metering inaccuracies to explain water loss. After the water audit, they also looked to authorized and unauthorized un-billed, un-metered uses to explain water loss.
- Water systems' boards were informed and supportive of water use auditing efforts to minimize water loss.
- In all pilot studies, the water audit data collection and analysis was relatively simple to conduct and took less than a month to complete.
- In all three cases, the results of the water audit led the water system to make immediate changes to minimize water loss.

Lessons Learned for Conducting Water Audits

NMRWA found that three factors must be present to insure a successful water use audit.

Water System Interest and Support:

This factor is extremely important because the water system staff and board will be asked to collect documents, make copies, be interviewed and participate in field assessments of the customer meters and the master meter. The water system board may be asked to allocate funds to contract a leak detection assessment or to pay for system updates. In all three cases the water system staff and boards were interested and committed to the water use audit process. They understood the value of the effort and were willing to spend their time to collect the data necessary for an accurate Water Audit.

A Minimum of at least One Year of Accurate and Complete System Records:

This factor cannot be overstated. An accurate water use audit cannot be conducted without one year of complete records, including water systems input, water sales and other authorized use. A twelve month record is necessary since supply and demand typically fluctuate during different times of year. Good record keeping was a key factor in choosing pilot project communities. All three systems had good records that allowed the team to measure water loss.

Technical Support for Fieldwork and Analysis

Technical support is necessary for effective data collection, analysis and recommendations. In all three cases, NMRWA provided technical support in the form of meter testing, data analysis and implementation. The technical advice of experienced NMRWA staff was useful in assessing system deficiencies and possible solutions. In some cases professional leak detection assessments may be required. Arenas Valley contracted HD Supply Waterworks, Inc. to perform a leak detection assessment. The report indicated 7 main line leaks and 16 service connection leaks. This professional assessment greatly improved the quality of the water audit and set clear actions for the Arenas Valley Board to mitigate leaks.

The following section contains the three pilot project reports with water system specific findings.

**Arenas Valley MDWCA Report
New Mexico Rural Water Association
December 2006**

Water System Characteristics

Arenas Valley Mutual Domestic Water Consumers Association (MDWCA)	WSS#: NM3523009
Unit 64, Box 8 Silver City, NM 88061	Project Contact: Gilbert Miera, Board Member Phone 505.388.446
Connections: 437	Population Served: 1,242
Sources: water purchased from Silver City	Storage Capacity: none

Water System Context and Water Audit Overview:

Arenas Valley MDWCA is a residential area located just east of Silver City, in Grant County, New Mexico. Arenas Valley purchases water from Silver City and the system has no storage or treatment capacity, only distribution lines.

The Arenas Valley manager and staff keep good records of water purchased and water sold. Careful record keeping has allowed them to track their water loss, which ranged from 18% to 24% from 2004 to 2005.

From March to November 2006, NMRWA worked with Arenas Valley on a system-wide water audit. Data sources included a leak detection assessment report performed by Hughes Supply, Inc. in May 2006, system records, interviews with the general manager and field work performed by NMRWA staff and the Arenas Valley staff.

Water Audit Findings & Recommendations:

Arenas Valley MDWCA has 20% water loss that consists of approximately 10% *real water loss* in main lines and service connections and about 10% *apparent water loss* which is a product of an inaccurate and improperly installed master meter that is misreading the amount of water delivered from Silver City.

Real Loss:

Findings:

Arenas Valley hired HD Supply Waterworks, Inc. in May 2006 to perform a leak detection assessment. Hughes identified 7 main line leaks and 16 service connection leaks, for a total *real water loss* of approximately 50,000 gallons per month.

Recommendations:

Arenas Valley worked quickly to identify and repair leaks in their main line and in service connections. Due to the age of their distribution system and physical characteristics of their region, a formal leak detection process, like the one performed by HD Supply Waterworks, Inc. may be necessary every two to three years.

Apparent Loss:

Three areas of *apparent water loss* were found in the water audit: 1) Authorized un-billed, un-metered consumption, 2) Inaccurate master meter, and 3) Unauthorized use.

1) Authorized Un-billed, Un-metered Consumption

Findings:

Arenas Valley has three types of authorized un-billed, un-metered consumption including water used by the fire department for training, water used by the water association to exercise hydrants, and water used or lost during standard water system operations. The amount used is estimated but not metered.

Recommendations:

Consider installing meters to track authorized un-billed, un-metered consumption. Consider charging fire and emergency organizations a flat annual fee for a set amount of water used for training.

2) Inaccurate Master meter

Findings:

An Ultrasonic Clamp-on Master Meter Tester was used by NMRWA staff to test the Arenas Valley MDWCA Master Meter in Fall 2006. In a one hour test, the meter was registering 3.1% higher than Silver City's master meter. At low flow, the meter measured 0-60 gallons per minute (gpm) for a period of 45 minutes. At high flow, the meter measured 175-375 gpm for a period of 15 minutes. Due to the location of the meters at a high elevation, a very low flow measured no flow, even when the Ultrasonic Tester was measuring 20 gpm. Overall, it was found that the Arenas Valley Master Meter is misreading water flow as high as 7-9% on a regular basis and not registering low flow (under 20 gpm).

Additionally, it was found that the Arenas Valley and Silver City master meters were located too close together at a distance of 15ft. creating a level of turbidity between meters that causes the master meters to misread water quantity.

Finally, Silver City is lacking a back flow device. The result is that water backflows toward Silver City and is measured as a "credit" on the Silver City master meter.

Recommendations:

It is recommended that Arenas Valley recalibrate the existing master meter or replace it entirely. It is also recommended that a backflow device be installed on the Silver City side of the operation and that Arenas Valley and Silver City consider reinstalling the meters to allow proper distance between the two. Finally, it is recommended that Arenas Valley and Silver City schedule an annual test of both master meters to ensure accuracy.

3) Unauthorized use

Findings:

Arenas Valley staff believes that two or more households may have illegally tapped into the water system and are stealing water.

Recommendations:

Install more valves within the distribution system to better track water use in each area. Arenas Valley should disconnect non-paying users as soon as possible, utilizing local authorities if necessary.

Conclusion and Lessons Learned:

Although Arenas Valley MDWCA had water loss of 20% or higher, their excellent records and ongoing maintenance of meters and distribution lines, allowed for a thorough water audit. Managers and operators of Arenas Valley have the support of their board, which allowed them to put system money towards professional leak detection. Arenas Valley staff has taken steps to eliminate leaks, identify non-paying water users and replacing older customer meters. In the next year, they plan to address master meter problems.

Water Audit Worksheet: Arenas Valley MDWCA		
		gallons per month
System Input		3,300,000
Billed Metered Consumption		2,600,000
Billed Un-metered Consumption	plus	0
Revenue Water	equals	2,600,000
System Input		3,300,000
Revenue Water	minus	2,600,000
Non-revenue Water	equals	700,000
Un-billed Metered consumption		1,680
Un-billed Un-metered consumption	plus	66,627
Un-billed Authorized consumption	equals	68,307
Un-billed Authorized Consumption		68,307
Revenue Water	plus	2,600,000
Authorized Consumption	equals	2,668,307
System Input		3,300,000
Authorized Consumption	minus	2,668,307
Water Losses	equals	631,693
Unauthorized Use		10,947
Customer Metering Inaccuracies	plus	0
Apparent Losses	equals	10,947
Water Losses		631,693
Apparent Losses	minus	10,947
Real Losses	equals	620,746
Field Verification		
Leakage on Mains & Service Connections		49,320
Field Data of Real Water Losses		49,320
Real Losses		620,746
System Input	divide	3,300,000
Percentage of Real Water Losses	equals	19%
Non-revenue Water		700,000
System Input	divide	3,300,000
Percentage of Non-revenue Water	equals	21%
Real Losses in Gallons per Day		20,692
Number of Connections	divide	437
Real Loss in Gallons/Connection/Day	equals	47

Bosque Farms Water Audit 2006
New Mexico Rural Water Association
December 2006

Water System Characteristics

Village of Bosque Farms	WSS#: 3510732
PO Box 660, Bosque Farms, NM 87042	Project Contact: Cliff Hibdon, Operations Supervisor Phone 505.869.3430
Connections: 1411(1320 residential and 91 commercial)	Population Served: 6,000
Sources: two active wells	Storage Capacity: two tanks 1= 1 million gallons 2= 2.5 million gallons

Water System Context and Water Audit Overview:

Bosque Farms is growing community of 6,000 that is located 8 miles South of Albuquerque on Highway 47 in Valencia County, New Mexico. The Village of Bosque Farms has two active wells and two storage tanks.

The Village of Bosque Farms staff has detailed records and they have been tracking their water loss at about 8% annually.

From March to November 2006, NMRWA worked with The Village Bosque Farms on a system-wide water audit. Data sources included system input and water billing data collected by the Village of Bosque farms from 2003 to 2005, interviews with the Operations Supervisor and field work performed by NMRWA staff and the Village of Bosque Farms staff in October 2006.

Water Audit Findings & Recommendations:

The Village of Bosque Farms water system was built in 1988 and the distribution system and storage tanks are in excellent condition. The system's 8% water loss can be attributed to customer metering inaccuracies, storage tank leakage and authorized un-billed, un-metered consumption. Customer metering inaccuracies constitute 0.4% of water loss, storage tank loss constitutes 2.64%. The remaining 4.95% is likely to be unidentified leaks at service connections or within the distribution system and/or authorized un-billed, un-metered consumption used for training emergency professionals.

Real Loss:

Findings:

The Village of Bosque Farms carefully tracks their *real water loss* at their storage tanks. They estimate water loss due to storage overflow to be around 8%, or around 280,000 gallons monthly. Bosque Farm's Operations Supervisor has not identified any leaks within the distribution system or at service connections.

Recommendations:

As their system ages, the Village of Bosque Farms may want to conduct a leak detection assessment to determine the exact points of loss within their system. It is important to note that 8% total loss is low in comparison to national standards. At this point no action is needed to mitigate *real losses*.

Apparent Loss:

Two areas of *apparent water loss* were found in the water audit: 1) Customer metering inaccuracies, and 2) Authorized un-billed, un-metered consumption. During this water audit distribution system leak assessment, service connection leaks and master meter testing were not conducted due to the low overall water loss and the age of the system.

1) Customer Metering Inaccuracy

Findings:

In Fall 2006, NMRWA and Bosque Farm staff tested eight of the 1320 residential meters for accuracy. The oldest meters at the Village of Bosque farms were installed in 1988, the newest were installed in 1994. Five meters installed in 1988 or 1989 were tested and 3 meters installed in 1994 were tested. The results were averaged to determine total water loss resulting from customer metering inaccuracies. The results indicated that on average homes were losing up to 0.71 gallons per meter per day for a total of 42,857 gallons lost per month to customer metering inaccuracy. This represents 0.4% of total water loss in the Village of Bosque Farms. In all cases, the meters measured slightly less water than was delivered, favoring the customer.

Recommendations:

The Village of Bosque Farm's residential meters are performing within an acceptable range. Bosque Farms already has a preventative maintenance program to track and replace customer meters that are 10 years or older on a rotating schedule. To date, lack of funding has hindered efforts to replace older meters.

2) Authorized, Un-billed, Un-metered Consumption

Findings:

The Village of Bosque Farms provides water for training purposes to the fire department. They also do not currently account for water used in system maintenance such as exercising fire hydrants.

Recommendations:

Bosque Farms should consider metering training and maintenance water use that constitutes authorized and un-billed services in order to better track consumption.

Conclusion and Lessons Learned:

The Village of Bosque Farms has very low water loss (8%). Bosque Farms managers have plans to seek funding to replace older customer water meters and they may choose to meter authorized unbilled water use in the future. Both of these steps would help the Operations Supervisor account for additional *apparent water loss*. It was relatively simple to conduct a thorough water audit at the Village Bosque Farms primarily because the water system is less than 20 years old, the staff practice good preventative maintenance, and have detailed records.

Water Audit Worksheet: Village of Bosque Farms		(gallons per month)
System Input		123,051,667
Billed Metered Consumption		112,464,495
Billed Un-metered Consumption	Plus	0
Revenue Water	Equals	112,464,495
System Input		123,051,667
Revenue Water	Minus	112,464,495
Non-revenue Water	Equals	10,587,172
Un-billed Metered consumption		0
Un-billed Un-metered consumption	Plus	0
Un billed Authorized consumption	Equals	0
Un-billed Authorized Consumption		0
Revenue Water	Plus	112,464,495
Authorized Consumption	Equals	112,464,495
System Input		123,051,667
Authorized Consumption	Minus	112,464,495
Water Losses	Equals	10,587,172
Un-authorized Use		0
Customer Metering inaccuracies	Plus	42,857
Apparent Losses	Equals	42,857
Water Losses		10,587,172
Apparent Losses	Minus	42,857
Real Losses	Equals	10,544,315
Field Testing		
Leakage on service connections and Mains		0
Overflows on Storages	Plus	280,000
Field Data of Real Losses	Equals	280,000
Real Losses		10,544,315
System Input	Divide	123,051,667
Percentage of Real Water Losses	Equals	8.57%
Non-revenue Water		10,587,172
System Input	Divide	123,051,667
Percentage of Non-revenue Water	Equals	8.60%
Real Losses in Gallons per Day		351,477
Number of Connections	Divide	2,000
Real Loss in Gallons/Connection/Day	Equals	176

Ifeld MDWCA Report
New Mexico Rural Water Association
December 2006

Water System Characteristics

Ifeld Mutual Domestic Water Consumers Association (MDWCA)	WSS#: NM3500125
PO Box 4966, Santa Fe, NM 87507	Project Contact: Rick Konersman, Board Member Phone 505.421.0483
Connections: 99	Population Served: 225
Sources: 2 active Wells	Storage Capacity: 25,000 gallons

Water System Context and Water Audit Overview:

Ifeld is rural community located approximately 45 miles north of Santa Fe, in San Miguel County, New Mexico. Ifeld has two active wells. The water system serves 99 homes and is at current supply capacity in terms of both water rights and well production.

The Ifeld bookkeeper and water operator have detailed records. This careful record keeping has allowed the water system to track their water loss, which is around 10%.

From March to November 2006, NMRWA worked with Ifeld MDWCA on a system-wide Water Audit. Data sources included a 2004 preliminary engineering report by Serafina Technical Consulting and on-site data collection performed in 2006 by a team of NMRWA staff, Ifeld board members and the system water operator.

Water Audit Findings & Recommendations:

Approximately 6%, or 2040 gallons per month (gpm), of Ifeld's water loss can be attributed to customer metering and master meter inaccuracies. This suggests that the remaining 94%, or 31,900 gpm, water loss may be due to service connection leaks, main line leaks and storage tank overflow.

Real Loss:

Findings:

Leak detection was not performed on the distribution system, storage or service connections at Ifeld MDWCA due to cost. Since 6% of water loss was accounted for through *apparent loss*, it is likely that the remaining 94% or 31,900 gpm of water loss is occurring as *real loss*.

Recommendations:

In the future, Ifeld may want to conduct a leak detection assessment to determine the exact points of loss within their system. It is important to note that 10% total loss is low by national standards. Ifeld should consider conducting a leak detection assessment when their total water loss exceeds 13%.

Apparent Loss:

Two areas of *apparent water loss* were found in the water audit: 1) Master meter inaccuracy, and 2) Customer metering inaccuracies. The apparent loss identified in the Water Audit accounted for about 14% of total water loss.

1) Master meter inaccuracy**Findings:**

An Ultrasonic Clamp-on Master Meter Tester was used by NMRWA staff to test the Ifeld MDWCA master meter in Fall 2006. In a one hour test, the Ifeld master meter read approximately 0.5% higher than the test meter. Over a year's time, this meter inaccuracy could account for about 3000 gallons per month or approximately 36,000 gallons per year.

Recommendations:

The water audit suggests that the Ifeld master meter should be tested, and recalibrated if necessary, every few years to ensure accuracy. It is important to note that master meter testing is not precise and that a 5% margin is considered acceptable.

2) Customer Metering Inaccuracy**Findings:**

In Fall 2006, NMRWA and Ifeld staff tested five of the 99 customer meters for accuracy. They found that, on average, homes were losing up to .68 gallons per meter per day for a total of 2040 gallons lost per month to metering inaccuracy. In all cases, the meters measured slightly less water than was delivered, favoring the customer.

Recommendations:

Residential meters at Ifeld are performing within an acceptable range. It is recommended that Ifeld establish a program to track and replace customer meters that are 10 years or older on a rotating schedule.

Conclusion and Lessons Learned:

Overall, Ifeld has low water loss, approximately 11%. In the preliminary engineering report performed in 2004, several system improvements were recommended including replacing old distribution lines, storage tanks and non-functioning valves. When these system improvements are implemented, the Ifeld MDWCA should consider building a leak detection assessment into the project. Additionally, Ifeld MDWCA should continue to keep detailed system records and may want to consider implementing a preventative maintenance plan. Ifeld MDWCA's record keeping allowed for a good preliminary water audit, which should inform their water system's future planning efforts.

Water Audit Worksheet: Ilfeld MDWCA		
		gallons per month
System Input		315,958
Billed Metered Consumption		282,018
Billed Un-metered consumption	plus	0
Revenue Water	equals	282,018
System Input		315,958
Revenue Water	minus	282,018
Non-revenue Water	equals	33,940
Un-billed Metered consumption		0
Un-billed Un-metered consumption	plus	0
Un-billed Authorized consumption	equals	0
Un-billed Authorized Consumption		0
Revenue Water	plus	282,018
Authorized Consumption	equals	282,018
System Input		315,958
Authorized Consumption	minus	282,018
Water Losses	equals	33,940
Unauthorized Use		0
Customer Metering inaccuracies	plus	2,040
Apparent Losses	equals	2,040
Water Losses		33,940
Apparent Losses	minus	2,040
Real Losses	equals	31,900
Leakage on Mains and Service Connections		0
Storage Tank Overflows	plus	0
Field Data of Real Water Losses	equals	0
Real Losses		31,900
System Input	divide	315,958
Percentage of Real Water Losses	equals	10%
Non-revenue Water		33,940
System Input	divide	315,958
Percentage of Nonrevenue Water	equals	11%
Real Losses in Gallons per Day		1,063
Number of Connections	divide	99
Real Loss in Gallons/Connection/Day	equals	11

Glossary

Apparent Losses	Water loss that occurs as inaccuracies in water flow measurement, errors in water accounting, and unauthorized usage. Apparent losses consist of water that is delivered to an end use, including unauthorized use, but is not properly measured or recorded. The marginal cost of apparent losses occurs at the rate charged to the utility's customers
Master Meter	Meters that measure water production at the source or sources of a utility. Accurate master meter readings are the only reliable way to determine how much water the utility is using.
Real Losses	Water that physically escapes the distribution system, including leakage and overflows prior to the point of end use. Real Losses typically account for a greater volume of water lost by utilities in comparison to apparent losses. The marginal cost of <i>real water loss</i> occurs at the cost of production – the expenses associated with extraction, treatment, delivery, operations & maintenance.
System Input	The measure of water entering a utility from all sources.
Unaccounted-for Water	see “water loss”
Water Use Audit	Water use audits provide a rational, scientific framework that categorizes all water use in a utility. A water use audit determines where water goes and how much water is used. Water use auditing is an ongoing process.
Water Loss	The difference between system input and authorized consumption. Water losses are comprised of <i>apparent loss and real loss</i> .

Sources

1. *Water Use Auditing: A Guide to Accurately Measure Water Use and Water Loss*, New Mexico Rural Water Association, 2006.
2. U.S. Geological Survey, *Estimated Use of Water in the United States in 1995*, USGS Circular 1200, 1998.